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Rapra Review Reports

Bonding Elastomers: A Review of Adhesives and Processes

G. Polaski, J. Means, B. Stull, P. Warren, K. Allen, D. Mowrey and B. Carney

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Expert overviews covering the science and technology of rubber and plastics

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Macromolecules
33, No.6, 21st March 2000, p.2171-83

Title → **EFFECT OF THERMAL HISTORY ON THE RHEOLOGICAL BEHAVIOR OF THERMOPLASTIC POLYURETHANES**

Pil Joong Yoon; Chang Dae Han ← Authors and affiliation
Akron,University

The effect of thermal history on the rheological behaviour of ester- and ether-based commercial thermoplastic PUs (Estane 5701, 5707 and 5714 from B.F.Goodrich) was investigated. It was found that the injection moulding temp. used for specimen preparation had a marked effect on the variations of dynamic storage and loss moduli of specimens with time observed during isothermal annealing. Analysis of FTIR spectra indicated that variations in hydrogen bonding with time during isothermal annealing very much resembled variations of dynamic storage modulus with time during isothermal annealing. Isochronal dynamic temp. sweep experiments indicated that the thermoplastic PUs exhibited a hysteresis effect in the heating and cooling processes. It was concluded that the microphase separation transition or order-disorder transition in thermoplastic PUs could not be determined from the isochronal dynamic temp. sweep experiment. The plots of log dynamic storage modulus versus log loss modulus varied with temp. over the entire range of temps. (110-190C) investigated. 57 refs. ← Abstract

GOODRICH B.F. ← Companies or organisations mentioned
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Bonding Elastomers: A Review of Adhesives and Processes

G. Polaski, J. Means, B. Stull, P. Warren, K. Allen, D. Mowrey and B. Carney
(Lord Corporation)

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Contents

1 Foreword

The topics included in this review have been written by experts in rubber-to-metal bonding. These contributions are based on years of service working closely with end-use customers. It is meant as a practical approach to bonding various kinds of elastomers to substrates such as steel and plastics, as used in the manufacture of diverse products. These products include rubber covered rolls, urethane fork lift wheels, rubber lining for chemical storage or solid rocket motors (**Figure 1**), engine bushes and mounts, seals for transmissions, electrical power connectors and military tank track pads.

2 Introduction

There are over 20 kinds of elastomeric polymers each having unique physical and chemical resistance characteristics. For example, natural rubber (NR) has good vibration dampening properties, acrylonitrile-butadiene rubber (NBR) has good oil resistance, fluoroelastomers (FKM) have good chemical and heat resistance, and silicones have good low temperature properties. Through compounding, a given elastomer's performance can be enhanced but no single elastomer can be compounded to meet all applications. In the same manner, no single adhesive can provide the needed levels of adhesion and environmental resistance to all polymers. Even when bonding a particular elastomer, the adhesive of choice can vary depending upon the compounding of the rubber including the cure system, the environmental application of the bonded assembly, the substrate to which the rubber is going to be bonded (e.g., metal, plastic, textile, other elastomers) the moulding method (e.g., press, autoclave, extrusion) and the geometry of the part. Other factors affecting adhesive selection might include colour, conductivity, and means of application.

Thus the selection of an adhesive might seem overwhelming to the beginning technologist, however selector guides (e.g., www.chemlok.com), technical sales and service representatives, and this publication can be used to help find a suitable adhesive.

2.1 The Process

Adhesives for bonding of rubber in the vulcanisation process are of a paint-like consistency. They consist of a one-, two-, or three-coat system. The majority of adhesives used today employ a primer on the substrate to be bonded, followed by a topcoat adhesive. These are generally applied by brush, spray or dipping processes and are applied at a specified dry film thickness. The coated substrate is placed in a mould and mated with uncured rubber in a heated press. The rubber is then vulcanised usually in a range of 150-200 °C. The time will be dependent upon the mass of the article being moulded and the cure rate of the specific elastomer. The bonding between the rubber and the adhesive coated substrate takes place during this vulcanisation process.

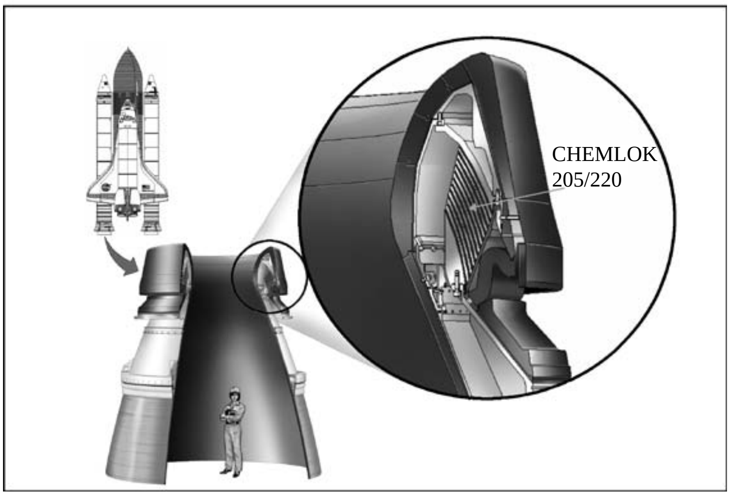


Figure 1

Adhesive use in aerospace application

Figure reproduced with permission from ATK Thiokol Propulsion

2.2 Primers

A primer is generally of a different colour than the topcoat so as to distinguish it from the adhesive. Traditionally the primer is grey and the topcoat black but there are other colour combinations. Primers consist of polymers and resins that promote adhesion not only to the substrate but also to the topcoat adhesive. The primer must cure (e.g., become a thermoset) during the vulcanisation process in order to provide resistance to a variety of environments such as water, hot oils, acids, bases, drilling fluids, salt spray, heat and combinations of these fluids. Primers may contain metal oxides, carbon black and other fillers. These materials aid in bonding and flow control.

Primers bond to metal surfaces via chemisorption, forming true chemical bonds with the metal or a treatment on the metal such as a phosphate treatment on steel or a chromate treatment on aluminium.

2.3 Adhesives

Topcoat adhesives are generally designed to bond a certain type of elastomer or a range of elastomers. They consist of a polymer that acts as a carrier and film former for the specific bonding agent. This bonding agent forms crosslinks with the adhesive polymer matrix and also with the elastomer backbone. The adhesive must bond to the primer as well as to the elastomer. Like the primer, it must cure or crosslink within itself during the vulcanisation cycle in order to provide environmental resistance. These types of adhesives generally require 135 °C activation temperature. The adhesive/primer combination cures and bonds rapidly so that when the part is finished being moulded, a high strength is obtained. Upon testing of a moulded part, the bond will be stronger than the cohesive strength of the rubber.

Some adhesives are self-priming. These are called one-coat adhesives and function in the same way as a two-coat system. Proper dry film thickness must be obtained to ensure adequate adhesion to both the rubber and the substrate.

Some adhesives do not contain fillers and added bonding agents. They function in a different manner, their polymer make-up being such that it can chemically react with the backbone of the polymer being bonded either by direct chemical substitution in the elastomer backbone or via free radical addition reactions. These types of adhesives are often based upon silane chemistry. They are applied as dilute solutions and as very thin films. Generally the film thickness is so thin as to not be able to be measured by electronic or magnetic film thickness gauges.

Some adhesives do not contain a specific bonding agent and rely more on diffusion of the ingredients into the rubber matrix with subsequent curing into the backbone of the polymer. These adhesives will bond to rubber at low temperatures such as 100 °C. Generally it takes many hours or even days to cure the rubber.

Thus the process of bonding is quite complex and involves various kinetic reactions, which have not been totally defined but seemingly are a combination of diffusion, chemisorption and inter/intra-crosslinking (**Figure 2**).

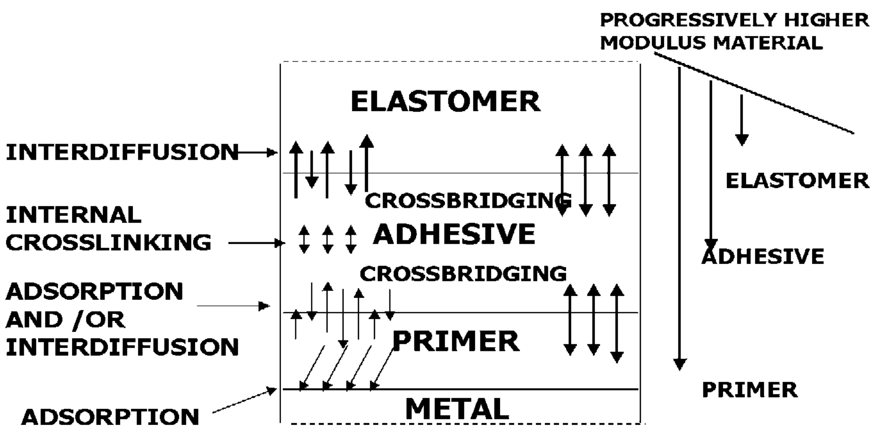


Figure 2

Interfacial dynamics of a rubber-to-metal bond

2.4 Environmental Concerns

Adhesives for rubber-to-metal bonding were first developed using solvents such as alcohols, ketones, halogenated solvents and aromatic solvents. These solvents allow viscosities to be obtained in the range suitable for brush applying and then can be readily diluted for dipping or spraying applications.

To meet government volatile emission standards (i.e., volatile organic compound (VOC)), some companies have installed incinerators to convert the solvents into acceptable emissions. However, many adhesives contain chlorinated solvents for controlling evaporation rate and rheology. When chlorinated solvents are incinerated, the potential exists for converting them to acids such as hydrochloric acid (HCl) which can damage the incinerator. Therefore the adhesive manufacturers have had to remove the chlorinated solvents and replace them with an aromatic such as xylene. For example, CHEMLOK 220X is a xylene based version of CHEMLOK 220 which contains halogenated solvents.

Additionally, some solvent-based adhesives contain lead compounds or other heavy metals. Because of concerns regarding waste disposal of dried adhesive such as from spray booth filters, new versions with non-heavy metal replacements have been developed. For example, heavy metal containing CHEMLOK 220 can be replaced with environmentally preferred CHEMLOK adhesives (EPCA) CHEMLOK 6220.

Adhesives are now available that do not use solvent as the carrier nor do they contain any heavy metals. These aqueous based adhesives have proven themselves in the market place and provide the same robust adhesion as the solvent systems: see the section on aqueous based adhesives and environmentally preferred adhesives.

3 Adhesive Application

3.1 Surface Preparation

There have been many publications on bonding that discuss the preparation of substrates. They all stress the fact that a clean surface is paramount to achieving a good bond. Laboratory experimentation shows that good primary adhesion may be obtained to rusty metal, however, when a part is subjected to an environment such as water or salt spray, the bond will fail in a short time. There are 3 basic metal preparations used today.

The first is mechanical preparation. Here the metal surface to be bonded is blasted with iron oxide grit that is angular as opposed to round shot. Blasting consists of impinging abrasive particles against the metal surface with an air stream. The duration of the blast, the shape and size of the blasting media, the particle velocity, and the hardness, porosity and other properties of the metal, determine the surface profile. Using grit is preferred over using shot because grit produces a rough, open surface, while shot peens the surface and sometimes causes occlusion with loose particles. The grit size most commonly used is G-40. The air used in blasting should be free of oil and water. Once blasted, the parts need to be degreased.

For many years, chlorinated solvents were used for vapour degreasing. However today, alkaline (hot detergent) baths are common. Some equipment is much like a dishwasher in that the parts to be degreased are washed with hot detergent followed by a hot rinse. The oils are then skimmed off the water for proper disposal.

Limited studies show that a high blast profile is not necessarily better than a low profile. Sometimes high profiles can leave ‘hackles’ that will trap solvent or break off and be the locus of a failure. Profiles of 15-25 microns are adequate. Aluminium oxide is used for aluminium substrates as well as stainless steel. Sand blasting is rarely done due to silicosis concerns. It is important that a clean fresh surface is available.

The second type of surface preparation for metals is phosphatising. The use of metallic phosphates for metal protection dates back to the Roman Empire. Rust-free household items have been found in remarkable condition in Germany from the 3rd Century. Some form of phosphatising is used on many items being adhered to rubber, particularly where the rubber will not coat the entire part and rust inhibition is desired.

The process is cumbersome in that many chemical holding tanks are needed for hot alkaline cleaning, rinsing and phosphatising. The more phosphate that is deposited on the metal surface, the more environmental protection can be expected. However, for dynamic parts such as engine mounts and bushes, the phosphate used as part of the bonding process can fail cohesively while under load. For this reason, film weights of 2200-4200 mg/m^2 are suggested. Also, the use of a calcium modified zinc phosphate is recommended as it results in finer crystal size or so-called ‘amorphous’ character. Seals for engine sealing (e.g., transmission seals) generally use lower phosphate coating weights not because of any dynamic considerations but because they will be immersed in oils and other fluids and do not need the type of environmental resistance (e.g., salt spray) that an exposed automotive underbody part might need. In many instances, sealers are used in the phosphate treatment to render the salts insoluble. It is known that sometimes a sealer may make the surface difficult to bond and a different adhesive system may be required. Iron phosphate is also used and does not present any problems in bonding as long as the film weights are kept low as noted above.

Other chemical treatments for corrosion are sometimes employed. While electrogalvanised steel is easy to bond, hot-dipped galvanised is extremely difficult. The 'spangled' metal surface usually has to be mechanically removed or sometimes if a primer is baked on prior to adhesive coating, good adhesion can be achieved.

For aluminium, various chromate treatments are applied or it is anodised. Generally these are bondable but each treatment should be tested on its own since there are so many types.

A third and newer technology for metal preparation is deposition coatings. 'E-Coat' is an electrodeposition epoxy coating that is applied to engine mounts for enhanced corrosion resistance. It is applied at a 25 micron thickness and works well with deeply recessed areas. The electrolytic deposition is done over phosphated metals and baked between 100-200 °C depending upon the system. This bake is very important and if not done correctly, can result in a bond failure that is cohesive within the coating. Adhesion to such coating does not appear to be difficult.

A newer deposition coating has emerged that is based upon phenolic chemistry. This treatment, MetalJacket® (Lord Corporation) is an autodeposition coating. It deposits on metal immersed in the solution coating and is self limiting in terms of the amount deposited. Adhesives bond well to this coating and provide outstanding salt spray corrosion resistance, eliminating the need for post painting.

3.2 Adhesive Selection

Adhesive selection is primarily based upon the type of rubber being bonded. **Table 1** shows a limited adhesive selector guide for Lord Corporation products based on the type of rubber. However, sometimes the type of substrate will also be a factor. For example, when bonding an SBR type of elastomer, a metal primer might be suitable whereas if the same SBR were to be bonded to a polyester textile, then a one-coat adhesive. If it were being bonded to a nylon type plastic, then another type might be suitable. Adhesive suppliers have selector guides available.

Table 1 Adhesive selector guide based on the type of elastomer to be bonded to metal

Elastomer	Primer	Adhesive
Natural rubber	CHEMLOK 205	CHEMLOK 220 CHEMLOK 252X CHEMLOK 6100
	CHEMLOK 8007	CHEMLOK 8560S
Butyl & EPDM types	CHEMLOK 205	CHEMLOK 252X CHEMLOK 6100
Fluoroelastomers		CHEMLOK 5150 CHEMLOK 8116
Nitrile types		CHEMLOK 252X CHEMLOK 6100 CHEMLOK 8110
Silicones		CHEMLOK 608 CHEMLOK 8116

Note: 'X' denotes all xylene system, '6000 series' denotes EPCA types, '8000 series' denotes aqueous

3.3 Adhesive Preparation

Many adhesives contain fillers, pigments and bonding agents that are solids dispersed into the solvent/polymer solution (or in an emulsified polymer in the case of aqueous adhesives). These materials settle to varying degrees requiring the product to be well stirred prior to application. If the ingredients are not well mixed, bond failures can result since the bonding agent may not be present in sufficient amount after the adhesive is applied. If diluted for dipping or spraying, the solids can settle even faster and for these cases, constant agitation might be required. Care must be taken in spray lines that the adhesive does not settle in the delivery hoses. Some adhesives are solutions (no dispersed materials) and do not require mixing. Aqueous adhesives likewise contain solids that can settle out. Slow agitation is suggested so as not to cause foaming.

For small containers hand mixing is adequate, but for larger size containers an air-powered mixer is suggested. **Figure 3** illustrates an air driven motor attached to a shaft in a drum of adhesive. The shaft has blades attached to it near the bottom. After breaking the solids loose using a hand crank in a back and forth motion, the air mixer is run for about 8 hours at 40-60 rpm prior to any of the adhesive being removed.

Figure 3

Air mixer on a drum

For spraying or dipping the adhesive may have to be diluted. In some special cases, the adhesives must be diluted independent of the application procedure in order to minimise any buildup of the adhesive. The technical literature on each product should be consulted to determine the proper diluents to use and to determine what amount to add in order to achieve the necessary viscosity for proper application.

3.4 Adhesive Application

The method selected for application of a primer and adhesive usually depends upon the shape of the part and how many parts are to be coated in a given time period. For example, in the seal industry, they coat hundreds of small metal rings at one time, sometimes for three shifts a day. However, for a large earthquake bearing pad or the inside of a solid rocket booster motor for the space shuttle program, only a few parts a week at most might be coated. **Table 2** lists the main methods of adhesive application.

3.5 Film Thickness

The most important part of adhesive application is applying the correct amount of adhesive. Insufficient film thickness will cause bond failures and have poor environmental resistance. Excess film thickness can cause runs/tears in the film, which in turn entraps solvent resulting in a bond failure.

Table 2 Common methods of adhesive application

Method	Examples
Brush	Wheels for fork-lifts, blow-out preventors, bridge bearing pads, rubber rolls
Roller	Tank lining, large flat plates
Dip	
Tumble	Automotive seals
Straight (hand, conveyor)	Railroad car seals, engine mounts, railroad track fasteners, bushings, engine gaskets
Screw-auger	Automotive seals
Dip-spin	Non-flat parts such as automotive engine mounts
Spray	
Hand spray	Limited runs of medium/large size parts
Automatic spray	Solid rocket motors
Chain-on-edge	Automotive bushings
Tumble spray	Automotive seals
Coil coating	Automotive weatherstrip
Flow coating	Inside of pipes such as drilling stators

Primers are generally applied in the range of 5-10 microns (0.2-0.4 mils) dry. The topcoat adhesive is applied 15-25 microns (0.5-1.0 mils) dry. One-coat adhesives are applied around 25 microns (1 mil) dry.

When bonding speciality elastomers such as silicones and fluoroelastomers, speciality adhesives are used. Usually they are one-coat adhesives and are applied as very thin films, less than 1 micron.

3.6 Drying

For aqueous adhesives, the inserts to be bonded usually have to be pre-heated to 50-65 °C prior to applying the primer as well as the adhesive. This is required to dry the film from 'inside-out' and to increase the ability for the adhesive to wet the surface.

With the use of automatic equipment such as mobile spray lines or moving dip lines, post heating is done to speed the process of drying. The temperature and the line speed must be co-ordinated. Most drying is done in the range of 65-100 °C.

If the adhesive is exposed to temperatures greater than 120 °C prior to bonding, there is a risk of pre-reacting the adhesive. If this happens, a bond failure will most likely occur between the rubber and the adhesive.

Most heating is done with gas-fired ovens. The use of infrared heat lamps is not suggested due to the extreme temperatures that the filament can reach and hence radiate that heat to the black adhesive.

3.7 Storage

After coating, the parts may be stored for a time depending upon the adhesive type. Most general purpose bonding agents can be stored for up to 30 days while certain speciality adhesives may be limited to less than three days. The supplier's product literature should be consulted and confirmed by practical experience. In many instances, the latter type of adhesives are applied by custom coaters and shipped to the company doing the bonding. The adhesive coated parts are generally protected by the use of desiccants in the container with the parts.

4 Moulding

4.1 Methods of Mould Bonding

Once the type of rubber has been selected and compounded for a particular use, and the adhesive is selected and coated on the substrate to be bonded, they are combined in a mould with heat and pressure to manufacture the desired part (see **Figures 4-6**). While most moulding is done between 150 °C and 200 °C, there are applications where the curing/bonding temperatures are much lower such as at 100 °C for cast urethane bonding (see section on Bonding Urethanes) and for rubber lining (see section on Rubber Lining). These types of adhesives have a different chemistry than those used for general purpose rubber bonding which allow them to cure and bond at the lower temperatures. Curing at lower temperatures generally takes a relatively longer time (e.g., hours) than mould bonding (minutes). Thus, the adhesives that cure at lower temperatures normally do not work well at the higher temperature/faster cycle times.

Table 3 shows the various methods of bonding.

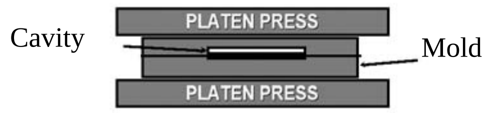


Figure 4

Compression mould bonding

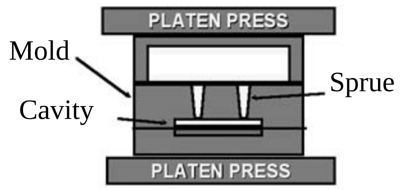


Figure 5

Transfer mould bonding

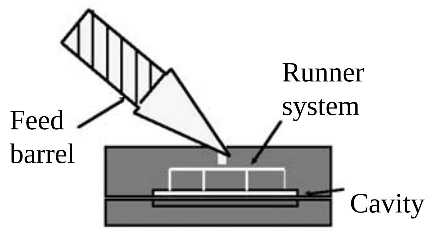


Figure 6

Injection mould bonding

Table 3 Common methods of mould bonding	
Method	**Examples**
Compression (**Figure 4**)	Automotive seals, large components
Transfer (**Figure 5**)	Bushings, engine mounts
Injection (**Figure 6**)	Engine mounts
Autoclave	Rubber rolls, rubber lined pipes
Extrusion	Supported weatherstrip, wire and cable
Pressureless steam	Rubber lining of railroad tank cars

Each method has its advantages and disadvantages such as initial cost, handling, compounding and physical preparation of the rubber, waste (e.g., flash) and retention of the physical dimension of the part.

When loading multi-cavity moulds, loading boards are often used. The parts are all preloaded into a fixture and when the mould is ready for the inserts, the fixture is placed over the mould. A release mechanism allows all the parts to fall into place for each cavity at one time. These 'speed loaders' prevent the adhesive coated parts from pre-baking which might occur if the cavities were loaded one at time and the first inserts reach activation temperature (usually around 135 °C).

4.2 Sweeping (Flow)

Because of the mould design, some adhesives might be prone to 'sweeping' which is sometimes referred to as flowing or wiping. As the rubber flows over the adhesive coated part, it causes the adhesive to spread out or be pushed in one direction. This can result in a poorly bonded part. Changing adhesives or perhaps doing a mild pre-bake of the primer and/or adhesive may help 'set' the adhesive and make it more resistant. Changing the mould design might be required (**Figure 7**).

4.3 Pre-bake Resistance

If a coated insert is left sitting in a hot mould cavity too long prior to coming into contact with the elastomer to be bonded, the adhesive may pre-react. Different adhesives give different amounts of pre-bake resistance. The type of stock being bonded also affects the degree of pre-bake resistance. Most adhesives will give at least 5 minutes of pre-bake resistance at 160 °C. Generally this is enough time to load all the inserts and to begin moulding. Higher temperatures can reduce the pre-bake resistance.

4.4 Mould Release

Mould releases are used on moulds to allow the rubber to release after moulding preventing the rubber from getting surface blemishes or even tearing. Adhesive coated parts that are either in the mould cavities or sitting in a bin near the press, should not be allowed to come into contact with the mould release. Part bins should be covered in case air currents carry the mould release onto the parts. Silicone mould releases should not be used and if they are being used even in another part of the plant, they can possibly get circulated throughout due to air currents.

4.5 Demoulding

Care should be taken when removing bonded parts after moulding. Some adhesives have poor hot tear resistance and a bond failure can occur during demoulding.

In most instances, bonded parts will have excess rubber (i.e., flash) on them after moulding. This flash is sometimes removed via cryogenic deflashing (e.g., –32 ºC) or just by tumbling them in a barrel with some ceramic media. If parts fail during cryogenic deflashing, then the time of exposure needs to be reduced.

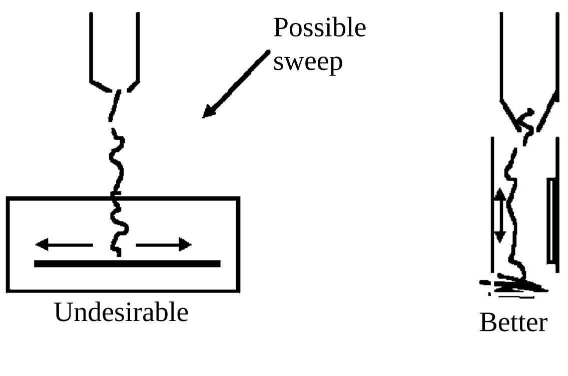


Figure 7

Mould design

5 Environmentally Preferred Adhesives

On September 18, 2000 the Directive 2000/53/EC on End-of-Life Vehicles became effective. The main aspect of this directive is to reduce waste that is annually generated from vehicles disposed of within the European Union. Upon disposal of a vehicle as much as 25% of the vehicle's weight (shredding residue) is hazardous waste such as polychlorinated biphenyls (PCBs) heavy metals, and hazardous fluids. These hazardous components are released to the environment through landfill dumping. They account for 10% of the total amount of hazardous waste that is generated annually in the European Union.

One of the main features of the European Directive involves the elimination of heavy metals from all vehicles put on the market after July 1, 2003. Any suppliers of components and finished vehicles must comply with this in order to continue to supply parts or vehicles to the European Union.

In the United States, the Environmental Protection Agency (EPA) announced a change (January of 2001) in its Toxics Release Inventory (TRI) with specific concerns for lead and lead compounds. The specifics of the new rule will require more stringent reporting of environmental releases of lead under the EPA's public right-to-know program. TRI is part of this program. The major change in this rule for lead and lead compounds will deal with the reporting thresholds. Previous rules required facilities that used lead compounds to report lead and lead compound emissions to the air, water and land if they manufactured more than 25,000 pounds annually or if they used more than 10,000 pounds annually. The new rule simply states that the threshold will be 100 pounds for any facility emitting lead or lead compounds.

The European Directive, coupled with the EPA's new TRI guidelines, makes it imperative for automotive suppliers to keep heavy metal content below the reporting threshold or to remove them altogether where possible. Additionally, the costs of proper disposal of waste from products containing heavy metals will continue to increase. Many end users of rubber-to-metal adhesives would like to see products with lower amounts of heavy metals. This presents a challenge to the industry to find alternate adhesives with low lead content and acceptable performance.

Low lead versions (lead content is limited to detectable levels as trace impurities but kept well below 1000 ppm) of some of the industry's most widely used solvent borne adhesives have been developed. These new adhesives have performance equivalent to the lead containing versions.

5.1 Adhesive Description

The recently developed low lead adhesive systems can be described as versatile general-purpose products for bonding a wide variety of uncured elastomers. The adhesive systems are applied as a two-coat system over an environmentally preferred primer. Generally these adhesives will bond natural rubber (NR), styrene-butadiene (SBR), chloroprene (CR), nitrile (NBR), butyl (IIR) and ethylene-propylene-diene (EPDM) to a wide variety of metal surfaces including grit blasted cold rolled steel (GBS) and calcium modified zinc phosphated steel (Znphos). These adhesives are designed for maximum environmental resistance. Films of the adhesives in non-bonded areas provide added corrosion resistance along with an aesthetically pleasing surface on the metal substrate.

5.2 Formulations

The replacement of lead can be problematic. Lead is an effective acid scavenger that inhibits corrosion by forming water-insoluble halide salts. Zinc compounds can also be used. However, zinc is reactive with the polymers typically found in Chemlok adhesives and it has the potential to destroy the heat resistance of the vulcanisate. The new replacement material for lead does not show this tendency. Adhesives for rubber-to-metal bonding generally contain two key types of active ingredients: crosslinking agent and one or more halogenated polymers/film formers. Other typical ingredients also found in these formulations are as follows:

- Inorganic acid scavenger/acceptor
- Co-curatives
- Reinforcing agent/colorant
- Solvent system.

The replacement material may be directly substituted at the same weight percent as the lead containing material. There is no need to change the manufacturing process of the new adhesives. The same procedures can be used to obtain the same general physical properties. The formulated new adhesives exhibit slightly lower viscosity at the same total solids content compared to the leaded versions.

5.3 Application

The new general purpose adhesive systems can be applied using spray, dip and brush techniques. When completing the general purpose bond performance studies the primer and adhesives were sprayed onto zinc phosphatised steel metals. The metals were preheated to 65 ºC (150 ºF) to accelerate adhesive drying. The viscosity of the new adhesives will be slightly lower; therefore adjustments to the solids content may be necessary for dipping and roll coating. Primers are applied at 5-10 microns (0.20-0.40 mils). Typical covercoat adhesive thickness is between 12.7 microns (0.50 mils) and 17.8 microns (0.70 mils).

An added advantage of the new adhesives is the increased versatility in dry film thickness (DFT) measurement. Adhesives containing lead are typically measured for DFT using magnetic induction or eddy current. These materials interfere with the radioactive isotope used in beta backscatter probes. Beta backscatter measurement is more versatile because it is able to measure a blasted profile and a wider variety of substrates.

5.4 Rubber Formulations

For testing the general purpose adhesives two different natural rubber compounds were used: low durometer (soft, **Table 4**) and high durometer (hard, **Table 5**). Both of these compounds are cured with sulfur. The Tables show the recipes and mechanical properties for the rubber compounds used.

Table 4 Soft NR

Stock recipe	
Ingredients	**Phr**
SMR-5CV NR rubber stock	100.00
Zinc oxide	5.00
Stearic acid	2.00
Flexone 3C	1.00
Agerite resin D	1.00
Antilux 111	1.00
N550 black	20.00
Sunpar 115	3.00
Sulfur	1.00
OBTS*	1.50
TMTM**	0.25
Mechanical Properties	
Properties	**Data**
Tensile strength (psi)	3367.0
Elongation (%)	585.0
Tear strength (pli)	267.0
Shore A durometer	40.0
Compression set (%)	17.9
t-90 cure @ 160 °C (minutes)	6.5

** N-oxydiethylenebenzothiazole-2-sulfenamide*
*** Tetramethyl thiuram monosulfide*

Table 5 Hard NR

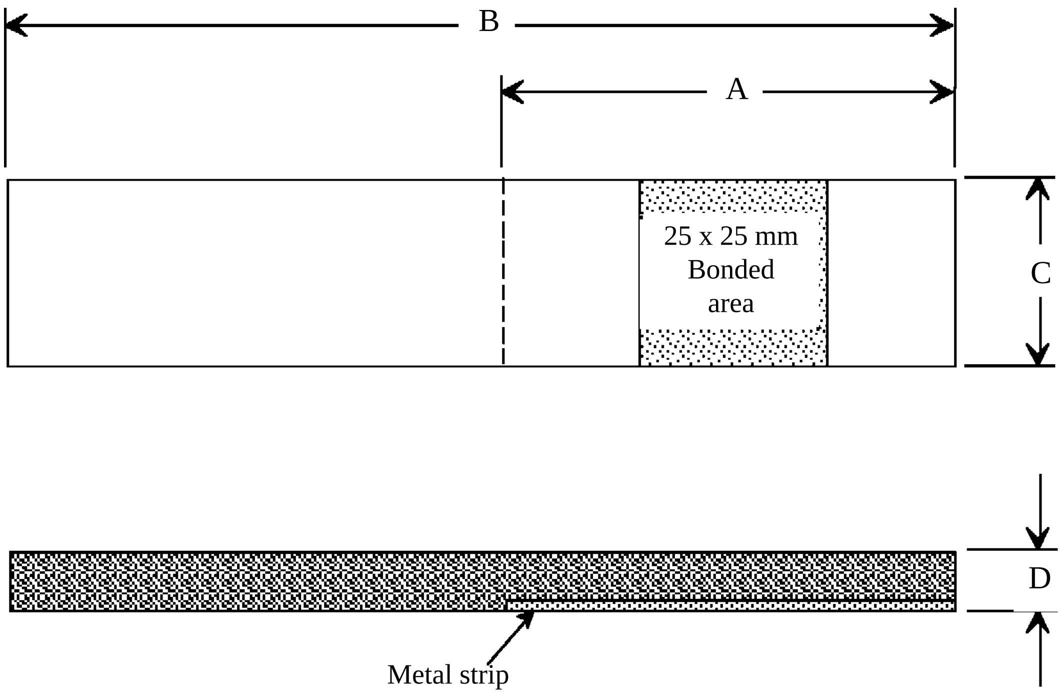
Stock recipes	
Ingredients	**Phr**
SMR-CV60 NR rubber stock	100.00
Zinc oxide	5.00
Wax anticheck #55	2.00
Pinetar tarlac 30	2.00
Agerite hipar T powder	1.00
Flectol TMQ	1.00
N330 HAF black	40.00
Stearic acid	1.00
Sulfur	1.80
Reogen E liquid	1.00
MBTS*	1.70
ZDMC**	0.31
Mechanical properties	
Properties	**Data**
Tensile strength (PSI)	3633.0
Elongation (%)	533.0
Tear strength (PLI)	362.0
Shore A durometer	52.0
Compression set (%)	23.6
t-90 cure @ 160 °C (minutes)	2.0

** MBTS: 2-mercaptobenzothiazole disulfide*
*** ZDMC: zinc dimethyl dithiocarbamate*

5.5 Testing

5.5.1 Bond Performance

Studies were completed with the environmentally preferred adhesive systems (designated CHEMLOK 205HC/6110, 6125, 6100 and 6109), as well as the lead containing controls (designated CHEMLOK 205/220 and 252X). All testing of general-purpose adhesives used ASTM D-429 Method B coupons as shown in **Figure 8**. The tests included primary adhesion and multiple accelerated environmental tests (**Figures 9** and **10**). The value axis in all graphs is the percent rubber retention in the bonded area of the part after the rubber

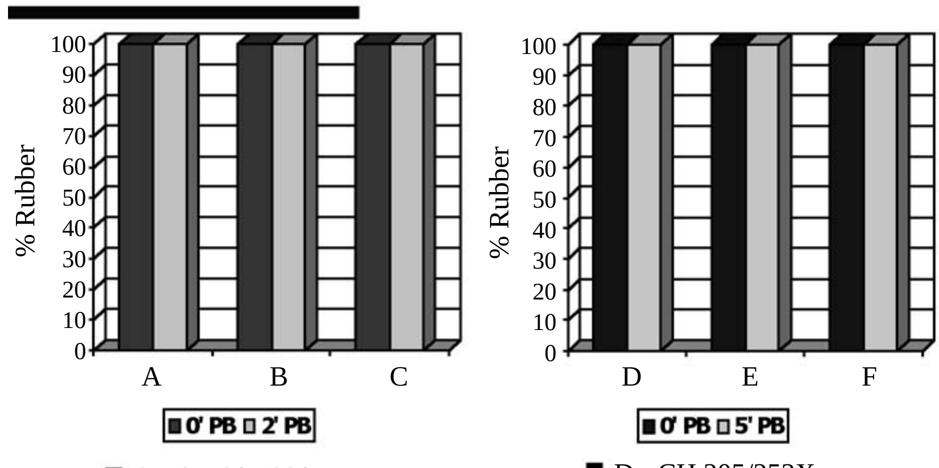


A	60.5 mm	2.38 in
B	127 mm	5.0 in
C	25.0 mm	1.0 in
D	7.9 mm	0.31 in

Figure 8

Drawing of ASTM method B coupon

Primary Adhesion
(ASTM D-429 Method B at 45° peel, 508 mm/min)
Elastomer: Shore A 40 (Soft NR) cured @ 149 °C



- A - CH 205/220
- B - CH 205HC/6110
- C - CH 205HC/6125

- D - CH 205/252X
- E - CH 205HC/6100
- F - CH 205HC/6109

Figure 9

Adhesion testing of lead and lead-free adhesives for soft rubber-to-metal bonding, showing the percentage of rubber retained on the metal after separation (with or without a pre-bake (PB) step)

Primary Adhesion
(ASTM D-429 Method B at 45° peel, 508 mm/min)
Elastomer: Shore A 52 (Hard NR) cured @ 171 °C

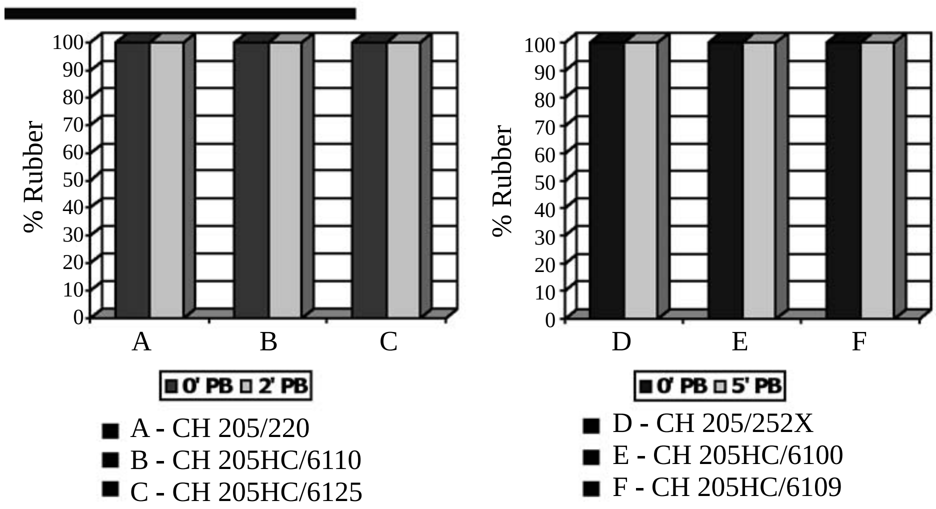


Figure 10

Adhesion testing of lead and lead-free adhesives for hard rubber-to-metal bonding, showing the percentage of rubber retained on the metal after separation (with or without a pre-bake [PB] step)

has been separated from the metal. Pre-bake (PB) is used to simulate the time (in minutes) an adhesive coated part may be exposed to the bonding temperature in the mould prior to introduction of the rubber.

5.5.2 Primary Adhesion

The ASTM D-429 Method B peel test was done at a modified 45º-peel angle and at a crosshead rate of 508 mm/min (20 in/min) at ambient conditions. All parts were destructively tested using a three-station tester made by United Testing Systems, Model: SFM-20-3CAP. All environmentally preferred products (designated CHEMLOK 205HC/6110, 6125, 6100 and 6109) performed as well as the lead containing versions (designated CHEMLOK 205/220 and 252X). All products gave 100% rubber retention (**Figures 9** and **10**).

5.5.3 Sweep

This is a test to insure that the adhesive system can withstand the wiping action of the rubber as it fills the mould and moves over the adhesive film during injection moulding. All parts were destructively tested using a three-station tester by United Testing Systems, Model: SFM-20-3CAP. All of the adhesives used for this study passed without any signs of sweeping (**Figure 11**).

5.5.4 Hot Tear

The ASTM D-429 Method B peel test was done at a modified 45º-peel angle and at a crosshead rate of 508 mm/min (20 in/min) after a hot air soak of 15 minutes at 149 ºC (300 ºF). All parts were destructively tested using a three-station tester by United Testing Systems, Model: SFM-20-3CAP. **Figures 12** and **13** show that the new environmentally preferred adhesives provide robust performance in hot tear and work equally as well as the lead containing products.

5.5.5 Salt Spray

The ASTM B-117-97 test is performed at 35 ºC in a chamber with a fog density of 1-2 ml/hr/80 cm^2. The fog is made up of 5% sodium chloride and 95% water. The duration of the test is 168 hours. The ASTM D-429 Method B coupon is stressed at the bond line for the duration of the test. All parts were destructively tested using a three-station tester by United Testing Systems, Model: SFM-20-3CAP. **Figures 14** and **15** show the durability of these adhesive systems in corrosive environmental conditions. The performance is similar for both the environmentally preferred (designated CHEMLOK 205HC/6110, 6125, 6100 and 6109) adhesives and the lead containing adhesive systems (designated CHEMLOK 205/220 and 252X). Rubber retention for these tests averaged 90-100%.

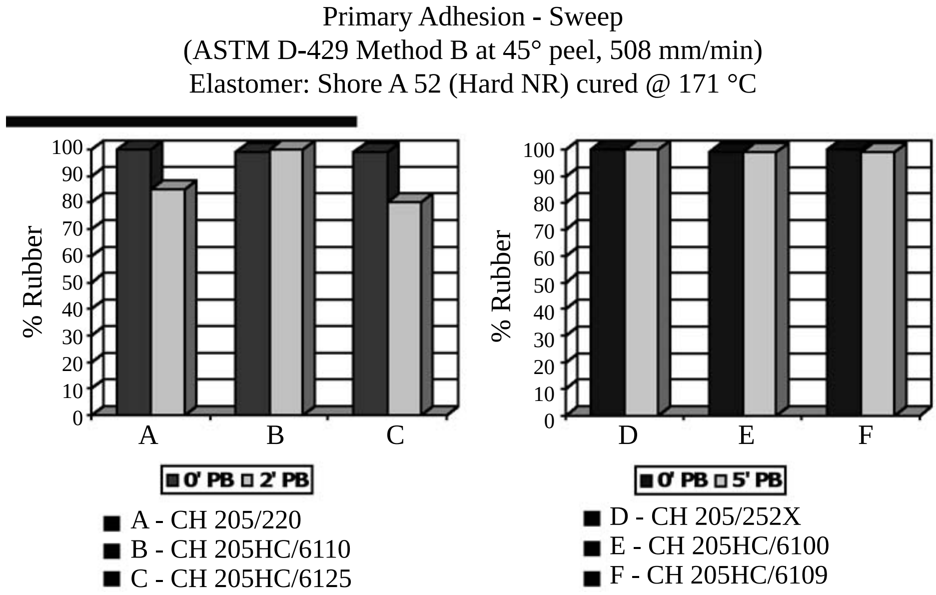


Figure 11

Primary adhesion: sweep testing of hard rubber-to-metal bonding

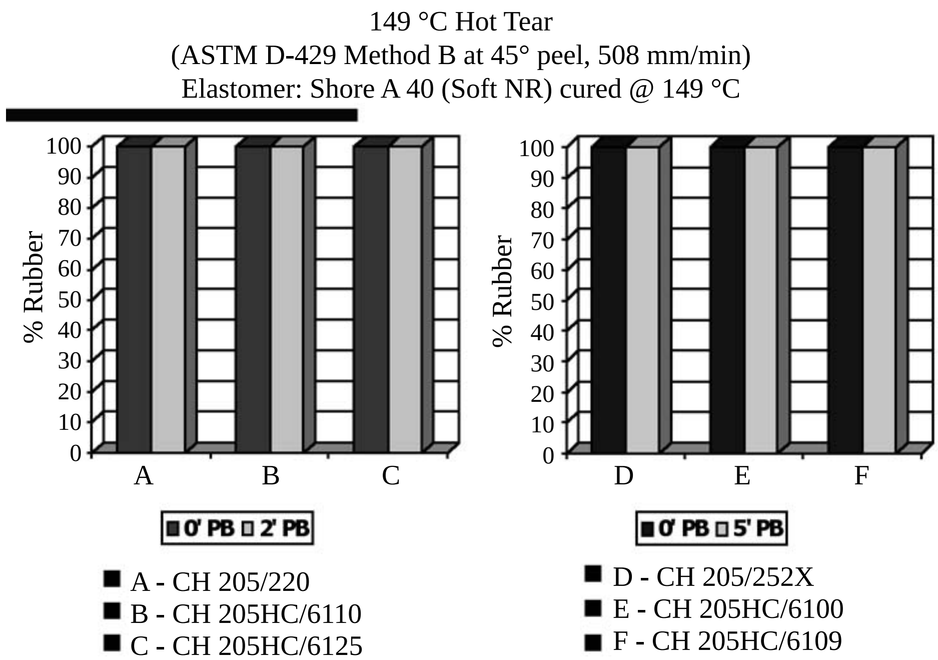


Figure 12

Hot tear testing of soft NR-to-metal bonding

5.6 Results

For primary adhesion all adhesive systems are virtually identical. Sweep results show that all adhesive systems show excellent resistance to sweeping under transfer injection conditions. Hot tear results show that both the environmentally preferred and lead containing adhesives have excellent hot tear resistance. Salt spray results show the adhesives have long-term durability in a corrosive environment. Generally, it can be said that the new environmentally preferred adhesive systems give the same high level of performance as the lead

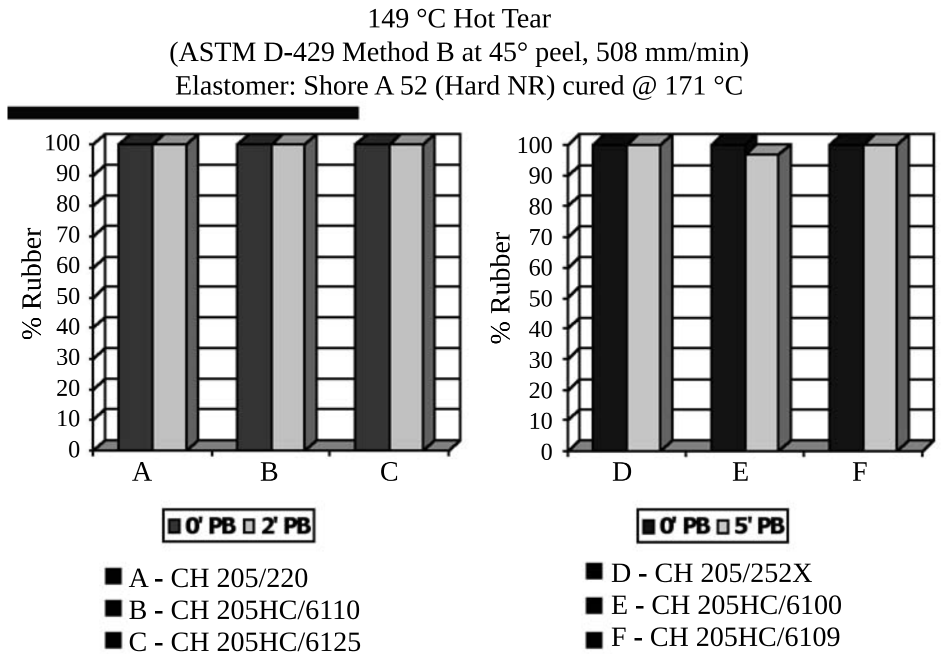


Figure 13

Hot tear testing of hard NR-to-metal bonding

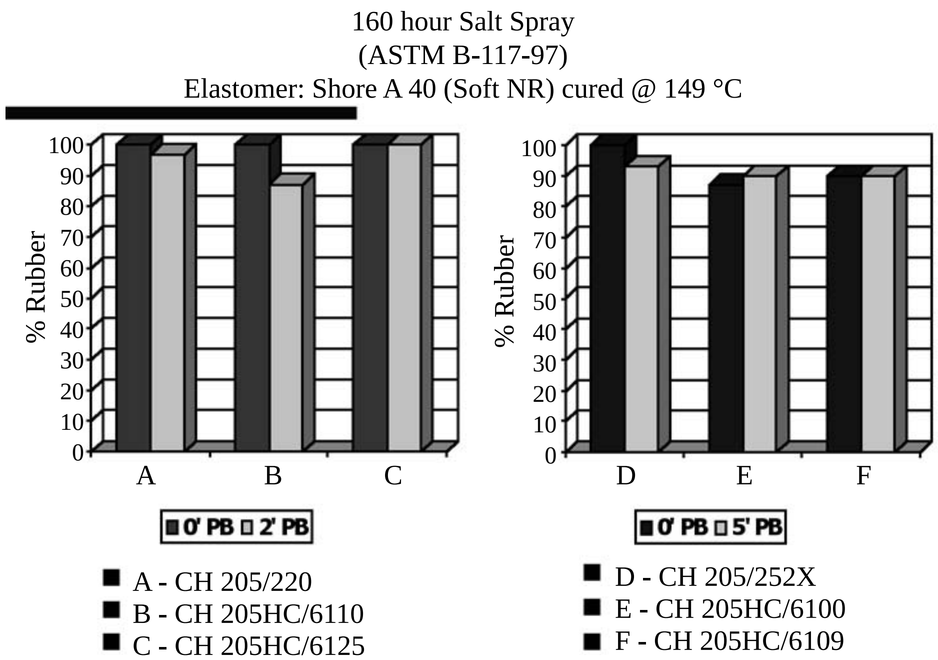


Figure 14

Adhesion of soft NR-to-metal under salt spray conditions

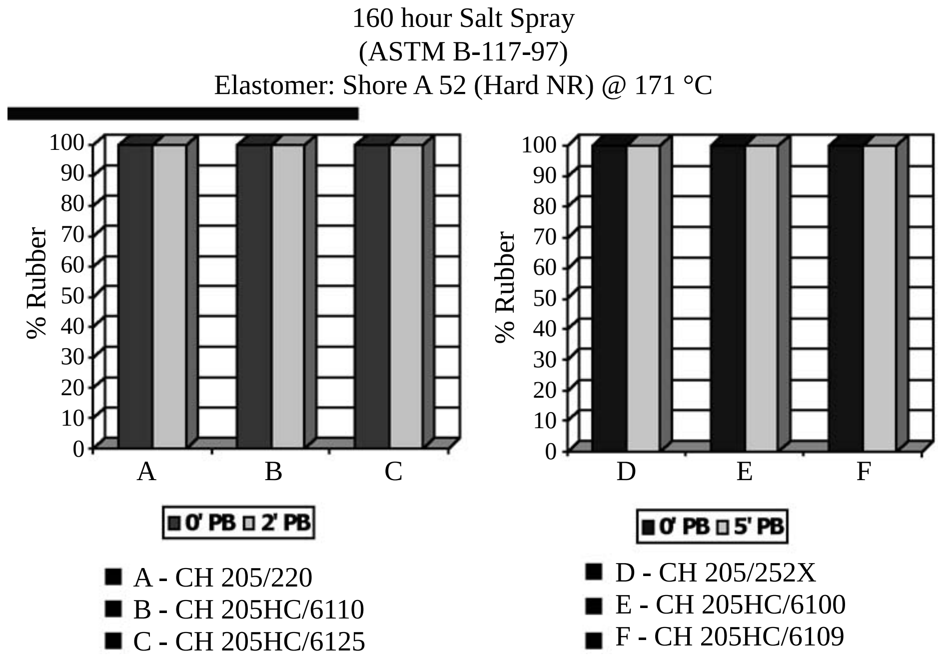


Figure 15

Adhesion of hard NR-to-metal under salt spray conditions

containing systems in ambient as well as accelerated environmental conditions.

5.7 Summary

We have attempted to provide the reader with a brief background of current industry guidelines for the use of lead containing products. Recently developed products will help customers comply with TRI reporting guidelines and the European Directive for End-of-Life Vehicles while providing the same level of performance as standard adhesives.

6 Aqueous Adhesives

The passage of the 1990 Clean Air Act Amendments (CAAA) significantly impacted adhesives used to chemically bond uncured rubber to a variety of substrates during the vulcanisation of the rubber. Up until this time period adhesives being used to bond rubber were typically 70-80% organic solvent. The solvent allowed the polymer constituent to go into solution and was an excellent medium for grinding the pigments, fillers, and curatives during adhesive manufacture. Most importantly the solvent is an excellent carrier for getting the non-solvent portion of the adhesive to the substrate in a controlled and uniform manner. In addition to the Title I CAAA regulations, Title III of the CAAA considers many of the solvents being used in adhesives as hazardous air pollutants (HAPs) and requires that emissions of these substances be controlled through the use of maximum achievable control technology (MACT). This generally includes emission control equipment such as incinerators or carbon absorbers but can also include the use of compliant adhesives that contain no hazardous air pollutants. Now that the emission of these solvents is regulated and continually being reduced under the CAAA, aqueous adhesives have been developed and water has taken the place of the solvent in this new generation of rubber-to-metal adhesives. Not only were the organic solvents replaced in the new aqueous formulations but also the heavy metals such as lead were eliminated.

6.1 Aqueous *versus* Solvent Based Adhesives

Bonded rubber components can be found in many applications. For example rubber-to-metal bonded parts can be found on an automobile serving a variety of functions: from sealing out noise and the environment to isolating vibration during vehicle operation. Failure to achieve durable bonds could seriously jeopardise both vehicle performance and safety. So when developing new aqueous adhesives for replacing solvent-based adhesives, performance was not to be sacrificed. Also it was desirable not to depart from the current adhesive processes and application methods being used.

Solvent-based adhesives are well known around the world for their ability to bond a wide variety of rubber types to metal and other substrates and retain this excellent adhesion when subjected to a variety of harsh environmental conditions. Aqueous adhesives have been developed to replace the general-purpose two-coat adhesive system, CHEMLOK 205/CHEMLOK 220, and the one-coat adhesive, CHEMLOK 252X, as follows:

CHEMLOK 205 (solvent-based primer)	CHEMLOK 8007 (aqueous primer)
CHEMLOK 220 (solvent-based covercoat)	CHEMLOK 8210 (aqueous covercoat)
CHEMLOK 252 (solvent-based one-coat)	CHEMLOK 8560S* (aqueous one-coat)
	CHEMLOK 8560D**(aqueous one-coat)

** Spray apply version*
*** Dip apply version*

There are a number of other aqueous Chemlok adhesives that address specific compounds or market segments.

To get to the stage of commercialisation the aqueous adhesives were tested along side the solvent-based equivalents in a number of different tests that included primary adhesion and environmental tests. Test results showed that the aqueous products performed at least as well and in some cases out performed the solvent-based adhesives.

6.2 Experimental

All vulcanisation rubber-to-metal bonded test assemblies were moulded per ASTM D429-B, using three test specimens per condition. The testing to be shown was conducted on a SAE 1010 cold rolled steel. The surface of the cold rolled steel was prepared in one of two manners for the testing shown. The first method of preparation involved a solvent vapour degrease followed by steel grit blasting and then a final vapour degrease (GBS). The second method was calcium modified microcrystalline zinc phosphate treatment (ZPS).

The adhesives and primers were applied either by dip or spray to the metal substrates. The primer dry film thickness was maintained between 5.1-7/6 microns (0.2-0.3 mils) and the covercoat adhesive dry film thickness between 15.2-20.3 microns (0.6-0.8 mils). One-coat adhesive dry film thickness was 25.4 microns (1.0 mil).

The adhesive coated metal parts are capable of bonding many types of rubber compounds: natural, neoprene, styrene-butadiene, nitrile, and butyl. Only data from natural rubber will be shown. Primary adhesion testing was completed at room temperature and the rubber was peeled from the substrate at a rate of 50.8 mm per minute at a 45-degree peel angle. The maximum peel force and percent rubber retention on the test part were recorded.

Environmental testing was also conducted with ASTM D429-B assemblies. Environmental tests included heat ageing, hot tear, and salt spray testing. Heat age testing required the bonded assemblies to be exposed for 16 hours at 121 °C before testing at 508 mm per minute at a 45-degree peel angle. The hot tear testing was completed by peeling the rubber from the parts immediately upon removal from the mould and percent rubber retained on the part was recorded. The salt spray parts had the rubber tail stressed and tied back with wire to apply a stress to the bond line. After being stressed and tied back the bonded assemblies were exposed to 72 hours of 5% salt fog at 35 °C.

In some primary adhesion and environmental tests, the effect of adhesive pre-cure heat tolerance (commonly called pre-bake) was evaluated. Pre-bake is the length of time the coated part resides in a hot mould before the introduction of rubber and pressure is applied. Bond performance at pre-bake conditions of zero, three, and six minutes were compared.

6.3 Results and Discussion

Figures 16-18 show primary adhesion data for both the solvent-based and aqueous adhesives. Each chart shows a different pre-bake condition. In all cases excellent 100% rubber tearing bonds were obtained when tested according to ASTM standards.

Environmental Tests – **Figures 19** through **22** show data obtained from a variety of environmental tests. Again the aqueous products provide the same performance as the solvent-based products. Only **Figure 21** shows some bond failure due to environmental reasons. The adhesives were applied over grit-blasted steel and when exposed to the salt spray conditions previously described, under-bond corrosion starts to initiate bond failure.

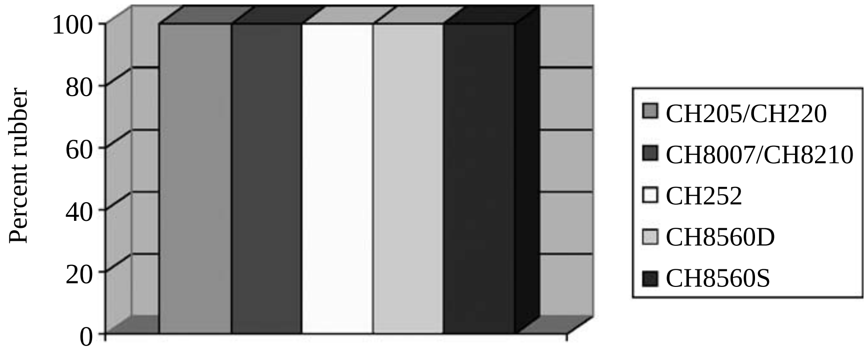


Figure 16

Primary adhesion testing of NR-to-metal bonding (no pre-bake)

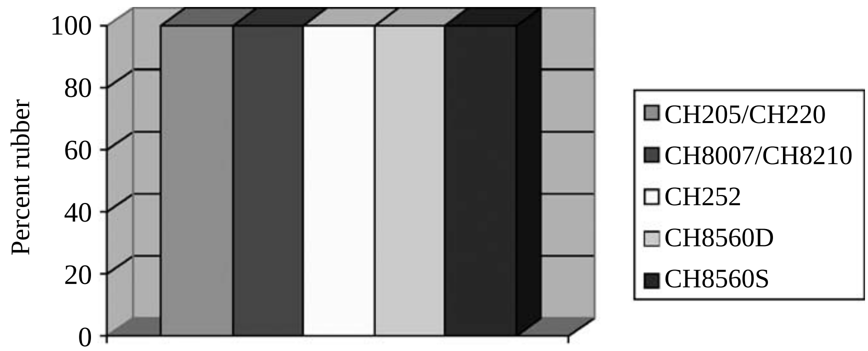


Figure 17

Primary adhesion testing of NR-to-metal bonding (3 minutes pre-bake)

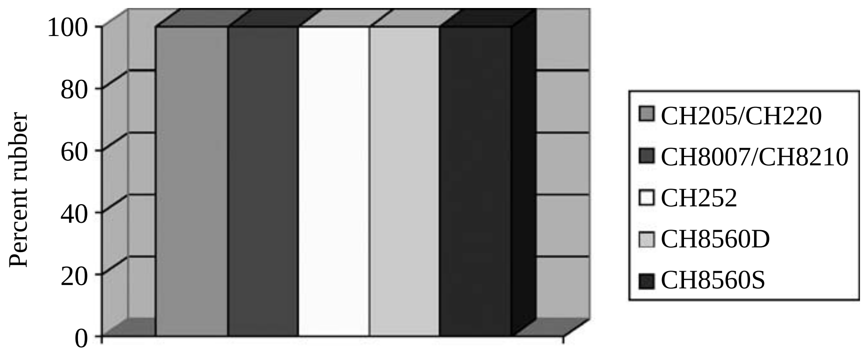


Figure 18

Primary adhesion testing of NR-to-metal bonding (6 minutes pre-bake)

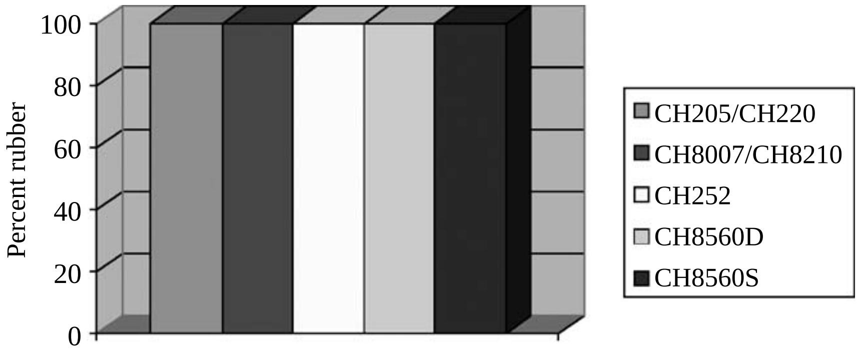


Figure 19

Heat age testing of NR-to-metal bonding/16 hrs 121 °C/ZPS
Peeled hot at 508 mm/minute

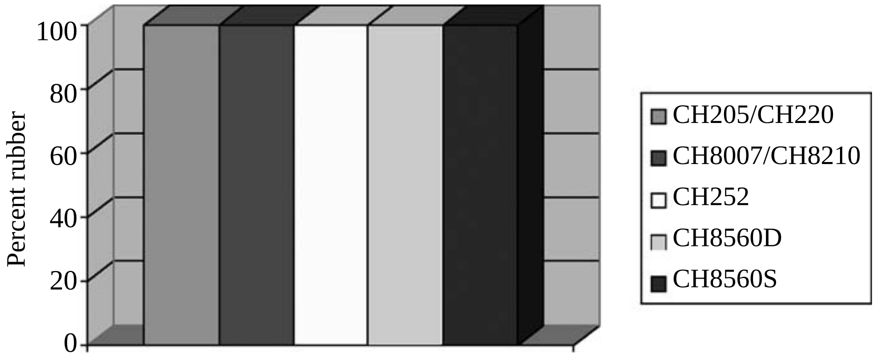


Figure 20

Hot tear testing of NR/160° C/ZPS
Peeled 508 inches per minute/45 degree angle

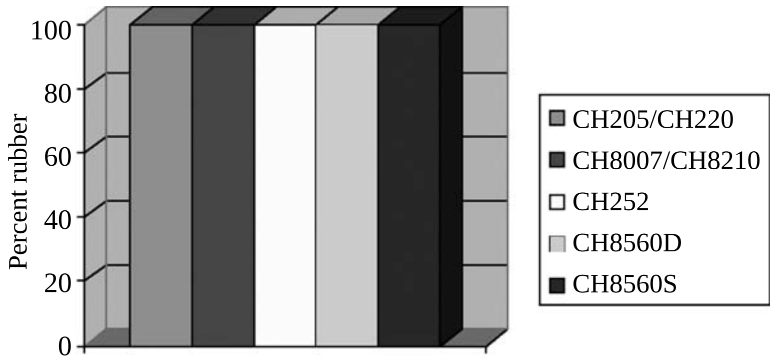


Figure 21

Salt spray test/72 hours/35° C/5% salt fog/ZPS
Stressed and tied back/hand peeled with pliers

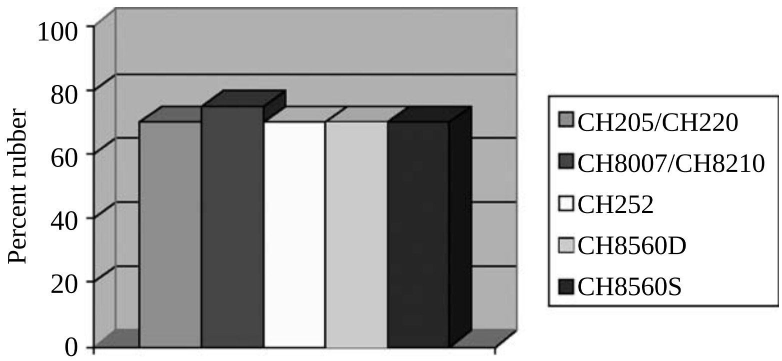


Figure 22

Salt spray test/72 hours/35 °C/5% salt fog/GBS
Stressed and tied back/hand peeled with pliers

6.4 Summary

Aqueous adhesives can provide the same excellent adhesion as the earlier developed solvent-based adhesives when applied at the same dry film thickness. Extensive laboratory studies and successful production trials have lead to the commercialisation of many aqueous adhesives for rubber-to-metal bonding. Often adhesives are developed to meet special needs and applications. For example, CHEMLOK 8115 was developed for nitrile bonding and the seal industry. CHEMLOK 8116 and CHEMLOK 8117 were also developed for the seal industry and bond almost all peroxide cured compounds and are especially good for fluoroelastomer bonding. It is always best to talk to technical experts when attempting to select the proper adhesive for a certain application.

7 Troubleshooting

There are innumerable items made for automotive, aerospace and industrial applications where elastomers are adhered to metal using adhesives that bond the rubber to the metal substrate during the vulcanisation cycle. Included are engine mounts, dynamic seals, automotive weatherstrip, various shock and vibration dampeners for down hole drilling, rubber covered rolls, pump impellers and solid rocket motors for missiles and space applications. If manufacturing or in-service adhesion failures occur, the reasons for the failure need to be understood so that corrective actions can be implemented. There can be different modes of failure. By properly investigating the nature of the failure, causes can be identified. In addition, the root cause of the failure must be discovered so as to prevent further problems in the future. In some cases, various surface analyses may be conducted using sophisticated techniques to determine the nature of the failure and the possible cause.

In the 1950s, two-coat adhesive systems consisting of a primer and a reactive topcoat were developed to bond a variety of elastomers to metals, textile and other substrates during the moulding operation. Here the adhesive coated substrate is placed in a mould cavity and rubber then moulded to it. During this vulcanisation step, the rubber cures, the adhesive cures, and adhesion is developed. The thermoset bond that is formed is expected to be stronger than the rubber and able to resist the same environments to which the rubber will be exposed. These environments include hot oils (such as for engine seals), salt spray (for under-the-hood components), drilling muds (for down hole drilling), and hot and cold temperatures (for equatorial and arctic conditions). The whole insert moulding process is made up of various steps and failure to properly follow these steps can lead to bond failures.

Paramount to the process is the selection of the most suitable adhesive system for a given application. If the correct adhesive is not used to start with, then the part will not be manufactured properly. Adhesive selection is primarily based upon the type of rubber to be bonded. For example, a certain adhesive suggested for bonding natural rubber to steel would most likely not be suitable for bonding the same metal to a silicone elastomer. Factors other than the type of rubber that may influence the choice of adhesive include the substrate, the cure package, the durometer and the environment that the bonded component must operate in. Another key element in the selection is the application method which includes dipping, spraying and brushing. The final choice of adhesive is sometimes determined by the results of standardised adhesion tests in a laboratory (i.e., ASTM D-429).

Assuming that a suitable adhesive is found and is being used correctly, then a bond failure must be addressed as a process problem. In order to understand what process factor may be responsible, the type of failure must first be determined. Then, possible causes for the failure can be explored. Surface analysis testing may be useful. From there, the possible root cause and solution may be determined.

7.1 Types of Failures

7.1.1 Rubber Failure

Several modes of failure can occur in a bonded assembly. The first is called rubber failure (**Figure 23**). In this instance, when a part is tested, the failure occurs within the rubber substrate. This is a desirable mode of failure as it tells the manufacturer that the bond is intact and is in fact, stronger than the rubber. Assuming the rubber has been compounded correctly, then the part has been correctly engineered and manufactured. The results are usually expressed in terms of the percent rubber coverage over the bonded area. In this case it would be 100% rubber. It should be noted that there can be various degrees of rubber thickness in the failure such at thin rubber or thick rubber. Sometimes the thin rubber isn't obvious and one may have to look under a microscope to determine that rubber is present.

7.1.2 Rubber-to-Cement (RC) Failure

Another type of failure that can occur is failure between the rubber and the adhesive film (**Figure 24**). ASTM test methods found in D-429 designate this as RC failure, that is, the failure is between the rubber and the 'cement'. Here the adhesive remains on the substrate side (e.g., the metal) and appears to be a hard black film. If you were to use a No. 2 lead pencil and lightly write on the failure, the pencil would leave a mark. If rubber were present, most likely there would not be a mark.

7.1.3 Cement-to-Metal (CM) Failure

With CM failure, the adhesive, along with the primer (assuming a two-coat system) will come off of the metal leaving the metal bare and relatively clean (**Figure 25**). If the primer is grey (as is usually the case), one can see the grey primer on the rubber side of the bonded area. This type of failure is more readily recognised than RC because of the colour difference between the layers. With RC failure, you often have a black adhesive against a black rubber compound.

7.14 Other Failures

In rare instances, failures can occur between the adhesive and the primer. This is called 'CP' failure. In some cases, there can be a mixture of the types of failures mentioned above. For example, a part could exhibit some RC failure as well as CM failure.

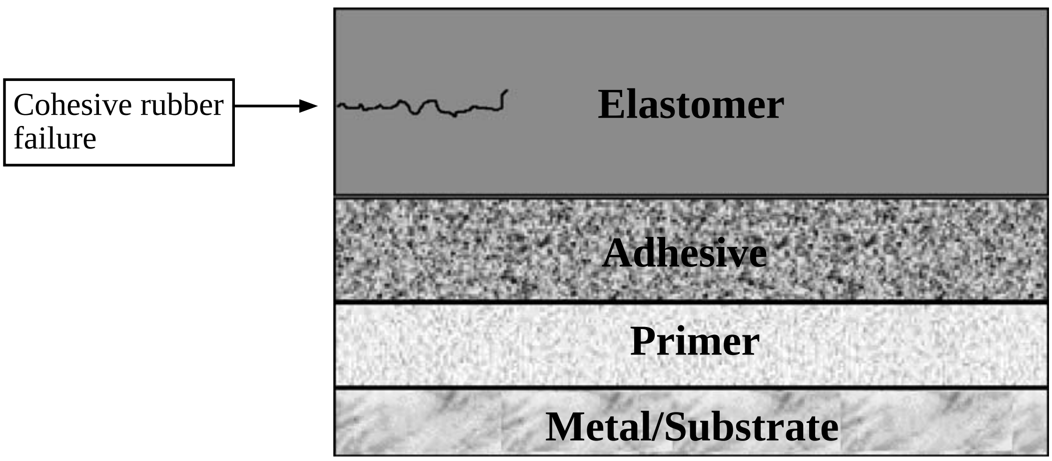


Figure 23

Cohesive rubber failure

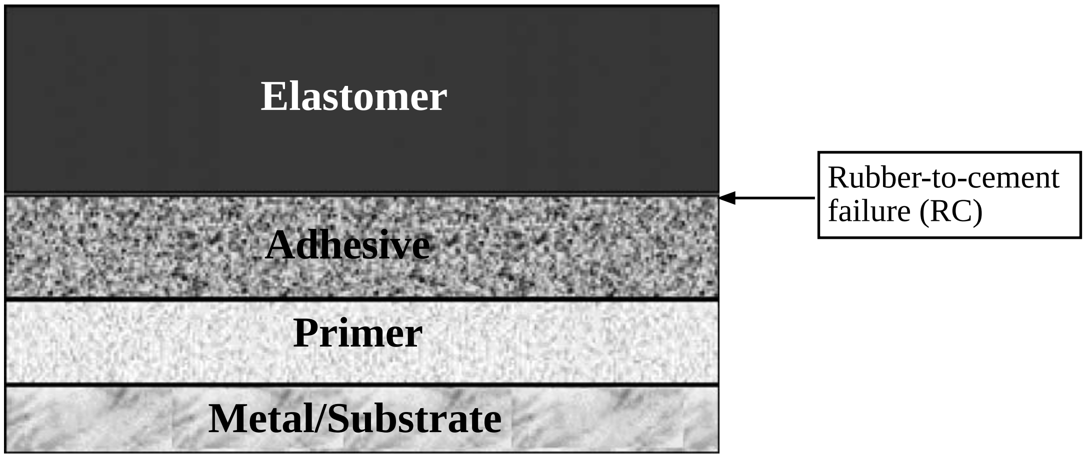


Figure 24

Rubber-to-cement failure

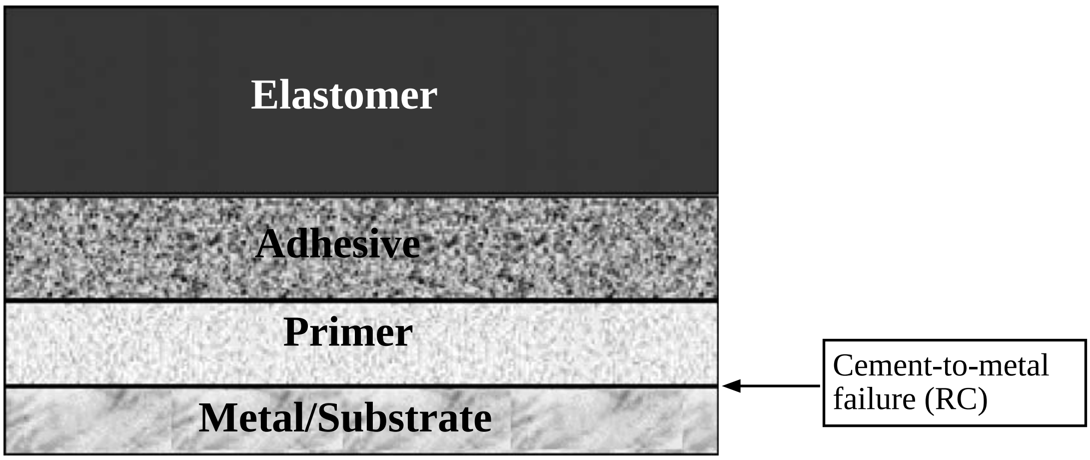


Figure 25

Cement-to-metal failure

7.2 Failure Analysis

7.2.1 Rubber-to-Cement (RC) Failure

There are many reasons why RC failure can occur and the most frequent ones are as follows:

1. **Failure to mix the adhesive before application**. This might leave some of the adhesive's active ingredients settled on the bottom of the container and therefore you would not get a bond. Many adhesives consist of resins and curatives dispersed into a polymer/solvent blend. The solids have a tendency to settle to the bottom and must be thoroughly mixed prior to application.

2. **Improperly applied adhesive**. Adhesive suppliers have guidelines for the proper amount of adhesive to be applied. For example, a general purpose bonding agent requirement might be 15-25 microns. If only 10 microns were present, there may not be sufficient amount of adhesive to achieve the bond

3. **Wrong adhesive applied**. Many moulders have a variety of adhesives in their plant. Most of the adhesives today are black and if the workers are not sufficiently trained, the wrong adhesive could be applied.

4. **Excessive pre-bake**. Adhesives for bonding rubber are heat activated. If the coated parts reside in the mould for an excessive time period before the rubber is introduced (such as in a shuttle mould) then the adhesive could react and cure. There would no longer be sufficient reactivity left for adhering to the backbone of the rubber during moulding. If the mould has many cavities and is hand loaded, it's possible that the first parts inserted might bake out and the last ones would be fine. Improper use of infrared drying could pre-activate the adhesive also.

5. **Lack of heat**. Large adhesive coated inserts may provide too much of a heat sink during moulding. The adhesive would therefore not get up to activation temperature and RC failure would occur. Sometimes the failure here may be a mixture of cohesive rubber failure and RC (e.g., 40%R, 60% RC) as the location of the heater rods and pins in the mould would allow differential heat transfer.

6. **Other**. Other reasons include contamination of the adhesive coated inserts prior to moulding. Adhesive coated parts should be covered when sitting on the plant floor to avoid contamination from mould release. When handling the adhesive coated parts, clean white cotton gloves should be worn to prevent contamination of the adhesive film by hand lotions, skin oils, etc. The shelf life of the adhesive should be considered also.

The adhesive supplier or their literature should be consulted to find out the shelf life of the product. Sometimes it is good to run a different lot of adhesive when a failure is encountered. This will help decide if the adhesive is defective or if the process is out of control.

7.2.2 Cement-to-Metal Failure

When a failure occurs where it appears that the primer (in a two-coat system, or adhesive in the case of a one-coat system) is no longer on the substrate (e.g., metal) and seems to be on the rubber side, the failure type is termed 'CM' for cement-to-metal. (Note: ASTM D429 uses 'M' for this designation). Some of the reasons for this type of failure are as follows:

1. **Failure to mix the primer before application**. As noted above under 'RC', failure to thoroughly mix all of the ingredients together prior to application, may result in a bond failure. It should also be noted however, that in many instances, good primary adhesion might be achieved. However the environmental resistance will be compromised and field failures may occur. This is especially true when a primer is being used with a topcoat adhesive that was designed to be a one-coat adhesive. The use of a primer may not contribute to primary adhesion but is being used to enhance the environmental resistance.

2. **Improperly applied primer**. For some systems, if insufficient film thickness is applied, the adhesive may still have a good initial bond but poor environmental resistance may result. The primer supplier should be contacted for film thickness guidelines.

3. **Contamination**. Improperly cleaned substrates can result in CM failure. When metals are processed (holes drilled, punch died, etc) they have various types of oils on them, which must be removed before the chemistry of the primer can sufficiently interact with the substrate. Plastics may have mould release on them. Some metals, like aluminium, oxidise rapidly and need to be primed immediately after mechanically blasting the surface. Contamination can also occur from oil being in the lines of a spray system. Chemical baths that have depleted their ability to clean obviously won't clean the surface well enough for good adhesion to occur. Contamination is probably the leading cause of CM type failures. Sometimes the contamination can creep into the system quite unknowingly. For example, if another part of the plant begins to implement a silicone release agent, it is possible that the silicone can get carried through the plant via air circulation. There have been cases where the contaminant has been carried outside via air ducts only to have it re-enter because the wind is in such a direction as to blow the contaminant from the exhaust to the intake air vents.

4. **Poor metal pretreatment.** Many bonded assemblies made of rubber and steel use phosphate treatments to enhance the corrosion resistance of the part, particularly in the non-bonded areas. Such treatments include iron phosphate, zinc phosphate, and modified zinc phosphate. Other treatments on metals include auto-deposition coatings, electro-deposition coatings and various chemical corrosion resistant coatings. While good primary adhesion may be achieved, when the final part is put into service, or a bending or swaging operation, the metal treatment may fail cohesively. This type of failure may appear as a 'CM' failure but upon closer inspection with surface analysis techniques, it may be determined that some of the treatment is on the rubber side of the failure and thus had fractured within itself.

7.3 Surface Analysis Techniques

In many cases, visual observation and/or microscopic analysis are sufficient to determine the type of the failure. The actual cause of the failure however is not readily apparent. The use of certain analytical tools can help determine the cause of the failure.

Some of the major methods used for surface analysis are as follows:

Scanning electron microscopy (SEM)

Energy dispersive X-ray spectrometry (EDS)

X-ray photoelectron spectrometry (XPS)

Ion scattering spectrometry (ISS)

Secondary ion mass spectrometry (SIMS)

Auger electron spectrometry (AES)

Rutherford backscattering spectrometry (RBS)

Each method has its pros and cons and often more than one technique is required to generate sufficient data. When looking at RC failure, the search is generally to detect if there is something like mould release present (for example the presence of silicone) when it is known that there is no silicone in the rubber or in the adhesive. Additionally, the relative film thickness may be measured or it may be determined if the failure is possibly cohesive within the adhesive as opposed to 'plain' RC failure.

On the metal end, contaminants may be detected by the fact that they are chemically unlike anything that would be found in the primer. Oils and mould release are commonly found, as are fractures in the phosphate. In this case, the phosphate is found on the backside of the primer, stuck to the rubber.

7.4 Root Cause

Once the type of failure has been identified, the question remains as to why it occurred and a solution found to fix it. In one actual example, an RC failure was identified and the cause of it shown to be low film thickness. But there still remained the question of why was there low film thickness? Investigation revealed that the adhesive was diluted too much and the amount being deposited was too low. However that still was not the root cause. The reason that it was diluted too far needed to be determined and was shown to be related to lack of training of a new employee. The remedy then was to provide the correct training.

An example of CM failure on brass was traced to the metal not being thoroughly cleaned. Further, the root cause was that the company began to get varying grades of brass and their acid cleaning step was not adequate for some grades. The solution to this problem was to mechanically blast the metals. Another would have been to establish a specification for a certain type of brass and work just with that material to develop a suitable cleaning method.

7.5 Summary

To successfully complete the process of bonding rubber-to-metal in the manufacture of quality rubber engineered components, several steps are required:

1. Proper substrate preparation
2. Proper selection of adhesive
3. Proper adhesive preparation
4. Proper adhesive application
5. Proper moulding conditions

When a bond failure occurs, each of these steps must be considered during failure analysis. The type of failure must be identified as the first step. Sometimes it is necessary to use sophisticated surface analysis techniques. Once the type of failure is identified (such are RC, CM, or other) there are various possible reasons for a specific type of failure. Some of the major reasons are listed in this paper. Finally, when the reason for the failure is found (e.g., lack of sufficient adhesive thickness) then the root cause must be identified (adhesive is overly diluted) and the problem corrected (e.g., employee training) to prevent it from recurring.

8 Testing

Of great interest to manufacturers of rubber-to-metal bonded assemblies is bond strength and bond durability. Bond strength is the ability of the assembly to stick together while durability refers to how long the bond will last in a given environment. These environments can include water immersion, acid and alkali exposure, salt spray, oil and fuel resistance, heat and cryogenic resistance, dynamic cycling, as well as a vast array of other environments.

The best test is to make the part and test it under actual conditions. Most engineering companies use a simulating test that may accelerate the failure. The accelerated test gives an indication as to the life expectancy of the bonded part or at least be able to discern between various adhesives.

The American Society for Testing and Materials International (ASTM International) and the International Organization For Standardization (ISO) are two organisations that have test methods for measuring bond strength. These standards describe a method to make test pieces that can be peel tested, or tested in tensile or shear (see **Table 6**).

The bonded test specimen can often be placed in various environments (with or without stress) for testing beyond primary bond strength. By using such tests, various adhesives and rubber formulations can be screened to determine the best adhesive to use in making trial production parts.

9 Markets

The art and science of adhesive usage can differ from the above processes according to what type of item is going to be manufactured. These sections address some of those areas by market segments.

Table 6 ASTM International D-429 test methods for rubber-to-metal bonding

ASTM International	Related ISO standard	Type of test
A	814	Tensile
B	813	Peel
C	5600	Tensile/shear
D	814	Tensile (for cured rubber)
E	-	Peel (rubber lining)
F	-	Tensile/shear
G	-	Double shear (durability test)
H	1827	Quadruple shear (durability test)

9.1 Bonding Rubber Rolls

For over 40 years, adhesive systems have been successfully used to bond rubber rolls. The markets include rolls used to transport various types of materials in consumer goods, agriculture and mining industries. Other applications include graphic arts and printing, where the rolls transfer inks and process pulp and paper products. Additional applications include coating and lamination rolls that transfer adhesives, coatings and packaging labels to various goods. In all these applications, the adhesive plays a very important role in maintaining a strong, durable bond between the core and the rubber for the service life of the manufactured roll. The intent of this chapter is to provide an overview of the manufacturing process, which provides details on core preparation, adhesive selection and application, vulcanisation and a troubleshooting guide.

9.1.1 Core Preparation

The most common core constructions used in the industry are steel or aluminium. Occasionally, magnesium, brass, copper, titanium and nickel-plated thin wall cores are used in special applications. Additionally, non-metallic cores, such as glass-reinforced composites or other engineering plastics, are employed for weight reduction and chemical compatibility.

The majority of roll manufacturers reprocess their serviced cores because of the expense of the cores. This is accomplished by removing the used rubber and adhesive with machining lathes, sanders, grinders, and/or high temperature bake cycles. Once old material is removed from a serviced core, the surface can then be mechanically and/or chemically prepared.

The first step in creating a successful bond between the rubber and the core material is core preparation. Core preparation throughout the industry is performed in a variety of ways and all serve to provide a clean and consistent anchor profile (contour of the core surface) for the adhesive system to attach to. Core preparation is considered the foundation for successful rubber to core adhesion and is crucial to the success of the subsequent process steps to achieve a consistent, high quality, durable bond.

Core preparation can be subdivided into two basic categories: chemical and mechanical preparation. Either of these methods may be used independently or together. Most importantly, in-process bond adhesion tests, production testing, and field service operating conditions assist in determining the best core preparation steps required to achieve and maintain good adhesion.

The function of chemical preparation is to dissolve or suspend then remove the organic contaminants (i.e., cutting oils, greases, dirt, etc.) that may be present on the core surface from fabrication or service. Chemical methods typically utilise organic solvents to remove these contaminants because they often interfere with or degrade the adhesive system's ability to bond to the core surface. Rinsing, washing, soaking, brushing, or wiping is generally performed to remove these contaminants. Collectively, these methods are referred to as degreasing. These methods are generally accomplished with organic solvents such as alcohol, methyl ethyl ketone (MEK), toluene or xylene.

Degreasing can be performed prior to and after mechanical preparation. In some cases, solvent vapour degreasing may be employed, although recent solvent emission regulations have limited their use in the industry. Additionally, some of the newly developed machining oils may not be soluble with the types of solvents mentioned above, so alternatives such as alkaline or citric acid cleaners must be used to assist in their removal.

Lubrication and cooling solutions used with the machining equipment should be identified and used with caution. Coolant additives such as Teflon® and silicone emulsifiers should be avoided as they can cause potential bond failure.

Frequent change and disposal of solvents ensures adequate cleaning activity. If solvent replacement is infrequent or ignored, the cleaning solvent may become ineffective, perhaps detrimental. All equipment associated with core cleaning, such as brushes, rags and containers should be disposed of when contaminated.

Mechanical preparation is performed to remove any inorganic contamination (i.e., weld scale and surface oxidation) as well as any remaining adhesive and rubber. The purpose of this step is to expose a fresh, new bonding surface, which promotes adhesive wetting. Mechanical preparation methods include blasting with hand or automated blasting units, hand grinders, hand or automated belt sanding units, wire brushes, steel wool, or machining lathes. Prior to mechanical preparation, degreasing should be employed to minimise the transfer of organic contamination (oils, greases, dirt, etc.) into this process.

Due to the size of most rolls, surface grinding by hand using a rotary disc, or hand or automated belt sanding is the most common method used to achieve a good profile. The disc or belt materials are typically silica or aluminium oxide with a range of 700-180 micron (25-80 mesh) grit. The surface profile typically created is 25-50 micron (1-2 mil) in height, from peak to valley. The abrasion pattern created with the belt or disc should be randomised to create maximum surface area. Caution must be used during machine lathing, grinding or belt sanding to avoid deep grooving as these processes can lead to potential adhesive system puddling that may result in adhesive failure. The disc or belt should be changed frequently to ensure an aggressive and consistent anchor profile is maintained. This also minimises transfer of residual contamination from the disc or belt back to the core surface.

Shot, sand or grit blasting is employed in some cases. Each of these media can provide a consistent surface profile on the core for the adhesive to attach to; 420 micron (40 mesh) grit is common; however, smaller or larger grit sizes are acceptable, depending on the core composition and equipment available. Grit media is preferred to shot media because its angular shape tends to rip and tear the core surface. This promotes good adhesive wetting because of the sharp ridges and valleys produced. Shot tends to produce less surface area than grit because its rounded shape tends to peen the surface, creating a 'crater-like' profile. Shot also tends to drive surface contamination into the core surface, instead of removing it.

The media should be inspected frequently and changed or refreshed periodically to retain a consistent profile. Blast unit filters should be inspected routinely and cleaned or changed to minimise fine media introduction into the process. Blasting air sources should contain air/water extractors. These extractors should be inspected frequently and drained periodically to avoid contamination of the media and the core surface. An indicator for excessive oil and/or moisture in the adhesive film is 'fish-eyes', which appear as small pinholes within the adhesive film. Additionally, bearing surfaces and bores on the core should always be protected from media overspray, as well as minimising contamination to the inside diameter of hollow cores.

After surface preparation is completed, a visual inspection should be performed to ensure the core profile is uniform and free of any debris. Areas that may have been lightly abraded or missed completely should be identified and corrected. The level of cleanliness is subjective because it is difficult to measure; therefore adhesion testing is a common way to verify the effectiveness of the cleaning solvents and associated preparation processes. In some cases, the core can be checked for cleanliness with a water break test (reference ASTM International, F22-65). This test is a good, quick method to determine if oil may be present on the core surface, but since this test is considered subjective, results may not always assure a successful bond.

It is optional to degrease the core again after abrasion is complete, but often this step can remove excess media fines and residual core debris as well as other contamination left on the core surface. An air blow-off step with clean, dry air is typically sufficient to remove excess media fines and residual core debris, provided no other forms of contamination are present. For stainless steel cores, aluminium oxide belts, sand, or glass bead media must be used to eliminate the chance of dissimilar metals from coming in contact and causing under-bond corrosion.

Following visual inspection, the adhesive system should be applied as soon as possible to minimise the reoccurrence of surface oxidation and other forms of contamination. The period of time between mechanical preparation and adhesive application is referred to as layover. As layover time increases, the risk of forming a weak oxide layer increases. Weak oxide layers can be pulled away from the core surface by the adhesive, which may result in adhesive failure to the core surface. Layover time varies with each manufacturer and is dependent on such factors as the core composition, the method of preparation and the plant conditions. A common practice is to complete adhesive application within one hour after mechanical preparation.

In limited cases, the core may have a chemical conversion treatment, such as zinc or iron phosphate, nickel-plating, or other plating treatment. The function of these treatments is to deposit a corrosion resistant layer, which also must have bonding compatibility with the adhesive system. Often, these treatments do not require any additional preparation steps prior to application of the adhesive system. A clean, dry air blow-off, dry rag wipe, or light solvent wipe is suggested to remove any potential airborne contaminants like dust.

9.1.2 The Adhesive System Selection Process

Proper selection of the adhesive system for the roll application is equally as important as adequate preparation of the core. Before an adhesive system is chosen for a particular application, the rubber cover type must be provided. Rubber selection is based on a variety of criteria that satisfy the specific end-use requirements for the roll and its corresponding service. To begin the adhesive system selection process, basic information such as the base polymer type and cure package is needed. Additional information such as the curing unit (autoclave or conventional press), cure conditions plus service dynamics, temperature, and chemical resistance also aids the selection process.

Additionally, the type and amount of cure system, fillers, plasticisers, and other processing aids can affect the ability of the adhesive to bond the rubber. The most common industry challenge is bonding low polarity type compounds, such as EPDM and butyl. Additionally, these types of compounds lack attachment sites for the adhesive to bond to. Softer compounds below 40 durometer Shore D are also typically more difficult to bond. In special cases where lower durometer compounds are required, higher durometer (easier to bond) compounds can be used at the core surface to bridge the outer layer of lower durometer compounds.

Since rolls are often subjected to very demanding field service environments, most manufacturers choose a two-coat (primer/adhesive combination) system for best service durability. For example, CHEMLOK 205 provides the required core adhesion, followed by the appropriate Chemlok adhesive (often referred to as topcoat or covercoat) to bridge the interface between the primer and rubber surfaces.

One-coat adhesive systems can offer labour and cost savings. However, the addition of a primer can improve their environmental performance. Exceptions are noted when bonding speciality elastomers, such as silicones and fluoroelastomers, where specialised systems such as CHEMLOK 607 and CHEMLOK 5150 must be used.

Once the adhesive candidates are identified, bond testing is needed to determine the optimal system with the specific materials and processes. For initial bond evaluations, simply peeling the rubber away from the core with hand tools or machining lathes can provide a good determination of the adhesive's bond quality. Prior to rubber lay-up and vulcanisation, a strip of tape or Mylar can be placed on the adhesive coated core. The strip creates a non-bonded area (i.e., a rubber 'tab') for ease of bond evaluation. With larger cores, lathes, hoists or cranes may be required for evaluation of the bond. Other methods include employing smaller 'witness' cores that offer ease of testing bond quality, especially when new materials and processes are being considered.

In addition to the compatibility between the adhesive and rubber, the bond at the core surface is also tested.

In special cases, bond strength measurements may be required to meet customer specification. A good bond is established when the rubber fails within itself.

Given the multitude of manufacturing materials and processes, the adhesive selection process is specific for each manufacturer. For many manufacturers, multiple adhesive systems are required because of the variety of compounds utilised. The correct choices are generally derived from trial-and-error, tradition, suggestions from the rubber supplier, as well as feedback from other roll manufacturers within the industry. Regardless of the source, **Table 7** condenses the selection process, based on Lord Corporation testing and customer manufacturing histories. Not all adhesives are listed.

Table 7 Chemlok selector guide for rubber rolls

Rubber type	Chemlok One-coat systems	Chemlok Two-coat systems
Butyl	250, 252X, 253X, 6254	205/234B, 205/236A, 205/238, 207/259
Chloroprene	250, 252X, 6254	205/220, 205/234B, 207/259
EPDM and EPR	250, 252X, 253X, 6254	205/234B, 205/236A, 205/238, 207/259
Epichlorohydrin	250, 607, Ty-Ply BN	205/233
Fluoroelastomer	5150, 5151, 607	None
Nitrile	205, 250, 252X, 253X, 6254, Ty-Ply BN	205/220, 205/233, 207/259
Carboxylated nitrile	205, 252X, 253X, 6254	205/217
Hydrogenated nitrile	205, 6254	205/220, 205/233, 205/234B, 207/259
Natural	250, 252X 253X, 6254	205/220, 205/234B
SBR	250, 252X 253X, 6254	205/220, 205/234B
Silicone (peroxide)	607, 608, Y-1540	None
Silicone (addition)	606	None
Urethane (castable)	213, 218	219/213, 219/218
Urethane (millable)	218, 219, 250, Ty-Ply BN	205/233

9.1.3 Handling, Mixing, and Application Processes

The second step in creating a successful bond between the rubber and the core material is proper handling, mixing, and application of the adhesive system after core preparation is completed. The handling, mixing, and application processes all rely on each other for reproducible bond performance of the adhesive system.

For ease of discussion, the term ‘adhesive’ below refers to a primer or an adhesive.

Temperature variations encountered during shipping and storage typically do not affect the performance of the adhesive systems; however, storage temperatures and shelf life periods should be adhered to in order to ensure optimal adhesive performance. Exposure to excessive temperatures has the most effect on the shelf life of the adhesive system. Storage temperatures of 21-27 °C (70-80 °F) are suggested for most products. The user should refer to product literature for additional specifics regarding the storage period and additional handling instructions. Temperatures above 38 °C (100 °F) for extended durations, such as warehouse storage on upper racks of non-air conditioned areas, should be avoided. Outdoor winter storage or refrigeration below 10 °C (50 °F) should be avoided. Storage of the adhesive systems in cool, well-ventilated and well-lighted storage areas is suggested for optimal performance.

Many solvent-based products do not freeze, and freezing temperatures simply increase viscosity and some products may become ‘gel-like’ upon cool or cold storage. In these cases, the products should be permitted to equilibrate to ambient plant temperatures, then mixed thoroughly before using. If this procedure is followed, adhesive performance is not typically affected. Viscosity checks should then be performed.

Inventory rotation procedures should be monitored to ensure that fresh product is used within its shelf life. Fresh product is essential to maintain consistent adhesion. If material is suspect concerning shelf life, it should be replaced with new material while disposing of the older material. Refer to the specific product literature for storage conditions and other information regarding proper use and handling of the adhesive system.

Many of these products are flammable due to the type of solvents that they contain. Solvents used in these products include aromatics, acetates, alcohols, ketones and chlorinated solvents. Appropriate safety procedures for flammable liquids should be practiced when handling products containing any of these solvents.

It is essential to refer to the MSDS (Material Safety Data Sheet) and label of the specific product to ensure that it is stored, handled, and utilised safely and that appropriate controls and personal protective equipment are used.

The most common container used throughout the industry is the single gallon can, due to its ease of dispensing and quantity required for the job. Single gallon containers can be mixed with paint shakers or air mixers, but hand mixing is the most common method. Adequate mixing is required for optimal performance of the adhesive system. Hand stirring with a 'figure 8' motion for 15 minutes is usually sufficient to disperse the solids within the solvent system. The purpose of dispersing the solids within the solvent system is to equally distribute the solids within the bulk of the liquid portion. Mixing should continue until all settled material is removed from the bottom and the adhesive has a uniform appearance. The material should be frequently stirred during use, especially if the product is unused over break periods and production shift changes.

To minimise potential contamination and solvent loss, the container lid must be replaced when it is not in use. With frequent opening and closing, solvent loss increases solids content and viscosity. Lids and container edges should be kept clean of excessive primer or adhesive build-up to permit adequate container sealing. Labels should be clearly legible to ensure that the proper product is used for the particular job.

Prior to adhesive application, the core should be placed in the work area and its temperature should be permitted to reach ambient plant conditions. In the cooler months, cores that are stored or processed in unheated areas should be brought up to room temperature slowly and permitted to equilibrate to the plant conditions for a period of time. This step minimises the formation of condensation, which could compromise adhesion to the core. Additionally, it is important to ensure that the core surface is permitted to cool down to ambient temperature after friction heat is generated from belt sanding or blasting. When the core is too hot to be coated, typically above 60 ºC (140 ºF), the adhesive solvent carriers can evaporate very quickly, which can result in reduced wetting of the adhesive. Additionally, excessive adhesive film thickness can result in failure within the adhesive layer.

During layover periods, dust, release agent, oil, and other debris can also contaminate the core before adhesive application. During these periods, cores should be protected with plastic, vapour barrier paper, or other suitable material until the adhesive is applied. Care should be taken to avoid wrapping the material too tightly to avoid trapping excess moisture. As previously mentioned, cores are typically processed within 30-60 minutes after mechanical preparation.

Cores should be supported or elevated above the floor to reduce transfer of contamination during the application process. The core is commonly rotated by hand in a cradle or by use of a lathe while the operator traverses across the core surface with an adhesive loaded brush. Cores should continue to rotate to reduce the amount of tears that may form on the bottom leading edge. The continued rotation also reduces the dry times for the adhesives. Tears are typically caused by the adhesive's low viscosity and gravity. In some cases, excessive tearing can lead to failure to the core or failure within the adhesive layer. Since application methods vary, the product's viscosity may require adjustment with solvent diluents to optimise its application.

Adhesive systems are commonly applied by brushing. Brushing is a simple, effective, and comparatively inexpensive method to apply adhesive to the core. Natural or camel hair brushes are suggested because they offer improved wetting and leave behind fewer brush marks than less expensive disposable synthetic brushes. Adhesive systems are commonly hand brushed 'as received' from the container. When using this method, clean gloves and a clean working environment are essential. Brushes should be dedicated to the specific adhesive and should be thoroughly cleaned with the appropriate solvent after each use. Brushes should be replaced when worn or damaged and should not be stored inside the adhesive containers.

When solvent evaporation occurs, particularly with frequent opening and closing of containers, small amounts of dilution solvent should be added to the adhesive system to return it to its original viscosity. It is important to ensure that the proper solvent and amount is added to the adhesive. If an incorrect solvent is added, the material's stability, application, drying, and bonding performance may be compromised. If an incorrect amount is added, the applied adhesive thickness may not be within specification. When adding the proper solvent to the adhesive system, the mixture should be stirred while small amounts of solvent are slowly added to reduce the chance of 'shock'. Shock can occur when large amounts of solvent are added quickly with little or no mixing, and can result in 'gel-like' or hard-settled product that is unusable.

Viscosity (a measure of the adhesive's consistency) directly impacts product application characteristics and the amount (or thickness) of adhesive applied. The

General Electric Zahn viscosity cup is the common tool for monitoring in-process viscosities, and serves as a relatively quick check for adequate mixing and potential solvent loss. The frequency of Zahn cup checks is determined by production histories. It is suggested that initial checks be performed prior to the start of the job and periodically throughout the use of the product. The product literature contains typical viscosity specifications and the cup type to be utilised.

When the adhesive system is applied by brush, a smooth, uniform brush stroke technique is important to produce a uniform thickness of the adhesive system. One thin application coat is preferred over multiple coats. Multiple coats can often lead to poor adhesive performance due to shearing within the thick layer of adhesive.

Since dry film thickness is often impractical to measure due to the aggressive profile on the core, brass shim stock of approximately 50 microns (2 mils) and a micrometer can be employed at a relatively low cost. A dry film thickness measurement is done by placing a clean shim in the application area and coating it with the desired product. Once the product is thoroughly dry on the shim, measure the total thickness of the adhesive plus the shim, and then subtract the known shim thickness from the total to yield an approximate thickness of the adhesive film. This method is typically accurate within a few tenths of a mil and gives a relative thickness that covers the core. If the core has a suitable surface for measurements, digital film thickness gauges can be utilised, which are easy to use, quick and more precise than the shim and micrometer method.

The typical recommended dry film thickness of primers is 5-10 micron (0.2-0.4 mil) and of adhesives is 15-20 microns (0.6-0.8 mil), with an average of 25 micron (1.0 mil) for the two-coat system. One-coat adhesive systems normally require a dry film thickness of 18-30 micron (0.7-1.2 mil) to provide optimal performance. There are some product exceptions; check product literature for optimal dry film thickness. A common technique in the industry is to rely on visual inspection to avoid heavy or light application areas. Most importantly, a relationship between adhesive thickness and bond performance exists, and thin or thick applications of primer or adhesive can create a potential weak bond or failure.

Roll coating techniques with paint rollers and trays are used when brushes are not feasible for larger cores. The paint roller nap height is typically less than 6 mm (0.25 inch). The paint roller core and nap construction must withstand the solvent systems and should not release the nap onto the core surface during application. Similar to brush application, technique is important to successful roller application. Spray application with hand-held spray guns or pressure feed spray systems is occasionally used for bulk processing of smaller cores. Details on proper dilutions and equipment resources are contained in product literature and associated product guides.

Adhesive systems typically dry within 30 to 60 minutes after application at 24 °C (75 °F) and 50% relative humidity. If insufficient drying occurs, adhesion can be poor and typically results in large blisters or bubbles due to solvent entrapment. If more rapid drying is necessary, explosion-proof fans or ovens set at 66-93 °C (150-200 °F) for 5-10 minute cycles are satisfactory. If fans or ovens are not feasible or available, the drying time can be extended to several hours. Adequate ventilation in the immediate work area is necessary to avoid build-up of solvent vapours to provide a safe, suitable working environment. Once the adhesive films are thoroughly dry, the rubber lay-up step can begin.

The rubber lay-up and vulcanisation steps should begin as soon as possible after the adhesive system is dried. If longer time periods (layover) are required, adhesion tests should be used to ensure that the layover period does not impact adhesive performance. Typically, layovers can be extended for several shifts, provided the cores are protected from contamination. During layover, adhesive coated cores should be protected with plastic, vapour barrier paper, or other suitable material to protect against UV light and airborne contamination, particularly silicone release agents. Care should be taken to avoid wrapping the material too tightly to avoid trapping excess moisture.

Caution must be used to protect the coated core ends from contaminated gloves, while the core is transported to the rubber lay-up area. Contaminating, damaging, or removing the adhesive system by improper or rough handling of the coated cores may lead to failure of the adhesive system. Small areas should be thoroughly cleaned and touched-up with the primer or adhesive depending on the extent of damage. If larger areas are contaminated or damaged, the cores should be reprocessed.

Tack coats, tacky tie coats, or tie cements are used to help fasten the rubber to the adhesive surface during the rubber lay-up process. With particular core configurations and/or non-tack rubber formulations, such as EPDM, the tack coat is essential. Tack coats are usually brush applied to the dried adhesive surface just prior to the rubber lay-up step. The tack coat generally dries within 20-30 minutes; shorter periods may be used depending on the type of tack coat adhesive used and plant conditions. Caution should be used when applying a solvent-borne tack coat to reduce the potential of smearing or removing the adhesive system.

In most cases, the tack coat is custom manufactured by dissolving a suitable rubber into an appropriate solvent system. The solids, viscosity, thickness, and degree of tack should be monitored. Some tack coats are available commercially. In some instances, a light solvent wipe to the rubber surface can provide sufficient tack. This is performed just prior to rubber lay-up and caution must be used to reduce the chance of excess solvent entrapment, which typically results in blisters before or after the cure cycle.

9.1.4 Rubber Lay-Up and Curing

Whether hand lay-up of calendared sheet or automated extrusion feed is employed, it is important that all potential air pockets be removed to allow the rubber to remain in contact with the adhesive surface prior to and during the vulcanisation cycle. Air entrapment is more common with hand lay-up because of lower pressures and temperatures. Operator technique of the lay-up and subsequent shrink tape wrapping are key factors in achieving good contact pressures and minimising air entrapment. The rubber should always be freshly mixed to minimise surface bloom. Process oils or other ingredients that may bloom can degrade or interfere with the adhesive system's bond performance. Most importantly during cure, lack of or inconsistent heat and pressure can compromise adhesive performance. For optimal bond results, each manufacturer must optimise and monitor the cure time, ramping, and temperature parameters for best adhesive performance.

9.1.5 Troubleshooting

Every roll manufacturer strives for a high quality roll, but bond failures do occur. Failures result from a variety of causes, and gathering all processing information, along with the details on the location and type of failure that occurred, as well as the number of failures, is important to aid in resolving the bond problem. Manufacturing failures can be a result of a single step or a combination of several or multiple interactions of processes and materials.

Failures can become expensive with associated labour, materials, and downtime required for customer replacement. Occasionally, bond failures are not detected on the finished roll, so careful final inspections should be conducted prior to shipment to minimise this possibility.

The cause of a bond failure can become very difficult, sometimes impossible, to determine after a roll has been returned from service. Most often, key information is lost because of oxidation and corrosion, plus the abrasive and polishing effect of the rubber against the adhesive and the core. Occasionally, the failure may be the result of an environment or condition that is rated beyond the capabilities of the materials utilised. The most common examples of failures are caused from excessive temperature, chemical attack, excessive load and speed conditions or deformation in the rubber cover.

The American Society for Testing and Materials provides a set of detailed symptom descriptions for bond failures. These can be used to assess the problem to determine appropriate corrective actions. (The terms, 'elastomer' and 'adhesive' can be interpreted as 'rubber' and 'cement,' respectively). Rubber failure is always the end goal and is considered the best bond obtainable. **Table 8** is a troubleshooting guide for rubber rolls.

9.2 Bonding Urethanes

There are four basic types of polyurethane materials utilised in the rubber-to-metal bonding industry. The types include Reaction Injection Moulding (RIM), millable gum, thermoplastic urethanes (TPU) and castable polyurethanes.

Castable polyurethanes are the most popular material choice when bonding, and the conventional systems are comprised of two components: an A or resin side consisting of a polyester or polyether based polyol coupled with a TDI (toluene diisocyanate) or MDI (methyl diisocyanate), and a B or curative side typically based on active hydrogen, either hydroxyl or amine chemistry. Once the heated components are mixed, degassed, then cast, the polyurethane moulded assembly is produced. The focus of this section is bonding castable polyurethanes to substrates.

9.2.1 Bonding Applications

The majority of bonding applications include industrial rollers, machinery wheels and casters, elevator track/door wheels, and amusement ride wheels. Other

Table 8 Rubber roll adhesive troubleshooting guide

Failure mode	Possible cause	Corrective action
Cement-to-metal: Look for partial or complete removal of primer and/or adhesive from core surface. Look for partial or complete transfer of primer and/or adhesive to the rubber surface.	Contamination before, during, or after core preparation	Remove fine media, core material, greases, oils, dirt or other contaminants. Re-process the core.
	Excessive oxidation of the prepared core	Remove the weak oxide layer. Reduce the layover time before primer or adhesive application.
	Insufficient anchor profile on the core	Install new belts or charge new blast media to improve the profile.
	Core is too cold or hot prior to primer and/or adhesive application	Allow the core to equilibrate to room temperature before primer and/or adhesive application.
	Primer and/or adhesive is out of shelf life	Use fresh primer and/or adhesive and dispose of expired material.
	Insufficient mixing of primer and/or adhesive	Remix primer and/or adhesive until solids are completely dispersed.
	Solvent loss in primer and/or adhesive	Cautiously add proper solvent in small amounts while mixing.
	Improper thickness of primer and/or adhesive	Re-apply primer and/or adhesive at the proper thickness(es).
	Insufficient drying of primer and/or adhesive	Extend primer and/or adhesive dry times. Use low heat if available.
Cement-to-primer: Look for primer and adhesive separating from each other. (Occurrences are rare.)	Contaminated primer or contaminated primer surface	Use fresh primer and dispose of contaminated primer. Identify/remove contamination.
	Incorrect primer and adhesive combination	Re-check combination; consult for proper combinations.
Rubber-to-cement: Look for adhesive adhering to the core surface, and not to the rubber surface.	Adhesive is out of shelf life	Use fresh adhesive and dispose of expired material.
	Improper thickness of adhesive	Re-apply the primer and/or adhesive at proper thickness(es).
	Contaminated adhesive or contaminated adhesive surface	Use fresh adhesive and dispose of contaminated adhesive. Identify/remove contamination.
	Lack of heat and/or pressure during the cure cycle	Check cure parameters, ensuring that sufficient time and temperature conditions were used. If shrink-wrap is used, check for sufficient pressure.
	Adhesive/rubber incompatibility	Select another adhesive system.

examples include seals and mounts utilised in mining, agricultural and oilfield industries. In these examples, the adhesives must be engineered to withstand dynamic loads under varying temperatures as well as water and harsh chemical environments.

Substrate preparation is the foundation for successful adhesion. Most often with the bonding applications, the substrate is mild steel or aluminium. The parts are typically degreased with the appropriate solvent, such as MEK, abraded, such as grit blasting, followed by a final degrease. It is common practice to grit blast the substrates with 707-420 micron (25-40) mesh grit media to provide an aggressive anchor profile. An aggressive profile is important because it promotes good wetting of the adhesive, especially under the high shear loads, which are due to the high tensile strength of the polyurethane system. After preparation is completed, adhesive application should be completed as soon as possible (typically within 1 hour) to avoid the reformation of weak oxide layers, which can compromise adhesive bond performance.

9.2.2 Adhesive System Selection

This is a range of adhesive systems for castable polyurethanes. Thinners can be used to improve brush and dip application or when spray application is necessary. Non-pigmented versions of adhesives can be used when cosmetics are of concern. To determine which adhesive system is best, bond testing with the specific substrates and polyurethane systems is required.

9.2.3 Adhesive Application

The adhesive systems can be applied by a number of different methods. Most adhesives are brush applied; however dip or spray or other forms of application can be employed, depending on the equipment available, assembly configuration and volume requirements. For optimal performance of the adhesive, apply it at the recommended dry film thickness. Avoid thick or thin applications as they can lead to poor adhesive performance.

After adhesive application and sufficient drying (typically 1 hour at room temperature), a pre-bake cycle of the adhesive coated substrate is recommended. The purpose of the pre-bake cycle is to begin activation of the adhesive to the substrate, bring the temperature of the substrates close to the casting temperature, and improve the environmental performance of the final assembly. Pre-bake is accomplished by placing the adhesive coated parts into a safety-approved oven for a minimum cycle of 2 hours at 121 ºC (250 ºF). The optimal time and temperatures depend on the mass, configuration and materials being processed.

Prior to the casting process, the two components (the resin and curative) are pre-heated, mixed together and de-gassed to remove trapped air during the mixing step. Next, the pre-baked adhesive coated substrate is placed into a mould cavity, followed by the casting of the polyurethane to fill the mould cavity. After the casting is completed, a cure cycle (typically 1-2 hours) is performed, followed by demoulding with a final post-bake oven cycle (typically 4-8 hours) of the moulded assembly. The temperatures of the urethane components, casting, moulds and post-bakes are in the range of 82-121 ºC (180-250 ºF). The optimal times and temperatures depend on the material choices and are optimised through testing.

Once the moulded assembly has cooled, the adhesive strength can be evaluated. The end goal is to produce a polyurethane-tearing bond, wherein the polyurethane fails cohesively (i.e., failure within itself).

Table 9 is an example of a bonded test sample with some environmental data using CHEMLOK 213.

9.3 Thermoplastic Elastomer Bonding

The introduction of thermoplastic elastomers (abbreviated TPE) into the marketplace in recent years has permitted the end user to compete against thermoset rubbers. TPEs can offer the physical properties of thermoset rubber with the advantages of thermoplastic processing. Essentially, the TPE is a formulation comprised of two main materials, small rubber particles dispersed within a plastic matrix. The three general types of TPEs include styrenic thermoplastic elastomers, hard polymer/elastomer alloys and multi-block polymers with hard crystalline segments. Specific classifications include SBCs (styrene blocked copolymers), TPOs (thermoplastic olefins), TPVs (thermoplastic vulcanisates), TPU (thermoplastic urethane), and COPEs (copolyester elastomers). The array of material combinations for TPEs has permitted performance advantages against thermoset rubbers coupled with the ease of thermoplastic processing, reduced cost, design flexibility, high production throughput, and reduced waste with the ability to recycle. These materials are processed through the use of plastics technology through injection, extrusion and blow-moulding techniques. The focus of this section will be the discussion of injection moulding of TPEs to substrates utilising adhesives.

Table 9 Adhesion values (cast urethane to metal)

Specific test	**Adhesion results (N/25 mm)**
Initial primary adhesion @ 0.5 mils DFT	689 N (155 PLI)
Initial primary adhesion @ 1.0 mil DFT	1326 N (298 PLI)
2 h boiling water	1000 N (225 PLI)
Pulled @ -35 ºC (-30ºF)	2015 N (453 PLI)
Pulled @ 100 ºC (212ºF)	792 N (178 PLI)
7 day salt spray ASTM B117	983 N (221 PLI)
14 days @ 38 ºC (100ºF)/100% R.H.	916 N (206 PLI)

DFT = dry film thickness, N = Newtons, PLI = pounds per linear inch, castable polyurethane to grit blasted SAE 1010 cold rolled steel per ASTM D429B, modified to 45º angle of peel, pulled at 50 mm/minute, fluid soaks at room temperature

9.3.1 Bonding Applications

Adhesive systems play a key role in adhesion where the bond interface between the TPE and the adjoining substrate is important. Some of the bonded examples include various handles or grips for industrial tools, medical instruments, sporting equipment, as well as bumpers, rollers, and various automotive interior/exterior components. Other examples include various seals, impellers and electrical plug body terminations. In these examples, the adhesives must be engineered to withstand dynamic loads under varying temperatures as well as protection against water and harsh chemical environments.

9.3.2 Bonding Methods

There are two general types of bonding TPEs with adhesives. The first type involves bonding a substrate to a pre-moulded TPE by use of a structural adhesive, such as a urethane, epoxy or cyanoacrylate. The choice of adhesive type depends on the specifics of the application. This process is typically carried out at room temperature with little or no heat and pressure.

TPEs by nature present non-polar surfaces; therefore a primer can be used in conjunction with the structural adhesive to promote bonding. A primer may also be used on the TPE surface when various protective coatings or double-sided acrylic tapes are required.

The second type of bonding involves the use of injection moulding machinery, where an adhesive coated insert is placed into a mould cavity, followed by TPE injection to form the moulded assembly. The insert is first prepared by chemical and/or mechanical preparation, followed by adhesive application. Most often, the inserts are degreased with an appropriate solvent, such as MEK, followed by mechanical preparation, such as grit blasting, with a final degrease to complete the preparation process. The prepared inserts should be coated with the adhesive as soon as possible (typically less than 1 hour) to minimise the chance of forming weak oxide layers. If weak oxide layers are present, they can interfere or decrease adhesive performance.

9.3.3 Adhesive Selection (for Use in Injection Moulding)

With the variety of materials available, **Table 10** summarises Chemlok adhesive selection for many of them.

Table 10 Adhesive selection for TPE bonding

Type of thermoplastic material	Chemlok adhesive
Santoprene®	487A/B or 481/Curative 44
Kraton G®	487A/B or 481/Curative 44
Sarlink® 3000-9000	487A/B or 481/Curative 44
Alcryn®	480/Curative 44
Sunprene®	485/Curative 44
Telcar®	487A/B
Estane®	213, 219, 610
Hytrel®	218, 250, 402
Pellethane®	213, 219, 610
Texin®	213, 219, 610
TPSiv®	AP-134, 213, 218

Santoprene® registered trademark of Advanced Elastomer Systems, Kraton® registered trademark of GLS Corporation,
Sarlink® registered trademark of DSM Elastomers, Alcryn® registered trademark of Advanced Polymer Alloys,
Sunprene® registered trademark of A. Sclulman Inc., Telcar® registered trademark of Teknor Apex,
Estane® registered trademark of Noveon, Hytrel® registered trademark of E.I. DuPont de Nemours and Company,
Pellethane® registered trademark of Dow Chemical Co., Texin® registered trademark of Bayer Polymers and
TPSiv® registered trademark of Multibase

9.3.4 Application

Most adhesives are brush applied; however dip or spray or other forms of application can be employed, depending on equipment available, assembly configuration and volume requirements. For optimal performance of the adhesive, apply it at the recommended dry film thickness. Avoid thick or thin applications as they can lead to poor adhesive performance.

9.3.5 Pre-Baking Adhesive Coated Parts Prior to Moulding

After adhesive application and sufficient drying (typically 1 hour at room temperature), a pre-bake cycle of the adhesive coated part is suggested to improve adhesive performance. This is accomplished by placing the adhesive coated parts onto a hot plate or safety approved oven residing near the injection machine. A pre-bake cycle of 10-15 minutes at 121 ºC (250 ºF) is typical, but the optimal cycle depends on the part configuration, materials and equipment utilised. The next step involves placing the adhesive coated part while still hot into the mould cavity (immediately following pre-bake), followed by TPE injection to fill the cavity.

9.3.6 Injection Moulding

Most TPE materials are pelletised for ease of handling, charging the hopper and facilitating melt flow. TPEs can be processed directly from their packaging, however a drying cycle may be required prior to processing to drive off potential moisture absorption. Rear, centre and front zones of the injection machine are typically held in the 177-204 ºC (350-400 ºF) range. Pack pressures are typically 28-83 bar (400-1200 psi), however the specific settings must be established with set-up trials. The temperatures and pressures depend on the specific TPE material that is processed, the assembly configuration and the injection equipment utilised. Mould cycle dwell times are typically 15 seconds to one minute, depending on the amount and type of TPE processed. The moulds are typically water cooled to maintain mould temperatures under 66 ºC (150 ºF) to allow the TPE to cool and permit demoulding of the bonded assembly.

9.3.7 Checking Bond Adhesion

Once the moulded assembly is demoulded, it is suggested to allow it to sit for 24 hours before checking adhesive bond strength as there may be further crosslinks established during that period. The end goal is to produce a bond wherein the TPE fails cohesively (i.e., failure within itself). It has been noted that softer durometer TPEs are typically easier to bond than harder durometer TPEs, which is probably due to differences in formulation.

9.3.8 Bond Performance

Table 11 shows an example of a bonded test sample with some environmental data using CHEMLOK 487A/B:

Table 11 Adhesion of Santoprene® to metal

Specific test	Adhesion results (N/25 mm)
Initial primary adhesion	107 N (24 PLI) -100R
99% Sulfuric acid	102 N (23 PLI) -100R
50% Sodium hydroxide	102 N (23 PLI) -100R
Transmission oil	67 N (15 PLI) -100R
Brake fluid	107 N (24 PLI) -100R
ASTM Oil #1	107 N (24 PLI) -100R
ASTM Oil #3	80 N (18 PLI) -100R

N = Newtons, PLI = pounds per linear inch, R = rubber failure, Santoprene® 101-45 (AES) bonded to SAE 1010 cold rolled steel per ASTM D429B, modified to 45 peel, pulled at 50 mm/minute (2'/minute), fluid soaks for 7 days at room temperature

9.4 Rubber Lining

The practice of bonding rubber liners to various types of storage tanks, mixing blades, pipes, and other process equipment has been going on for much of the 20th century. A critical factor in the rubber lining of storage tanks, mixing blades, pipes, and other process equipment is the proper selection and application of the adhesive system. Without suitable adhesives, the rubber lining could not be applied to the object, the lining would not be held in place, and the total system would fail. Thus, adhesives play a vital role in the lining industry.

9.4.1 Surface Preparation

For metals in rubber lining, surface preparation is accomplished by blasting with a suitable media such as aluminium oxide or iron oxide. The media size is usually 30-40 grit. Grit media is preferred over shot, since it produces a rough open surface, while shot peens or merely dents the metal surface and can drive the dirt into the metal causing occlusion of loose particles. The blasted surface is brushed or vacuumed cleaned to remove any loose particles and create a dust free surface to which the adhesive is applied. The blast media removes scale and oxide layers exposing a fresh metallic surface. Once the metal is clean and rough it is more chemically reactive and receptive to chemisorption by the primer. It is suggested to prime the prepared surface the same day it is blasted.

Satisfactory adhesion can be achieved to cast iron, although its porosity can present problems due to entrapped machine oil. Due to the porosity, two coats of primer may be required to get sufficient coverage.

For stainless steel, it's important to prime the surface immediately (within 1 hour) after blasting. While the percentage of chromium has been noted not to affect adhesion, the bond strength can decrease with an increase in the nickel content. So in mining operations, 12% chromium containing stainless will be superior to mild steel in resistance to mine water and can be bonded.

Concrete does not readily lend itself to rubber lining due to its inherent moisture, and laitance of freshly poured concrete (the powdery skin). However, the CHEMLOK 289/290 adhesive system has been successfully used in laboratory testing to bond natural rubber to concrete with an open steam cure. Fresh concrete should cure for 30 days prior to bonding. The surface should be clean, rough, and can be primed with a low viscosity two-part polyamide curing epoxy primer.

9.4.2 Rubber Lining

The bond surface of calendered uncured rubber is covered with plastic wrapping to protect it from contaminates and prevent the rolled stock from sticking to itself. After the plastic lining is removed, it is common for the surface to be washed with solvent (toluene, xylene, etc.), or a coat of tack cement is applied. Solvent washing, or the application of the tack cement allows the liner to stay in place when mated to the substrate surface.

9.4.3 Rubber and the Cure System

There are a variety of adhesive systems available today for rubber lining. The two major parameters are, what rubber is to be used and what is the method of cure.

For most rubber lining, natural rubber or natural rubber backed butyl types, and chloroprene are most commonly used. **Table 12** is a guideline in the Chemlok adhesive selection process for rubber lining. For autoclave cures, a great variety of adhesives are available, with just a few of the options listed here. Under these conditions, there is pressure and excellent heat transfer, sufficient to thermally activate the adhesives.

In open steam curing (pressureless cures), adhesion was achieved for CHEMLOK 220/TY-PLY RC system if the bond line temperatures were consistently maintained at about 80 °C (175 °F). However with the CHEMLOK 289/290 system, adhesion can obtained at lower cure temperatures.

Table 12 Adhesive selection for rubber lining

Rubber tpe	Autoclave (primer/adhesive)	Steam cure (primer/adhesive)	Chemical cure (primer/adhesive)
Natural	CHEMLOK 289/ CHEMLOK 290	CHEMLOK 289/ CHEMLOK 290	CHEMLOK 289/ CHEMLOK 290
	CHEMLOK 220/ CHEMLOK Ty-Ply RC	CHEMLOK 220/ CHEMLOK Ty-Ply RC	
Chloroprene	CHEMLOK 205/ CHEMLOK 220	-	- -
	CHEMLOK 289[1]	CHEMLOK 289[1]	-
Chlorobutyl	CHEMLOK 289/ CHEMLOK290	CHEMLOK 289/ CHEMLOK 290	-

[1]Single coat adhesive system

Note: CHEMLOK 286 tack cement may be used for natural rubber bonding using autoclave, exhaust steam cures, or chemical cures. For butyl types and EPDM, use CHEMLOK 287. A polychloroprene-based cement is used for chloroprene.

In many practical applications the steam may be at 93 °C (200 °F) or more, but the bond line temperature will never get that high due to the temperature surrounding the outside of the tank. If a tank is being lined in equatorial Africa or the mining country of northern Australia, there probably won't be a problem. In cold regions, a shroud may be needed over the tank to allow steam to circulate around the outside of the tank.

There are also chemical cure systems used in rubber lining. In this case, the rubber is compounded with several parts of an amine activator such as dibenzylamine. The rubber is then coated on the outside several times with carbon disulfide (CS_2), a highly flammable liquid. Being low in molecular weight, the CS_2 can easily diffuse into the rubber, where in combination with the dibenzylamine, it generates a species that can crosslink or cure the rubber. Without heat, it may take 7-14 days to get the rubber to the desired Shore A hardness. In addition to carbon disulfide, other sulfur donor materials can be used. They are safer to handle than the carbon disulfide, but are reported to be slower reacting. For these types of applications, it is desirable to have an adhesive, which will react with the curative system of the rubber, as opposed to being strictly heat activated.

Laboratory data has shown that CHEMLOK 289/290, not only works well in autoclave cures, but bonds well in pressureless steam cures, and with chemical cures. **Table 13** shows that the bonds in chemically cured specimens are very comparable to those obtained in autoclave and steam cures. This unique ability to function in a variety of curing conditions is primarily a function of the CHEMLOK 290 covercoat.

Table 13 Adhesion to various NR compounds using different cure conditions[1]

Condition	Cure	Durometer	Adhesion (N/25mm)
Autoclave	60[1] @ 132 ºC	32	131 100R
Steam	24 hrs @ 88 °C	32	245 100R
	23 hrs @ 88 °C	60	223 100R
	46 hrs @ 82 °C	60	250 100R
Chemical	5 days @ 43 °C	57	250 100R
	5 days @ 43 °C	53	289 100R

[1] *CHEMLOK 289 Primer*
CHEMLOK 290 Adhesive
CHEMLOK 286 Tack Cement

9.4.4 Primers/Adhesives/Tack Coats

Once the type of rubber and the cure system is known, suppliers can then suggest an appropriate adhesive system. Today, most adhesives for rubber lining, and in fact, most rubber bonding in general, consists of two coats – the primer and the adhesive. Of course, tack cement is then used on top of these to hold the liner in place during curing.

The primer, as mentioned earlier, must be applied to clean fresh metal surfaces. It should be reasonably resistant to UV light since it may not be cover coated for several days. It must also have resistance to corrosive attack by oxidation, and to condensation occurring due to a temperature drop below the dew point.

The covercoat adhesive is usually applied just prior to layup of the rubber. It's also desirable to have the covercoat adhesive be a different colour or at least a different shade of the same colour as the primer, to aid the workers in knowing where they are at during the application.

Selection of a tack coat, like adhesive selection, is dependent upon the type of rubber being bonded. For natural rubber, natural rubber cements are used, while chloroprene will usually have a chloroprene cement, and chlorobutyl, a butyl type cement. The cements are usually more than just the rubber being bonded dissolved in solvent. The cements contain their own cure systems and tackifiers to enhance the tackiness of the rubber cement for building purposes.

9.4.5 Adhesive Handling

Since adhesives and primers contain a variety of ingredients, phasing and settling can occur within the container. Therefore, in most cases, the adhesive must be stirred well prior to use and during use. The appearance of spots, the lack of normal colour, streakiness, and poor hiding quality are often indications that the adhesive needs to be agitated. Consult with the manufacturer to determine proper handling of the adhesive.

If the adhesive is noted to be thickening with time, it may be due to loss of solvent because the lid is not sealed or is being left off during use. Applicators/inspectors might consider using a Zahn cup type viscometer to monitor the thickness of the adhesives and compare their readings to the supplier's values. These viscometers are easy to use, and lend themselves to field use. However, it is important that they be kept clean when not in use.

Adhesives should be stored in a similar fashion as the rubber. They should be kept out of direct sunlight, rain, and snow. Indoor storage is recommended.

The primers, adhesives, and tack cements are in solvents, and are usually flammable. A material safety data sheet should be consulted for each product to ensure safe use.

9.4.6 Application

Brushing, dabbing and roller coating are the most common ways of applying adhesives in lining. Generally the products are supplied in a ready-to-use manner. Again, each supplier's product information sheet needs to be consulted for guidelines on film thickness. Depending on the degree of blasting and the type of primer being applied, one or two coats may be required. Adequate dry times should be permitted between coats of primer and adhesive, and between adhesive and tack cement.

Generally, exposure of the cements and adhesives to adverse environments prior to the rubber lay-up can be expected to have a negative effect. Such things as chlorine gas, diesel exhaust fumes, and UV radiation (i.e., sunlight) can be considered as possible adverse environments. **Table 14** for example, shows the negative effect of UV radiation on the adhesive CHEMLOK 290 but not on the CHEMLOK 289 primer. This suggests that the adhesive should be applied just prior to lay-up where sunlight exposure occurs.

Table 14 UV Resistance of CHEMLOK 289/290[1]

Layover exposed	Exposure time (min)	Adhesion[2] (N/25 mm)	
		Steam cure[1]	Chemical cure[3]
CHEMLOK 289	30	328 100R	223
	60	320 100R	233
	120	315 100R	210
	240	315 100R	193
CHEMLOK 290	30	320 100R	201
	60	289 100SR	201
	120	258 100SR	60
	240	79 100RC	22

[1]Steam Cure CHEMLOK 286 Tack Cement Natural Rubber
[2]100R = 100% cohesive rubber failure
SR = spotty rubber failure
RC = rubber-to-cement failure
[3]Dibutyl xanthogen disulfide (available from Robac Chemicals, www.robac.co.uk), 60 Shore A Natural Rubber. Exposure to Johannesburg April Sunlight, 10 AM – 2 PM.

9.4.7 Quality Control

As part of a quality control program, it is recommended that the manufacturer use witness panels, made in accordance with ASTM D429E, to check the quality of the bond. A witness panel is a separate bonded assembly that goes through the same processing as the actual finished part. When the bonding process is complete, the manufacturer will have a bonded test piece (i.e., witness panel), to check the quality of the bond. The use of a witness panel provides the manufacturer, and their customer with bond data from each specific job. The quality of the bond is determined by the pounds pull and the mode of failure of the test panel. The desired mode of failure is 100% rubber retention.

9.4.8 Summary

Rubber lining of various types of storage tanks, mixing blades, pipes and other process equipment continues to be an important process for many manufacturers. The use of adhesives in this process is largely an art, but the use of good manufacturing practices and sound scientific principles make up the foundation for this process. Manufacturers continue to use time-tested procedures to make valued added components.

9.5 Adhesives for Seals and Gaskets

Since the industrial revolution there has been a need to lubricate moving parts and reduce friction. In most cases a grease or fluid of some type is used as a lubricant. Early automobiles used cork or leather to seal in fluids for engine and transmission applications. Combustion engines also required cooling and fluids are again used to keep engines at the proper running temperature. To hold the fluid in the desired locations rubber seals and gaskets were developed. Synthetic rubber compounds such as nitrile and silicone provided good sealing for shaft seals in engines and transmissions. While synthetic rubber is used to contain the fluid, organic adhesives are used to bond the rubber in place. These applications are some of the most demanding for both the rubber compound and the adhesive. As the temperature requirements have gone up new polymers have been developed to provide longer service life. Increasing temperatures have led to the development of new fluids.

New fluids, new polymers, and higher temperatures have also led to the development of new adhesives.

Dynamic seals are defined as rubber-to-metal bonded components used for sealing fluids in crankshafts, transmissions, water pumps and brake applications. In modern automobiles, the dynamic seals are comprised of a compounded elastomer that is adhered to a metal support using an adhesive. The adhesive is applied using spray, dip, dip-spin, or brush techniques. The adhesive looks like a paint or thin coating on the metal substrate. The adhesive is air-dried or dried using a heat source. The adhesive coated metal is then placed in a mould and the rubber is introduced. The three rubber moulding processes commonly used are: compression, injection and transfer. The rubber is then cured using both heat and pressure. While the rubber is curing in the mould the adhesive is also curing and forming chemical bonds at the metal and rubber interfaces. The type of elastomer selected is primarily based upon its ability to resist the fluid it will be exposed to in service. Other factors that influence the choice of elastomers include cost, inherent dimensional stability and properties such as compression set, tear resistance and hardness.

Other types of seals fall into the category of gaskets. These include oil pan gaskets, head gaskets and exhaust manifold gaskets. In gasket applications sometimes an elastomer is bonded to the metal and is handled much like the dynamic seals described above. In the case of multilayer steel (MLS) gaskets and exhaust manifold gaskets a coating is applied that forms the seal between metal interfaces. The coating is often applied using reverse roll coating techniques. Once applied the coating is then cured in an oven to achieve the desired properties. Later the actual part can be stamped out of the coil stock. Here the coatings can be either one or two coats. Two coat systems are comprised of a primer or first coat and then a second coat of a different composition often called a covercoat. Adhesion only takes place between the primer and the metal or between the primer and covercoat. The covercoat or one-coat formulations include a rubber component that eliminates the need for a rubber bonding step.

9.5.1 Adhesive and Coating Selection

Adhesive selection for dynamic seals depends on the elastomer to be bonded. Other factors might include cost and preference for either water-based, environmentally preferred adhesives and coatings (EPCA), or solvent-based products. The adhesive chosen must withstand the service environment of the seal. This includes resistance to a variety of hot fluids and wide range of temperatures.

Table 15 is a Chemlok adhesive selector guide for the different compounds typically used in dynamic seal applications; most are either environmentally friendly or aqueous formulations.

Motorguard® 1100 (Lord Corporation) is a solvent-based coating developed for exhaust manifold gaskets. This low friction coating was developed for bonding to stainless steel. It is resistant to both high temperature and hot fluid. This coating should help reduce the 'ping' sound that occurs as the metal cools down and contracts after the engine is shut down.

9.5.2 Summary

The dynamic seal market uses a wide variety of synthetic rubber compounds. No single adhesive can bond all compounds and withstand all environments. This is also an area where new rubber compounds are constantly being developed to meet the needs and requirements of the automobile manufacturers. Before a new compound can be used there must be an adhesive system capable of bonding that compound. The adhesive must then be able to maintain adhesion throughout the life of the part even when exposed to extreme temperatures and harsh

Table 15 Adhesive selection

Elastomer	Solvent based	EPCA solvent	Aqueous
Ethylene-acrylic	CH250 CH250X CH5150	CH6250	CH610 CH8114 CH130 CH8115
Fluorocarbon	CH5150 CH5151	CH5150 CH5151	CH610 CH8114 CH130 CH8116*
Nitrile (NBR)	CH205 TY-PLY BN	TY-PLY BN	CH8110 CH8115 CH8116*
HNBR			CH8116* CH8117*
Polyacrylate	CH250 CH250X	CH6250	CH610 CH8110 CH130 CH8114
Silicone (peroxide)	CH607 CH608 CH Y-1540	CH607 CH608 CH Y-1540	CH8116* CH8117*

** Requires peroxide cure system in elastomer* fluids. If no adhesive currently exists a new formulation must be developed. Environmental regulations being adopted limit the adhesive manufacturer on what can be used in new formulations. For all of the above reasons there are a number of adhesives to choose from. Most of the new adhesive formulations are either environmentally friendly solvent-based adhesives or are aqueous products.

9.6 Adhesives for Automotive Weatherstripping

The quiet ride of today's automobiles, trucks and vans can be attributed to many rubber-to-metal bonded components. These components reduce or remove noise, shock and vibration in the various areas of the vehicle. Included in these ride improving components are automotive weatherstrip. Weatherstrip is used to seal window, door, hood, decklid and sun/moon roof openings. An intricate extruded profile is assembled consisting of an elastomeric material extruded over and bonded to a supported carrier. These profiles are designed to seal the passenger compartment from outside noise, dirt and inclement weather. Additionally, the weatherstrip retains heat in the winter/air conditioning in the summer, maintains clean glass surfaces, and sustains ice release properties between surfaces for ease of opening power windows and doors. Weatherstrip around the trunk, the hood, and the door openings also provide a buffer between the metal frame and the closure panel, reducing metal on metal noise.

9.6.1 Metal Profile Carriers

The metal carrier provides structural integrity for the profile. Some weatherstrip designs do not require a solid metal carrier and instead employ a woven wire mesh (lance) that can be formed as a support for the elastomeric component. Most often an adhesive is not required for the lance as the rubber will penetrate the lance and provide a mechanical lock to the carrier. The typical metal types used for weatherstrip carriers are aluminium, stainless steel and electrogalvanised steel. Adhesion of an elastomeric component to these surfaces requires the use of a primer and a topcoat. Prior to application of the primer, typical pretreatment for the aluminium is to clean the surface with detergent and a rinse, followed by a chrome-free pretreatment. For stainless steel the surface is commonly abraded to an R-19 scuff factor, cleaned, and treated with a chrome free pretreatment. Electrogalvanised steel generally has a very high zinc content. This metal is also given a chrome-free treatment. The metal is coated while it is in the form of a coiled roll. Application of the primer and adhesive requires a unique application technique known as coil coating.

9.6.1.1 Coil Coating

Coil coating is the continuous application of a primer and an adhesive to one or both sides of a metal coil. A cleaned and treated metal coil is uncoiled, run through a roll coat setup, followed by a bake cycle to dry/set the primer. The coating and baking steps are repeated for the topcoat adhesive application and the coil is rewound for shipment to a slitter or direct to the customer who will be manufacturing the weatherstrip.

Coil coating lines can be either single or tandem in setup. A single line means that the primer is coated and baked onto the metal, and then the coil is rewound. The coil is again fed through the single station coater for application of the topcoat adhesive. With a tandem line, the primer is applied and baked and the topcoat is applied and baked using two coating stations in line with one another. A typical tandem line is depicted in **Figure 26**.

This unique application method has many advantages. The transfer efficiency of the primer and the coating is 100%. Line speeds vary within the industry, but at a typical line speed of 150-250 feet per minute, this method produces a large quantity of coated substrate quickly. With the ability to coat both surfaces at one time, this also saves application time. Coil coating also allows the applicator control of the wet and dry film thickness of the primer and coating within very tight tolerances, as well as control over the cure state of the primer and adhesive. Energy savings can be achieved as many coil coaters recover heat from burning solvents being emitted.

Due to the high capital investment needed to build a coil coating line, there are dedicated businesses known as custom coil coaters, which weatherstrip manufacturers contract to coat coils for them. Not all coil coaters are setup to coat rubber to metal bonding adhesives. Reference the National Coil Coating Association online for a list of coaters (www.coilcoating.org).

9.6.1.2 Selecting Primers and Adhesives

The weatherstrip manufacturer selects primers and adhesives that are applied to coiled metal. Once the metal has been coated it will be slit into narrow widths, sometimes referred to as 'pancakes'. These 'pancakes' are then roll formed into an intricate shape as per the

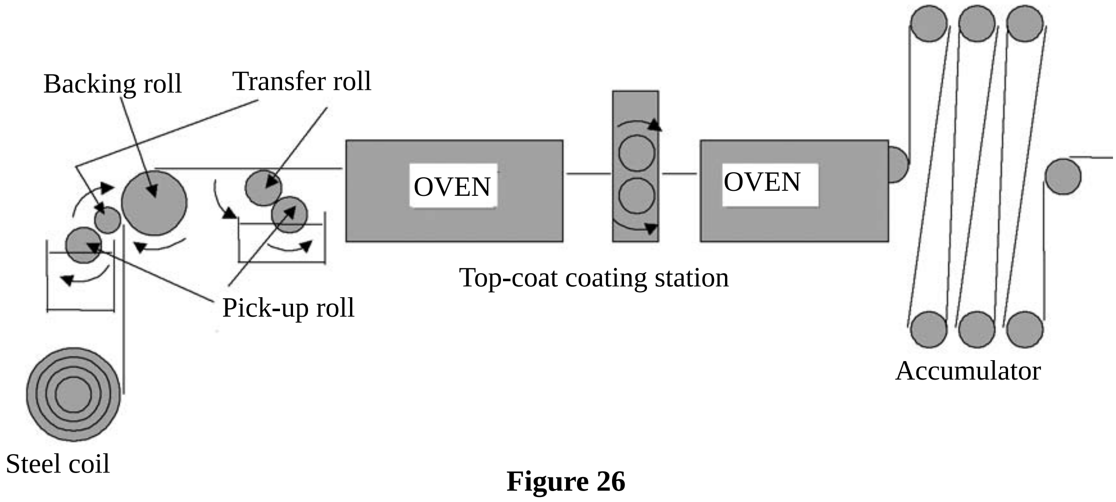


Figure 26

Coil coating line

OEM design print. The roll forming operation can bend the metal back upon itself referred to as an 0T-bend, or it may form gentle bends in the coated metal. Most rubber to metal adhesives do not have the flexibility to adhere to metals under such severe distortion. Lord Corporation has developed a primer specifically for the coil coating industry called CHEMLOK 208A primer which was formulated to provide the needed flexibility at a viscosity suitable for reverse roll coating application. The primer should be applied to the metal, targeting a wet film thickness of 10.2-25.4 microns, which will deposit a dry film thickness of 2.5-5.1 microns. Following the application of the primer, the metal should be baked to a peak metal temperature between 220-230 ºC to thoroughly cure the primer and to attain the maximum environmental performance. Physical properties for CHEMLOK® 208 Primer are given in **Table 18**.

Special adhesive systems have also been developed to adhere to extruded EPDM, common weatherstrip material. CHEMLOK® 237A Adhesive has been used for bonding weatherstrip carrier for over 25 years. With recent movement from heavy-metal containing materials on automotive parts, Lord Corporation has developed an environmentally preferred adhesive for EPDM rubber, called Autoseal® 3370 Adhesive (Autoseal® is a trademark of Lord Techmark Inc.). A comparison of the typical properties of both adhesives is given in **Table 19.**

Unlike the primer coat, the adhesive layer requires a much lower bake temperature following the application step. Both CHEMLOK 237A adhesive and Autoseal 3370 adhesive require a peak metal temperature between 138-149 °C. CHEMLOK 237A adhesive should be applied at a wet film thickness of 33.9-50.8 microns for a dry film thickness of 5.1-7.6 microns. It is imperative that the peak metal temperature be achieved. If the temperature is exceeded the adhesive could become fully cured and have no activity available for bonding to the elastomer during the extrusion process. If the metal does not reach the peak metal temperature, the adhesive could be undercured to the point where it

Table 18 Typical physical properties for CHEMLOK 208A Primer

Physical properties	CHEMLOK® 208A Primer
Viscosity:	
- Brookfield	75-200 cPs
- Zahn #4	13 seconds
% Solids:	
- Weight	33%
- Volume	23%
Appearance:	Grey liquid

Table 19 Typical physical properties of CHEMLOK 237A adhesive and Autoseal 3370 adhesive

Physical properties	CHEMLOK® 237A Adhesive	Autoseal® 3370 Adhesive
Viscosity:		
- Brookfield	150-450 cPs	200-800cPs
- Zahn #4	16-35 seconds	18-59 seconds
% Solids:		
- Weight	22%	25%
- Volume	13%	15%
Appearance:	Black liquid	Black liquid

will bond, or block, to itself when it is recoiled following coating application. Testing is available to determine if adequate cure is achieved.

With the movement of weatherstrip elastomeric materials going from EPDM rubber to thermoplastic vulcanisates (TPVs), newer adhesive systems are being developed to be coil coated to metal. Adhesives are presently available for offline application of adhesive.

9.6.2 Elastomeric Sealing Surfaces

Approximately 20 years ago, styrene-butadiene rubber (SBR) was used for automotive weatherstrip. EPDM became more popular for its advanced weathering capabilities, extrusion properties and ability to be extended. Presently the market is beginning to switch to thermoplastic vulcanisates for producing weatherstrip profile. TPVs have become popular for their ability to be colour matched to the vehicle interior, ease of processibility, recyclability and reduced energy costs due to lower temperature needs.

9.6.3 Extrusion Process

As noted earlier, the coated coil of metal is shipped to the weatherstrip manufacturer for processing into profiles. The coil is unwound and fed through a series of rollers (**Figure 27**), which roll form the metal into the desired shape of the carrier. This will become the backbone of the rubber-covered profile. The formed metal is then fed through an extruder. For most weatherstrip applications, EPDM rubber is the elastomer, which is extruded over the metal carrier. The extruder mixes and heats the rubber using a screw feed mechanism. A die on the end of the extruder is machined to yield a rubber component of the desired dimensions.

The heat of the rubber, now in intimate contact with the adhesive coated metal, will cause the adhesive to begin to bond to the elastomer. As the rubber cures, so will the adhesive. Rubber vulcanisation occurs at elevated temperatures (232-288 ºC) with dwell times of 2-3 minutes. Cure cycles exceeding 140 °C are needed to activate the adhesives that bond the EPDM to the metal.

The extrusion line can extrude one or two compounds at the same time utilising varying durometer elastomers. For instance, a weatherstrip belt line is typically made using a dual-durometer dense EPDM compound extruded over metal. A door seal is generally a coextrusion of a sponge rubber to create a sealing surface and a dense rubber to encapsulate the metal carrier, which will be fastened to the vehicle.

Auxiliary operations can also be performed on the profile following extrusion of the rubber. The rubber can have a slip coating applied to the surface of the rubber to provide ice release, abrasion resistance, weathering, and chemical resistance. Yet other parts, typically for glass run channels, are flocked. This process entails the deposition of a nylon or polyester fibre via electrostatic alignment in a wet adhesive. Both coatings and flock adhesives are available in the marketplace for this application. **Figure 28** shows a typical line setup.

The final step of the process noted above is to cut the profiles to desired lengths using a chopper. Some profiles are further moulded together in corner moulding operations to assemble full door, trunk, or window seals.

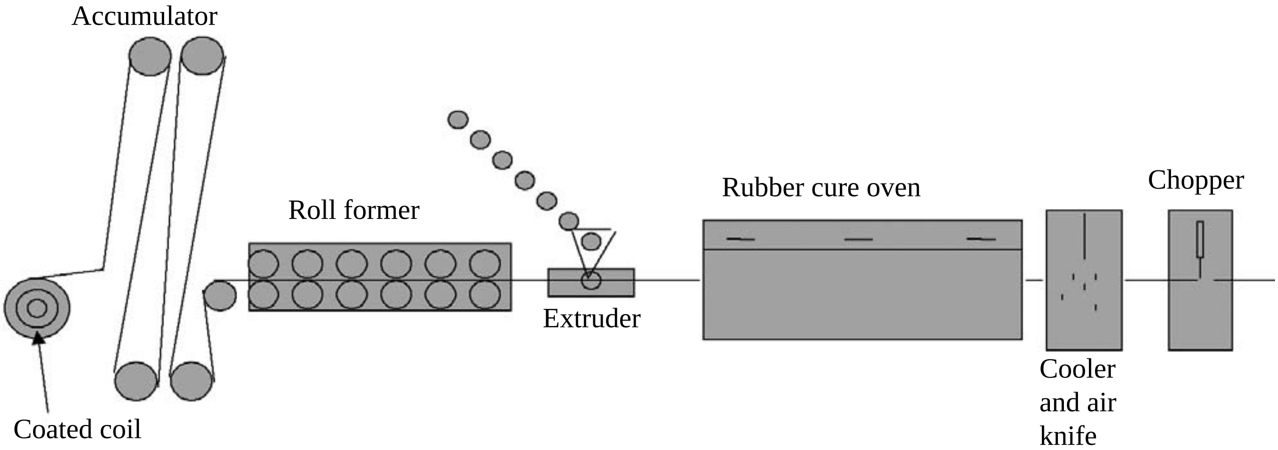


Figure 27

Roll forming/extrusion line

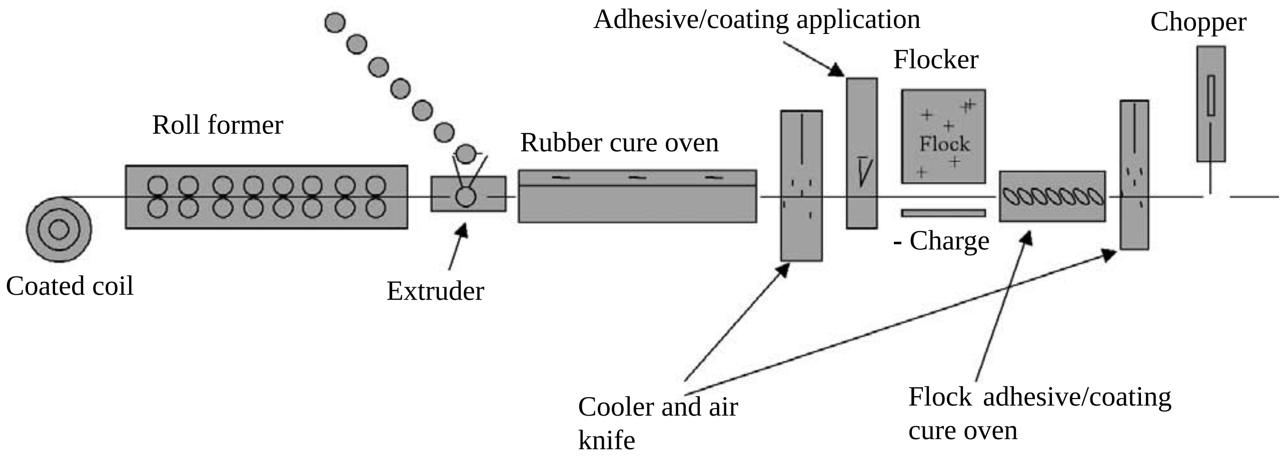


Figure 28

Roll forming/extrusion/clocking/coating line

9.6.4 Performance Testing

There are a number of tests that are routinely run on coil coated metal to measure adhesion and state of cure of the primer/adhesive.

Solvent Double-Rubs – This test is used to make sure that the primer and adhesive are not over- or under-baked. The National Coil Coaters Association Technical Bulletin Nos. II-18 covers this subject. Toluene is used for the topcoat adhesive and MEK is used for the primer. The adhesive should be resistant to between 5 and 15 double rubs of a saturated cloth with toluene. The primer should resist between 1-10 double rubs using MEK.

T-Bends – This test is used to determine the adhesion of the primer and adhesive to the metal after the metal has been crimped back on itself (such as would be done in a roll forming operation). This is conducted both with and against the grain of abrasion of the metal. The metal is bent back upon itself to what is called a 0T-bend. Scotch tape is then affixed along the folded edge. The tape is removed. The tape is inspected for flakes of adhesive or primer. If the first fold results in removal of adhesive or primer, the crimped piece is folded on itself, creating a gentler bend. The tape test is repeated. This second bend is called 1T. The process is continued until the tape shows no signs of primer or adhesive residue. A passing test would be less than 3T. For test details reference National Coil Coaters Association Technical Bulletin No. II-19.

Dry Film Thickness – A total film thickness can be measured using an electronic film thickness gauge. Toluene can be used to remove the black topcoat adhesive until the grey primer layer is evident. Measure the primer layer. Subtract the primer thickness from the total thickness to determine the adhesive thickness.

Rubber adhesion – This test determines adhesion of rubber to the coil adhesive. A typical test procedure may include the following:

- Mill rubber to a 3.2 millimetre sheet.
- Cut adhesive coated metal into 50 x 76 millimetre coupons.
- Cut pieces of rubber to 76 x 101 millimetre.
- Pre-heat rubber for 3 minutes at 93 ºC.
- Mate rubber right out of the oven to the coated metal and sandwich between two pieces of thin aluminium (508 micron).
- Place the sandwich in a press and compress to 6.8 megapascals; no heat.
- Remove the coated metal/rubber assembly from between the two pieces of aluminium and oven cure for 3 minutes at 232 ºC.
- Water quench to room temperature.
- Cut the rubber with a razor blade across the centre of the sample.

- Bend the sample end-to-end along the razor cut and check rubber adhesion along the folded edge and in the adjacent area.
- If the adhesive does not separate along the razor cut/folded edge, that is a passing result.

Figure 29 shows the difference between a passing and failing condition.

Zero Pressure Bond Test – This test is also used to determine adhesion of the rubber to the metal. The following steps are used at Lord Corporation:

- Mill rubber to a 3.2 millimetre sheet.
- Cut primed/top coated metal into 50 x 76 millimetre coupons. Mask off the edge, 50 millimetres width, with masking tape.
- Cut pieces of rubber to 76 x 101 millimetre.
- Pre-heat rubber for 3 minutes at 93 ºC.
- Mate rubber right out of the oven to both sides of the coated metal and sandwich between two pieces of thin aluminium (508 micron).
- Place the sandwich in a press and compress to 1000 psi; no heat.
- Remove the coated metal/rubber assembly from between the two pieces of aluminium and oven cure for 3 minutes at 232 ºC.
- Water quench to room temperature.
- Using needle nose pliers, peel the rubber away from the coated metal.
- If the rubber tears, leaving a thin layer on the coated metal, that is a passing result.

Blocking Test – The National Coil Coaters Association Technical Bulletin No. II-17 is the specification for evaluation of pressure marking and blocking resistance of organic coatings. This test is run per the specification and the affinity of the adhesive to 'stick' to another coated layer of metal is judged. Ideally, a Grade condition of 10 is desired.

9.6.5 Summary

There are many ways to bond rubber to metal. This section discussed a less known method for bonding rubber to metal that utilises pre-coated metal using a coil coater to apply the adhesive. This method is used primarily by the automotive weatherstrip industry, but due to the excellent transfer efficiency of this process, other companies are investigating the use of rubber bonded to pre-coated sheet steel to either punch out parts or to create bent configurations. Use of adhesive-coated coils may see more utility in the future.

10 Future Trends in Rubber-to-Metal Bonding

Over the last twenty years, there have been changes in certain aspects of the rubber-to-metal bonding process. Examples are the increased use of injection moulding, higher performance demands (especially those on automotive antivibration parts regarding heat and corrosion resistance), and the implementation of adhesives that are free of hazardous materials (such as lead). The future promises to bring more changes to those companies involved in manufacturing bonded

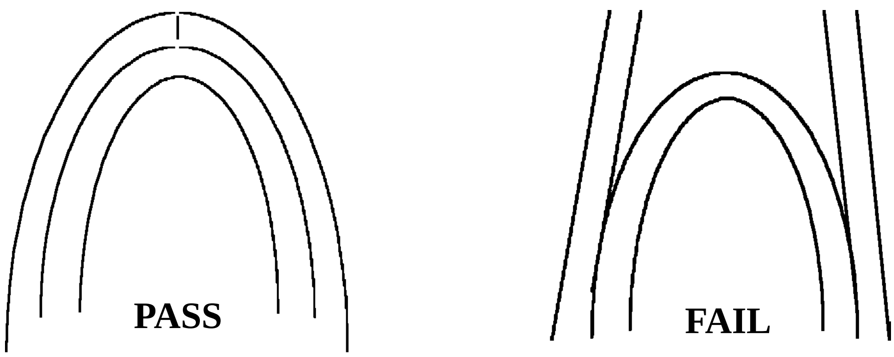


Figure 29

Rubber adhesion failure analysis

components. New elastomeric materials and substrates to be bonded, regulations affecting emission of volatile products and ever-changing performance demands will require new products and technologies from the suppliers of rubber-to-metal adhesives to meet the needs of the industry.

For antivibration characteristics, natural rubber (NR) is still the material of choice in bonded components. However, with tougher requirements for heat resistance and longer service life (especially in automotive applications), NR is nearing its limit as a useful material. This is especially true of NR cured with sulfur or sulfur donors. Advances have been made in the development of new cure systems for NR based on either di-urethane technology (Tradename NOVOR, sold by Elgem Technology) or peroxide plus co-curative chemistry. Elastomers cured via the non-sulfur approach have better heat resistance than their sulfur cured counterparts, but may be more difficult to bond with conventional adhesives.

Automobile component manufacturers are working to develop compounds based on other elastomer types (HNBR, silicone, peroxide-cured EPDM) that have better heat and ozone resistance, while still maintaining acceptable antivibration properties. New adhesive chemistries may be needed to bond these compounds.

Thermoplastic elastomers are popular because unused moulded material can be reused with virgin elastomer. Adhesive systems are available which can bond thermoplastic elastomers to metal and other substrates. However, the environmental resistance of these adhesives is not equivalent to that obtained with conventional thermosetting adhesives for NR bonding. If thermoplastic elastomers find use in automotive antivibration applications, new adhesives will be needed.

Over the years, materials have been developed that can be added to rubber to provide direct adhesion to metal substrates during vulcanisation; thus eliminating the need for adhesives. The advantages of this approach include cost reduction due to elimination of the adhesive application step and lessening of regulatory concerns due to the elimination of the (typically) solvent-based adhesive and its accompanying dilution solvents. This approach has several pitfalls. Typically, when such additives are put into rubber, they are cure system specific (i.e., useful for peroxide cured elastomers but not for sulfur-cured ones) and the physical properties of the cured rubber are compromised in some way. Typical properties affected are bin stability, scorch safety, tensile and elongation. Care must be taken to make sure that the rubber does not bond directly to the mould and runner system (if injection moulding). Similarly, plastic materials have been developed which bond to rubber during vulcanisation without the need for adhesives. Development in these areas continues today.

The typical metal substrate used for bonding to rubber is steel which has been surface treated via grit blasting, zinc or iron phosphatising. In the future, engineered plastics and aluminium may become the substrates of choice due to the desire for lighter weight automobiles for improved fuel economy. The major concern for adhesive suppliers regarding this possibility is in the increased use of plastics. The word ‘plastic’ refers to a wide variety of different types of engineering materials that range from nylon to high-density polyethylene (HDPE). Plastics with low surface energies (compared to that of steel) will be the substrates that will be most difficult to bond to. Unfortunately, these are the same substrates that are of most interest to component manufacturers due to their low cost.

Rubber to metal adhesives have traditionally been supplied in a solvent carrier (xylene, toluene, ketones, alcohols). Over the last 10 years, new bonding agents have been developed which are supplied as dispersions in water (along with a small amount of co-solvent). These water-based adhesives were developed to help customers comply with government regulations dealing with the release of solvents into the atmosphere. More restrictive regulations regarding solvent emissions have been issued (for example, the Miscellaneous Metal Parts and Products Standard in the US) and more are being formulated. Water-based adhesives are one technology that can address the new regulations. It may be necessary in the future to have rubber-to-metal adhesives provided in other physical forms to overcome any limitations with water-based adhesives. Some possible examples are adhesives supplied in film form, as powder coatings, or as UV or EB-curable liquids that have no volatile components.

Vibration isolation mounts typically employ rubber and metal, and as such, adhesives are needed to ensure that the mount maintains its structural integrity and functionality. Devices that use rubber to absorb vibration and noise are called ‘passive’ control systems because the device absorbs the vibration. ‘Active’ noise/vibration control systems act by the application of signals to cancel out the incoming vibration or noise. Active control systems are gaining favour in design because they are better at cancelling out vibrations below 500 Hz and are more compact than passive systems. Since active systems act by the introduction of cancelling signals, the need for rubber, and consequently, rubber/metal adhesives, is reduced.

Performance demands for rubber-to-metal adhesives in the future will also continue to change. Environmental resistance (particularly to heat and automotive fluids) requirements will continue to increase in severity as automobile engine compartments continue to become more compact and as warranties get longer. Adhesives are now expected to work at temperature extremes between 125 °C and –40 °C. New adhesive chemistries may be needed to meet these needs.

The need for higher production rates has forced rubber-to-metal part manufacturers to increase cure temperatures and reduce cure times to improve profitability. This means that adhesives need to have similar cure kinetics to the rubber under these conditions. Current rubber-to-metal bonding technology is still able to handle the cure cycles in use today. However, future needs may extend beyond the capabilities of current technology and require even faster curing adhesives.

Providing an adhesive that gives the desired performance at a lower cost to the customer is another challenge for the future. Generally, the applied cost of rubber to metal adhesives is about 1% of the total cost of the fabricated part. The performance of this small amount of adhesive is critical to the performance and life of the part. Even so, customers (especially automotive ones) are continually asking for products that lower their overall costs. Providing an adhesive with acceptable performance at a lower cost is one way to solve this problem. Adhesives that can improve a customer's manufacturing efficiency or reduce their labour and/or processing costs will also accomplish this goal.

In the future, adhesives used for automotive applications will be restricted to contain only materials considered to be 'environmentally friendly'. This will be done to:

1) Reduce worker exposure to hazardous materials during the manufacture of automobiles and components and

2) Improve the ease of recycling cars in the future.

Currently, this need translates to removing heavy metals such as lead and removing solvents such as methylene chloride and perchloroethylene from the adhesive. In the future, pressure will continue on adhesive manufacturers to remove other solvents (such as ketones, toluene and xylene) and materials that may be classified as being environmentally unfriendly. Different delivery systems (hot melt, 100% solids, etc.) may be needed to accomplish this.

In summary, there are a number of possible future developments that could affect the bonding of rubber to metal and the adhesive technology needed to accomplish this task. How many of these possibilities actually turn into realities will depend on political, ecological, and technical factors. Whatever the future holds, adhesive manufacturers will strive to provide the products and services necessary to ensure good, durable bonds between rubber and metal.

Abbreviations and Acronyms

AES	auger electron spectrometry
ASTM	American Standard Methods
CAAA	Clean Air Act Amendments
CM	cement-to-metal
CP	cement-to-primer
CR	chloroprene rubber
COPE	copolyester elastomer
DFT	dry film thickness
EB	electron beam
EDS	Energy dispersive X-ray spectrometry
EPA	Environmental Protection Agency (US)
EPCA	environmentally preferred Chemlok adhesive
EPDM	ethylene-propylene-diene
EPR	ethylene-propylene rubber
FKM	fluoroelastomer
GBS	grit blasted steel
HAP	hazardous air pollutant
HDPE	high density polyethylene
ISO	International Standards Organization
IIR	butyl rubber
ISS	ion scattering spectrometry
MACT	maximum achievable control technology
MBTS	2-mercaptobenzothiazole disulfide
MEK	methyl ethyl ketone
MLS	multilayer steel
MDI	4,4´diphenylmethane diisocyanate
MSDS	material safety data sheet
NBR	acrylonitrile-butadiene rubber, also known at nitrile
NR	natural rubber
OBTS	*n*-oxydiethylene-benzothiazole-2-sulfenamide
OEM	original equipment manufacturer
PCB	polychlorinated biphenyl
PLI	pounds per linear inch
RC	rubber-to-concrete
RIM	reaction injection moulding
SBC	styrene block copolymer
SBR	styrene-butadiene rubber
SEM	scanning electron microscopy
SIMS	secondary ion mass spectroscopy
TDI	toluene diisocyanate
TMTM	tetramethyl thiuram monosulfide
TPE	thermoplastic elastomer
TPO	thermoplastic olefin elastomer
TPU	thermoplastic urethane
TRI	Toxics Release Inventory
RBS	Rutherford backscattering spectroscopy
VOC	volatile organic compound
XPS	X-ray photoelectron spectrometry
ZDMC	zinc diethyl dithiocarbamate
ZnPhos	zinc phosphated steel

Abstracts from the Polymer Library Database

Item 1
China Rubber Industry
51, No.4, 2004, p.209-12
Chinese
IMPROVEMENT OF EPDM/METAL ADHESION BY ZINC DIACRYLATE
Liu L; Xin Z-X; Zhang B; Lu M-C; Huang T
Qingdao,University of Science & Technology; Qingdao Keeper Sealing Industry Co.Ltd.

The study revealed that the chemical bond between zinc diacrylate and metal formed during vulcanisation, giving rise to significantly improved EPDM/metal adhesion. The peel strength was 10 kN.m/1 when 10 phr of zinc diacrylate was employed and vulcanisate physical properties were significantly improved. 5 refs.

CHINA

Accession no.916784

Item 2
KGK:Kautschuk Gummi Kunststoffe
56, No.9, Sept.2003, p.434
German
COMBINATIONS WITH MULTI-FUNCTIONAL PROPERTIES - PERFLUOROELASTOMER METAL BONDS

This article reviews a new technique called ASTM D429-02B from the firm of Busak & Shamban in Stuttgart that enables a chemical bond between perfluoroelastomers and different metal substrates. As a result, it offers new solutions to problems regarding seals for pumps, armatures and valves as well as for applications in medicine, testing and control equipment. It can bond rubber and metal surfaces like aluminium, steel or bronze. Other possible applications discussed include the food industry, semiconductors and magnetic valves.

Busak & Shamban GmbH
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.915106

Item 3
China Synthetic Rubber Industry
27, No.2, 2004, p.101-4
Chinese
EFFECTS OF ACRYLATE METAL SALTS ON MECHANICAL PROPERTIES OF METAL TO RUBBER BONDING
Xingfa M; Aihua Z; Fenghua S; Fuxia X; Yihe Z; Shenwei D; Naichun L
China,Institute 53 of Ordnance Industry; Linyi,Normal College

The results obtained revealed that addition of 2 to 5 phr of zinc acrylate instead of from 20 to 30 phr carbon black markedly improved the tear resistance of the bonded rubber, the adhesion of the rubber to metal and the peel failure of rubber to metal bonding. Mechanical properties of the metal to rubber bonding were also maintained. The rubber employed was a blend of NR and solution-SBR. 9 refs.

CHINA

Accession no.914335

Item 4
IRC 2003. Proceedings of a conference held Nuremberg, 30th June-3rd July 2003.
Frankfurt, Deutsche Kautschuk Gesellschaft eV, 2003, p.155-61, 30cm. 012
German
STRUCTURE OF THE BRASS-COATING ON STEEL CORD WIRES AND ITS INFLUENCE ON THE RUBBER-METAL-ADHESION
Krone R; Floing D
Wolf G.,Seil- & Drahtwerke GmbH & Co.
(Deutsche Kautschuk Gesellschaft eV)

Highly-stressed technical rubber articles are strengthened by reinforcement materials such as wires or steel cords. On the surface of these reinforcing steel materials, metals - well-disposed towards rubber, e.g. brass, - achieve a permanent adhesion to the rubber. In order to optimise the properties of this rubber-metal adhesion, brass-layers of different structures are separated galvanically-cyanided and by diffusion from the wires of a chosen steel cord construction 6 x O 0.380 mm + 3 x O 0.200 mm. The structures of these brass-layers - surface concentration with copper and thrower distribution of the alloying components - are analysed with the help of Auger-electron spectroscopy (AES). Based on the results of AES, a simple laboratory method - the Dipp-Method - is developed. When dipping brass-plated wires into an optimised, aqueous solution, copper and zinc are dissolved out, layer by layer. Afterwards, the alloying components are determined and the distribution of elements - the distribution of the alloying component copper in function of the depth of the brass-layer - is compared to AES. Good correlation between the results found with AES and the laboratory method is noted. Using variable test conditions, the rubber-metal adhesion of the chosen cords is analysed. Optimum adhesion depends on surface concentration with copper and quantity of the brass coating (thickness of the brass-layer). Adhesion maximums of the differently structured brass-layers are presented. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.912542

Item 5
International Journal of Adhesion and Adhesives
24, No.4, Aug.2004, p.347-54
ANALYSIS OF WELD-BONDED DISSIMILAR MATERIALS
Darwish S M
King Saud University

Finite element analysis of spot-welded dissimilar material joints was conducted. It was found that the stress pattern was symmetrical and concentrated towards the far ends of the spot welding nugget of similar material joints (steel-steel). The stress concentration was, however, towards the weakest member of spot-welded dissimilar material joints (steel-brass, steel-aluminium, brass-aluminium). The introduction of an adhesive layer resulted not only in strengthening but also in balancing of the stresses in dissimilar material joints. It was, therefore, recommended that an adhesive layer should be used with spot welding in order to strengthen and eliminate the stress concentration problem associated with dissimilar material joints. 30 refs.
SAUDI ARABIA

Accession no.912881

Item 6
Polymer Bonding 2004. Proceedings of a conference held Munich, Germany, 27th-28th April 2004.
Shawbury, Rapra Technology Ltd., 2004, p.5-20, 30cm, O12
A REVIEW OF RECENT DEVELOPMENTS IN BONDING OF STEEL PRODUCTS FOR RUBBERS AND PLASTICS REINFORCEMENT
Mauer D
Bekaert SA
(Rapra Technology Ltd.)

Steel products with industrial applications in the reinforcement of plastics and rubbers, such as steel cord reinforcement of radial tyres, are described. Adhesion technologies, including direct adhesion and adhesion via a tie layer, and methods of adhesion testing such as the pull-out test, are discussed. Industrial applications currently under development, eg steel reinforced TPV transmission belts, are reviewed. 0 refs.
BELGIUM; EU; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE; WESTERN EUROPE-GENERAL

Accession no.910273

Item 7
Polymer Bonding 2004. Proceedings of a conference held Munich, Germany, 27th-28th April 2004.
Shawbury, Rapra Technology Ltd., 2004, p.21-30, 30cm, O12
STRENGTH VS. DURABILITY OF RUBBER-METAL BONDS: FACTOR EFFECTS FROM PROCESSING & CHEMISTRY
Del Vecchio R J; Ferro E
Technical Consulting Services; Corry Rubber Corp.
(Rapra Technology Ltd.)

The effects of substrate preparation, use of primers, different adhesives and different natural rubber compounds, on rubber-to-metal bonding were investigated using full factorial design by studying bond strength, bond hot tear strength and bond resistance to aggressive environmental attack (hot salt spray). The results were subject to statistical analysis and are discussed in terms of the factors affecting bond strength and durability. 4 refs.
USA

Accession no.910274

Item 8
Polymer Bonding 2004. Proceedings of a conference held Munich, Germany, 27th-28th April 2004.
Shawbury, Rapra Technology Ltd., 2004, p.51-65, 30cm, O12
THE DEVELOPMENT AND EXPLOITATION OF ACCELERATED DURABILITY TESTS - THE NEW ASTM D429 METHOD G IMMERSION TEST AND POTENTIAL FUTURE DEVELOPMENTS
Hansen P; Thomson B
Materials Engineering Research Laboratory Ltd.
(Rapra Technology Ltd.)

A novel accelerated durability test, now adopted as ASTM D429 Method G, for adhesive bond strength in rubber-to-metal bonding is described in detail. A selection of data obtained for a range of elastomer/adhesive/substrate combinations, including water-based systems, is presented. Application of the new methodology to study the effects of rubber compounding, adhesive type, surface preparation etc. on bond durability is discussed. 0 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.910277

Item 9
Polymer Bonding 2004. Proceedings of a conference held Munich, Germany, 27th-28th April 2004.
Shawbury, Rapra Technology Ltd., 2004, p.155-159, 30cm, O12
ONE COMPONENT BONDING AGENTS - TECHNOLOGY FOR ANTI VIBRATION AUTOMOTIVE PARTS PRODUCTION
Benarous A
Chemical Innovations Ltd.
(Rapra Technology Ltd.)

The advantages and disadvantages of one component water based and solvent based bonding agents for metal to elastomer (including natural and synthetic rubbers, silicone elastomers and fluoropolymers) bonding were reviewed in comparison with two-coat bonding systems comprising a primer and a cover coat. Some industrial applications of one component bonding agents are outlined. 0 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.910286

Item 10

Gummi Fasern Kunststoffe

56, No.12, Dec.2003, p.777-85

German

PROMOTERS FOR ENHANCED ADHESION OF STEEL CORD TO RUBBER

Shemenski R M; Su Y-Y

RMS Consulting Inc.; Amercord Inc.

A better understanding of vulcanisation kinetics and the surface structure of brass layers is put forward as a key in the search for a universally applicable adhesion promoter for enhancing the adhesion of steel cord to rubber. 27 refs. (Wire Association International Inc., 71st Annual Convention, May 2001, Atlanta, USA)

USA

Accession no.909884

Item 11

Constitutive Models for Rubber III: Proceedings of a conference held London, 1st-17th Sept.2003.

Lisse, A.A.Balkema Publishers, 2003, p.55-7, 25cm, 012

FATIGUE LIFE PREDICTION AND VERIFICATION OF RUBBER TO METAL BONDED SPRINGS

Luo R K; Cook P W; Wu W X; Mortel W J

Trelleborg IAVS

(London,University)

A brief report is presented on the use of continuum mechanics to predict the fatigue life of rubber-to-metal bonded springs in terms of the cyclic stress range. Fatigue failure is evaluated using an effective stress parameter utilising the uniaxial fatigue test as a basis and predictions of the theory are compared with experimental measurements carried out on Metacone mountings. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.907618

Item 12

Machine Design

76, No.3, 5th Feb.2004, p.54/6

RUST TAKES A REST

Kren L

Improved protection against rust and corrosion is one reason automakers have been able to offer longer vehicle warranties. These efforts go beyond cosmetic body panels to include hidden components such as metal-elastomer isolation and motor mounts, strut mounts and brackets. MetalJacket coating system from Lord Corp “autodeposits” barrier coatings without high voltage, rinses or the heavy metals of the zinc-phosphate plating process. In the two-part process, an autodepositing metal treatment called MetalJacket 1100 replaces the zinc-phosphating step and prepares mild steel for part two, the coating, MetalJacket 2100. For some rubber-to-metal applications, a one-part metal treatment called MetalJacket 1200 can be applied to clean, unphosphatized steel. The approach replaces zinc phosphating and rubber-to-metal primers.

LORD CORP.; HAHN AUTOMATION

USA

Accession no.906323

Item 13

Rubber Chemistry and Technology

76, No.4, Sept.-Oct.2003, p.1019-30

ADHESION OF RUBBER TO MAGNESIUM ALLOYS IN THE PRESENCE OF NICKEL BRANCHED ALKYL CARBOXYLATES

Mori K; Shi X; Hirahara H; Oishi Y

Iwate,University

The adhesion of blends of emulsion SBR and NR containing nickel branched alkyl carboxylates, such as nickel isooctylate or nickel isostearate, to surface treated magnesium alloys during curing was investigated. The magnesium alloys were subjected to various surface treatments and the effects of additives, such as curing accelerators, sulphur, zinc oxide and the nickel carboxylates, on peel strength examined. It was found that magnesium alloys treated with sodium hydroxide aqueous solutions adhered well to the rubber and that the nickel carboxylates accelerated the adhesion of the rubber to the alloys treated with the aforementioned solutions. 16 refs.

JAPAN

Accession no.906205

Item 14

IRC 2003. Proceedings of a conference held Nuremberg, 30th June-3rd July 2003.

Frankfurt, Deutsche Kautschuk Gesellschaft eV, 2003, p.37-9, 30cm. 012

AN ENVIRONMENT-FRIENDLY PROCESS FOR RUBBER-TO-METAL BONDING

Boccaccio G; Alberts H

Le Mans,Centre de Transfert de Technologie; Henkel KGA

(Deutsche Kautschuk Gesellschaft eV)

Solvents are commonly used in the rubber industry for mould cleaning, adhesion of new tread in the tyre retreading process, rubber coating of fabrics, anti-friction coating and of course rubber-to-metal bonding. Rubber-to-metal bonding is used for manufacturing many types of components including vibration damper elements, gaskets, seals, rollers, etc. The solvents are used for two main process steps: cleaning and degreasing the metal, and coating of the metal by the bonding agents. Control of VOC (Volatile Organic Compound) emission is an increasingly important issue in industry and the VOC legislation is becoming more and more severe. The European Union Directive of the 11th March 1999 gives emission limit values for each activity sectors; for the 'rubber conversion activity', the limit value of waste gas emission is 20 mg C/cub.m. For the past thirty years, many attempts have been made to substitute solvent-based bonding agents by aqueous systems and increasingly some bonding agent manufacturers have accepted the difficult challenge for providing environment friendly alternatives in aqueous forms. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.905544

Item 15
Polimery
48, No.9, 2003, p.614-9
Polish

PROBLEMS OF RESORCIN ELIMINATION FROM ADHESIVE SYSTEMS FOR STEEL CORDS

Hehn Z; Sajewicz J; Rajkiewicz M
Kedzierzyn-Kozle Institute; Instytut Przemyslu Gumowego Stomil Piastow

Urethanes with varying alkyl chain lengths were synthesised and used, together with acrylamide, for melamine-formaldehyde resin modification. A melamine-formaldehyde resin with a higher content of methylene groups was also developed. The resins, spread on calcium silicate, were used as systems for improving the adhesion of rubber to brass plated steel cords with the aim of eliminating toxic resorcinol resins from such systems. The results of rheometric measurements of rubber blends containing the resins and the results of investigations of strength properties of the vulcanisates obtained are discussed. The effects of ageing conditions and the type of melamine resin in the blend on the strength of rubber-brass plated steel cord joint were characterised. The best results in this study were obtained with resin modified with butyl urethane or acrylamide. The melamine-formaldehyde resins with higher content of methylene groups showed better strength properties but needed much longer time of vulcanisation. 17 refs.

EASTERN EUROPE; POLAND

Accession no.903657

Item 16
164th ACS Rubber Division Meeting - Fall 2003. Proceedings of a conference held Cleveland, Oh., 14th-17th Oct.2003.
Akron, Oh., ACS Rubber Division, 2003, Paper 65, pp.10, 28cm, 012

ADHESIVES FOR BONDING FLUOROELASTOMERS-TO-METAL IN AUTOMOTIVE SEALING APPLICATIONS

Polaski E; Mowrey D
Lord Corp.
(ACS,Rubber Div.)

The results are reported of trials carried out to evaluate the ability of solvent-based and water-based adhesives to bond fluid resistant fluoroelastomers to metals for automotive applications, such as seals and gaskets. Peel strength tests were carried out on samples bonded together by compression moulding and on samples immersed in various fluids and then oven aged for 500 hours at 150C. 5 refs.

USA

Accession no.903355

Item 17
164th ACS Rubber Division Meeting - Fall 2003. Proceedings of a conference held Cleveland, Oh., 14th-17th Oct.2003.
Akron, Oh., ACS Rubber Division, 2003, Paper 25, pp.13, 28cm, 012

NOVEL ADHESION PROMOTER FOR VARIOUS ELASTOMER/SUBSTRATE COMBINATIONS

O'Rourke S
Hall C.P.,Co.
(ACS,Rubber Div.)

The results of experimental investigations carried out on various rubber/substrate combinations employing Hallbond APS (Adhesion Promoter System) in various forms are presented and discussed. The rubbers employed include EPDM, NR and chlorinated PE and data on polyester cord adhesion, wire cord adhesion, rubber-to-textile adhesion and rubber-to-metal adhesion are tabulated.

USA

Accession no.903318

Item 18
164th ACS Rubber Division Meeting - Fall 2003. Proceedings of a conference held Cleveland, Oh., 14th-17th Oct.2003.
Akron, Oh., ACS Rubber Division, 2003, Paper 19, pp.29, 28cm, 012

MECHANISM OF IMPROVED AGED RUBBER-TO-BRASS ADHESION USING ONE-COMPONENT RESINS

Patil P Y; van Ooij W J
Cincinnati,University
(ACS,Rubber Div.)

An investigation was carried out to determine the effect of an adhesion-promoting one-component resin system on the mechanical properties of NR-based formulations. Mechanical properties tested included stress at break, stress at 300% strain, elongation at break, tear behaviour, adhesion and aged adhesion. The surfaces of the rubbers were analysed by ATR FTIR spectroscopy to confirm a previously proposed theory regarding the migration of resin from the rubber matrix to the surface. The corrosion performance of sulphidised cords embedded in a cured tyre was also investigated and a theory, which attributes loss of rubber-to-brass adhesion to the ageing of brass cords, proposed. 22 refs.

USA

Accession no.903313

Item 19

IRC 2002. Proceedings of a Conference held Prague, 1st-4th July 2002.

Prague,Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry, 2002, Paper 70, pp.8, CD-ROM, 012

SURFACE TREATMENT OF STEEL REINFORCEMENT MATERIALS

Suriova V; Janypka P; Hudec I; Simor M; Cernak M
Slovak Republic,Rubber Research Institute; Bratislava,Slovak Technical University; Comenius,University
(Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry)

The composition of steel cord, and the tensile properties of steel and polymers used for tyre reinforcement are briefly detailed. The use of plating and additives to enhance adhesion to rubber is discussed. Steel cord was treated by low temperature nitrogen or oxygen plasma at atmospheric pressure, and the adhesion to rubber determined using the Henley test. Enhanced dynamic adhesion was achieved compared with standard treatments. Optimum treatment times were 2-3 s, with the adhesion decreasing with extended treatment times. 5 refs.

SLOVAK REPUBLIC; SLOVAKIA

Accession no.901582

Item 20

IRC 2002. Proceedings of a Conference held Prague, 1st-4th July 2002.

Prague,Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry, 2002, Paper 63, pp.7, CD-ROM, 012

NEW BONDING SYSTEM BETWEEN RUBBER AND STEEL

Nah C; Chung K-H; Chang Y-W; Park S-J
Chonbuk,National University; Suwon,University; Hanyang,University; Korea,Research Institute of Chemical Technology
(Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry)

A bonding system for application to brass-plated steel cord used in tyres, to prevent the loss of bonding with the rubber in service due to dezincification, was investigated. Cobalt plating was applied onto the brass plating, followed by copper plating to improve the wire drawing. Samples of cured natural rubber containing the steel cord were aged in air at 100 C, or at 75 C in a relative humidity of 85%. Following ageing for 5-15 days, the force required to pull out the cord, and the amount of rubber retained on the cord surface, were measured. A cobalt layer of several nanometre thickness significantly enhanced the adhesion stability, and although the adhesion was reduced on ageing, a marginal superiority compared with cobalt-free wire was retained. 13 refs.

KOREA

Accession no.901575

Item 21

Tire Technology International

Annual Review 2003, p.140-5

ADHESION PROPERTIES OF STEEL REINFORCEMENT MATERIALS

Janypka P; Micuch M; Gazo P; Suriova V; Duris S; Hudec I; Szostak M
Matador AS; Continental Matador; Slovak,Technical University; Poznan,University of Technology

The adhesion of composite steel cord reinforcement material and tyre reinforcement coating compound, including tyre wire and steel cord surface treated with a plasma, was studied using three dynamic test methods, i.e. the Henley test, ultrasound and a test devised by the Technical University of Poznan. The action of plasma on the steel reinforcements and the morphology of rubber-steel cord systems were examined. The results obtained are presented and discussed. All three laboratory procedures were found to be suitable for the evaluation of rubber-metal adhesion, but verification of the results with those of real tyres under dynamic testing is required. 4 refs.

EASTERN EUROPE; POLAND; SLOVAK REPUBLIC; SLOVAKIA

Accession no.900568

Item 22

IRC 2002. Proceedings of a Conference held Prague, 1st-4th July 2002.

Prague,Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry, 2002, Paper 34, pp.19, CD-ROM, 012

BONDING RUBBER TO REINFORCING MATERIALS WITH ADHESION PROMOTING COAGENTS

Costin R; Amara Y
Sartomer Co.; Cray Valley
(Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry)

Two commercial additives to increase the degree of cure and enhance the bonding of rubber to reinforcement during peroxide curing, so eliminating the need to apply external bonding agents to the reinforcement, were evaluated. The rubbers investigated included: nitrile rubber, ethylene-propylene-diene terpolymer (EPDM), chlorosulphonated polyethylene, ethylene-vinyl acetate copolymer, styrene-butadiene rubber, silicone rubber, and natural rubber. Aramid and polyester fabrics were used as reinforcement, and the reinforced rubbers were characterised by measurements of tensile strength, modulus and elongation, and Shore hardness. Curing characteristics were determined using an oscillating disc rheometer. Rubber-to-metal adhesion was determined by shear and peel testing. The additives increased the degree of cure and enhanced the adhesive bonding between the rubber and un-treated metals and textiles. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; USA; WESTERN EUROPE

Accession no.900221

Item 23

Nippon Gomu Kyokaishi

76, No.5, May 2003, p.154-9
Japanese

DIRECT ADHESION BETWEEN POLYMER PLATED METALS AND RUBBERS DURING VULCANIZATION. IV. DIRECT ADHESION BETWEEN POLYMER PLATED STEEL AND PEROXIDE CROSSLINKED EPDM DURING VULCANIZATION

Gong P; Mori K; Oishi Y; Hotaka T
Iwate,University; Yokohama Rubber Co.Ltd.

The adhesion between polymer plated steel and peroxide-crosslinked EPDM during vulcanisation was studied with particular reference to the effect of the polymer film thickness and the contents of the compounding ingredients, such as HAF carbon black, process oil and peroxide. A three-variable central composite designed experiment based on a Box-Wilson response surface methodology was used to evaluate the effect of the compounding ingredients. The results showed that the thickness of the polymer plating film should be controlled in an optimum range from about 20 nm to 200 nm in order to obtain adequate peel strength of adherend. The peel strength was, however, affected by carbon black, process oil and peroxide contents, which was explained as a result of the balance of reactions between peroxide/rubber and peroxide/polymer plating film occurring at the adhesion interface during vulcanisation. The adherends under the optimum compounding showed very good thermal stability, moisture resistance and water resistance. 19 refs.

JAPAN

Accession no.898395

Item 24

Rubber and Plastics News

33, No.5, 6th Oct.2003, p.8

CAN YOU LEAD A HORSE TO WATER?

Meyer B

Upcoming Environmental Protection Agency rules are driving growth of aqueous adhesives in underhood automotive applications, as suppliers say the water-borne materials will comply with the directives easier than traditional solvent-based adhesives. Producers of rubber-to-metal goods say that while the aqueous adhesives measure up on a performance basis with solvent-based materials, cost will continue to play a vital role in which materials get used. In August, the EPA signed off on the long-anticipated new final rule for Maximum Achievable Control Technology standards for a number of end-use categories to regulate and control emissions of hazardous air pollutants. With the new MACT directives, there are a number of ways a rubber-to-metal bonder can meet the regulation, including: using all water-borne adhesives; using a hybrid aqueous/solvent system; and continuing to use solvent-based adhesives in conjunction with a thermal oxidiser to burn off hazardous air pollutants.

US,ENVIRONMENTAL PROTECTION AGENCY
USA

Accession no.897669

Item 25

European Rubber Journal

185, No.9, Sept.2003, p.24-5

GROWTH IN AV PARTS LEADS TO HIGH ADHESIVE USE

White L

Antivibration mounts are a major application for rubber-to-metal bonding agents and one that is growing faster than the total automotive market, according to Rohm & Haas. The trend for the car industry is to add more and more antivibration parts to reduce noise even further, which is driving this high growth. Use of antivibration parts is growing at some 4%/year, with bonding agent consumption growing at 2%/year worldwide. The global rubber-to-metal bonding agents business is worth some 120m US dollars, of which Rohm & Haas a share of roughly 30%. Rohm & Haas and CIL both have introduced lead-free lines of bonding agents. Water-based primers and adhesives for rubber-to-metal bonding have been developed, but are used in only about 10% of the business. The automotive industry has been seeking higher under-bonnet temperatures and OEMs have been looking at different elastomers to extend the performance of mounts and other parts. Processors are evaluating silicone rubber as an alternative to NR for antivibration uses.

ROHM & HAAS
WORLD

Accession no.894360

Item 26

Polymer Testing

22, No.6, 2003, p.671-6

STUDYING THE CURE KINETICS OF RUBBER-TO-METAL BONDING AGENTS USING DMTA

Persson S; Goude M; Olsson T
Metso Minerals (Skelleftea) AB; IFP Research AB

Results are reported of a preliminary evaluation of the potential of dynamic mechanical thermal analysis for use in characterising the curing of rubber-to-metal bonding agents. The materials studied were Megum 3270 primer, Megum 100 adhesive and NR/polybutadiene blend. DMTA was shown to be a promising technique for increasing

current knowledge of bonding agents and should provide information for optimisation of bonding agents developed in the future. 10 refs.

EUROPEAN UNION; SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.893135

Item 27

Journal of Elastomers and Plastics
35, No.3, July 2003, p.227-34

USE OF CARBOXY TERMINATED LIQUID NATURAL RUBBER(CTNR) AS AN ADHESIVE IN BONDING RUBBER TO RIGID AND NON-RIGID SUBSTRATES

Avirah D U; Avirah S A; Joseph R
Mahatma Gandhi University; Cochin,University of Science & Technology

CTNR was prepared by photochemical reaction using maleic anhydride and masticated NR. The use of CTNR as an adhesive in bonding rubber to rubber (NR to NR and NBR to NBR) and rubber (NR and NBR) to metal (mild steel) was studied. The peel strengths and lap shear strengths of the adherends which were bonded using CTNR were determined. The effect of using a triisocyanate with CTNR in rubber to metal bonding was also studied. It was found that CTNR could effectively be used in bonding rubber to rubber and rubber to mild steel. 8 refs.

INDIA

Accession no.891800

Item 28

International Journal of Adhesion and Adhesives
23, No.3, 2003, p.231-4

PHYSICO-CHEMICAL ANALYSIS ON CHEMICAL BONDING AT ADHESION INTERFACE BETWEEN RUBBER AND PD ALLOY

Ikeda Y; Nawafune H; Mizumoto S; Sasaki M; Nagatani A; Nishimori A; Yamaguchi K; Uchida E; Okada T
Konan,University; Hyogo Prefecture,Industrial Research Institute; Ishihara Chemical Co.Ltd.

Spectroscopic analyses were carried out on the adhesive interface layers formed by cure-adhesion of NR to electroless palladium or palladium-phosphorus alloys. TEM provided some clear images of the adhesion layer at the interface between rubber and electroless plating films of Pd and/or Pd-P alloys. The content ratio of Pd/S analysed by energy dispersive X-ray spectroscopy changed gradually along the depth at the rubber-metal interface layer for Pd alloy, but was kept almost constant irrespective of depth for Pd-P alloy. The results obtained indicated that the ready oxide formation in Pd-P alloy retarded the sulphide formation, resulting in slower and more homogeneous growth of adhesion layer. 9 refs.

JAPAN

Accession no.891384

Item 29

163rd ACS Rubber Division Meeting - Spring 2003. Proceedings of a conference held San Francisco, Ca., 28th-30th April 2003.
Akron, Oh., ACS Rubber Division, 2003, Paper 43, pp.12, 28cm, O12

EFFECT OF COMPOUND INGREDIENTS ON ADHESION BETWEEN RUBBER AND BRASS-PLATED STEEL CORD

Hotaka T; Ishikawa Y; Mori K
Yokohama Rubber Co.Ltd.; Iwate,University
(ACS,Rubber Div.)

The effects of compound ingredients in rubber on the adhesion characteristics with brass-plated steel cord was investigated. It was found that hexamethoxymethylmelam ine, a source of formaldehyde in resorcinol formaldehyde resin formulations, traps residual amines arising from the decomposition of sulphenamide-type accelerators in vulcanisation, leading to improved adhesive strength as well as crosslink density and strain modulus. The effect of carbon black on amine levels is also discussed. 22 refs.

JAPAN

Accession no.889994

Item 30

163rd ACS Rubber Division Meeting - Spring 2003. Proceedings of a conference held San Francisco, Ca., 28th-30th April 2003.
Akron, Oh., ACS Rubber Division, 2003, Paper 42, pp.30, 28cm, O12

MECHANISTIC STUDY OF THE ROLE OF ONE-COMPONENT RESINS IN RUBBER-TO-BRASS BONDING IN TIRES

Patil P Y; van Ooij W J
Cincinnati,University
(ACS,Rubber Div.)

The role of one-component alkylated melamine resins in improving the adhesion performance between the rubber compound and brass-plated steel cord in tyres was investigated, using squalene-based formulations. The vulcanisation process was followed by GPC to monitor the formation of intermediates and the rate of accelerator and sulphur disappearance. The steel cords were analysed by Energy Dispersive X-ray Spectroscopy and TOF-SIMS, and the morphology of the adhesion interface examined by SEM. 23 refs.

USA

Accession no.889993

Item 31

Constitutive Models for Rubber II. Proceedings of a conference held Hanover, Germany, 10th-12th Sept.2001.
Lisse, A.A.Balkema Publishers, 2001, p.277-82, 25 cm, 012

OPTIMIZATION OF ELASTOMER-METAL

COMPONENTS WITH TOSCA AND ABAQUS
Meske R; Sauter J; Friedrich M
FE-Design GmbH; Freudenberg Forschungsdienste KG (Hannover,Universitat)

To reduce time and costs in the development of elastomer-metal components while maintaining a high product quality it is essential to use efficient optimisation tools besides already established non-linear FE analysis. FE-Design offers with the optimisation system TOSCA an integrated solution for topology and shape optimisation with interfaces to major industry standard FE solvers. In combination with ABAQUS it is now also possible to perform topology and shape optimisation with moderate non-linearities. To apply the optimisation algorithms of TOSCA successfully for stronger non-linearities, an enhancement of the algorithms is necessary. This task is approached in the German research project ELAnO (Entwicklung und Konstruktion von innovativen Leichtbauprodukten unter konsquenter Verwendung adaptierter Analyse- und Optimierungsmethoden) in cooperation with Freudenberg and several other companies. The life time and durability of elastomeric bearing components is increased by the systematic application of topology and shape optimisation with TOSCA and ABAQUS under full consideration of geometric material and boundary non-linearities. First results are shown presentation and an outline of future developments is given. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.889205

Item 32
Revista de Plasticos Modernos
83, No.551, May 2002, p.474-5
Spanish
NEW MATERIAL FOR NOISE INSULATION IN THE AUTOMOTIVE INDUSTRY

Details are given of DuruLam, a rubber/metal laminate developed by Trelleborg Rubore for sound damping in automotive brake systems, and which is designed for optimised adhesion to metal substrates.

TRELLEBORG RUBORE AB
EUROPEAN UNION; SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.887771

Item 33
KGK:Kautschuk Gummi Kunststoffe
56, No.5, May 2003, p.237-41
ON THE ULTRASONIC INVESTIGATION OF RUBBER TO METAL ADHESION
Kostial P
Trencin,University

An original physical method of testing the adhesion of rubber to brass is presented. The measurement of reflection of ultrasonic waves on the brass-rubber interface was utilised to test the adhesion between both materials. The higher ultrasonic reflection, the better is the quality of adhesion. The ultrasonic method was verified by comparison with the standard mechanical test of adhesion (the two plate method). The results of both methods show close correlation. 10 refs.

SLOVAK REPUBLIC; SLOVAKIA

Accession no.887339

Item 34
Power at Work
Winter 2003, p.18-9
HITTING THE ROAD WITH HIGH-PERFORMANCE ADHESIVES

Fluoroelastomers are exceptionally good as seal components in automotive under-the-bonnet applications. However, it can be difficult to bond fluoroelastomers to metal with water-borne adhesives. When Rohm & Haas acquired the Megum rubber-to-metal bonding business from Chemetall in October 2001, it began offering the most complete product line available in rubber-to-metal bonding technology across a broad geographic area. Water-borne Megum W3295 is one star in a comprehensive portfolio that includes both Megum and Thixon adhesives, and it securely bonds challenging specialty elastomers like fluoroelastomers, silicone, XNBR, HNBR and Vamac. With operations all over the world, Chicago Rawhide Industries, the seal division of the world's leading bearing manufacturer SKF International, must receive identical Rohm & Haas adhesive formulations no matter the location.

ROHM & HAAS CO.
USA

Accession no.885959

Item 35
Journal of Adhesion Science and Technology
17, No.5, 2003, 725-36
DIRECT ADHESION OF NATURAL RUBBER TO NICKEL/SULFUR PLATING DURING CURING
Hachisuka S; Nakayama J; Mori K; Hirahara H; Oishi Y
Tokyo Rope Mfg.Co.Ltd.; Iwate,University

Direct adhesion of natural rubber to nickel/sulphur plating, obtained by the addition of sodium thiosulphate to the nickel chloride plating bath, during curing has been investigated. It was concluded that nickel/sulphur plating is deposited in an amorphous form with sulphur distributed uniformly. The sulphur content depends on sodium thiosulphate concentration, bath temperature and plating current. A sulphur content of 30 percent gave the optimum adhesion, as determined by tensile testing; thinner plating is preferable. It is concluded that during curing the nickel/sulphur plating is transformed to a crystalline mixture of alpha-nickel and nickel sulphide. 11 refs.

JAPAN

Accession no.884651

Item 36
Materials and Processing - Ideas to Reality. Vol. 34. Proceedings of the 34th International SAMPE technical conference held Baltimore, Md., 4th-7th Nov.2002. Carina, Ca., SAMPE International Business Office, 2002, p.1054-62, 23 cm, 012
NOVEL TECHNIQUES FOR ADHERING RUBBER COMPOUNDS TO METALS
Boerio F J; Rosales P I; Krusling E J; Trasi M; Dillingham R G
Cincinnati,University
(SAMPE)

Although rubber-to-metal adhesion is essential in many areas of technology, most rubber compounds do not adhere well to metals. As a result, the surface of the metal must usually be modified in some way to ensure adhesion of rubber. Many surface modification processes that are applied to metals to ensure adhesion of rubber introduce materials such as cyanides or volatile organic compounds into the environment. It is shown that plasma polymerised acetylene films are excellent primers for rubber-to-metal adhesion and that the process for forming these films is environmentally compatible. Peel test specimens prepared from steel substrates coated with plasma polymerised acetylene films show excellent adhesion when the films are deposited in a microwave reactor at relatively high powers and low pressures; these specimens fail cohesively within the rubber when tested. The mechanisms by which plasma polymerised acetylene films adhere to steel substrates are investigated using IR spectroscopy. Preliminary results indicate that oxygen-containing functional groups such as carboxylate and alkoxide groups play an important role in adhesion of the films to the substrates. 4 refs.
USA

Accession no.882830

Item 37
International Polymer Science and Technology
30, No.3, 2003, T/14-6
INFLUENCE OF THE METHOD OF PRODUCTION OF AN INORGANIC ADHESION ACTIVATOR ON ITS ACTIVITY
Kostrykina G I; Kitaev I Y; Solov'ev M E; Golikov I V; Nosova L V
Yaroslavl',State Technical University

The use is investigated of spent catalysts of the petrochemical industry as activators for improving the adhesion of rubbers to brass-coated metal cord. Fine comminution of the spent product was required to facilitate dispersibility in the polymer. Details are given of the two technologies investigated for processing the spent product, which differed with respect to the type of equipment for comminution and in the method for preliminary preparation of the product before comminution, and the resultant influence of processing on the activity of the spent catalyst used as an adhesion promoter. The presence of active centres was shown to predetermine the participation of the processing product in different reactions in the formation of the structure and adhesion properties of the rubber-metal composite. 3 refs. (Article translated from Kauchuk i Rezina, No.4, 2002, pp.10-12).
RUSSIA

Accession no.881454

Item 38
Industria della Gomma
46, No.2, March 2002, p.19-26
Italian
DIGITAL SHEAROGRAPHY IN THE NON-DESTRUCTIVE TESTING OF RUBBER-METAL STRUCTURES
Steinchen W
Kassel,Universitat

Digital shearography is examined as a non-destructive technique for the study of adhesion defects in rubber-to-metal bonded products. Applications in the evaluation of vibration dampers, shock absorbers and rubber covered rollers are described.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.873924

Item 39
Rubber and Plastics News
32, No.8, 18th Nov.2002, p.20/3
FAILURE ANALYSIS KEY FOR RUBBER-TO-METAL PARTS
Polaski G
Lord Corp.

There are innumerable items made for automotive,aerospace and industrial applications where elastomers are adhered to metal using bonding agents that cure and bond the rubber to the metal substrate during the vulcanisation cycle. If manufacturing or in-service adhesion failures occur, the reasons for the failure need to be understood so corrective actions can be implemented. The types of failure and reasons why failure can occur are discussed. In many cases, visual observation and/or microscopic analysis are sufficient to determine the type of failure. The use of certain analytical tools can help determine the cause of the failure.
USA

Accession no.871628

Item 40
162nd ACS Rubber Division Meeting - Fall 2002. Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.
Akron, Oh., ACS Rubber Division, 2002, Paper 95, pp.26, 28cm, 012
STUDY OF THE ADHESION LAYER FORMED ON BRASS BY SEM AND GRAZING INCIDENCE X-RAY DIFFRACTION

Kim J M; van Ooij W J
Hankook Tire; Cincinnati,University
(ACS,Rubber Div.)

The morphology and crystallography of a copper sulphide layer formed on brass panels cured in squalene. which acted as a liquid model system for NR, were investigated using a combination of scanning electron microscopy and grazing incidence X-ray diffraction. It was found that the morphology of the copper sulphide changed to a crystalline form with increasing cure temperature and that heat ageing of the adhesion layer induced the decomposition of zinc oxide and formation of zinc sulphide. 43 refs.

KOREA; USA

Accession no.871394

Item 41
Elastomery
6, No.3, 2002, p.12-6
Polish

MELAMINE RESINS MODIFIED BY URETHANE AS RESORCIN-FREE PROMOTERS OF RUBBER ADHESION FOR STEEL CORD. PART II

Hehn Z; Rajkiewicz M; Sajewicz J
Kedzierzyn-kozle Institute

The preparation of self-crosslinking melamine resins modified with urethanes and acrylamide and their use as adhesives for increasing the adhesion of rubber to steel/brass cords. 9 refs.

EASTERN EUROPE; POLAND

Accession no.871052

Item 42
Macplas
26, No.233, Nov.2001, p.113-4
Italian

WATER-BASED SYSTEMS FOR RUBBER-TO-METAL BONDING

Lindsay J
Mould Perfect Consultancy

Aspects of the rubber-to-metal bonding process using water-based adhesives are examined, and comparisons are made with the bonding process using solvent-based systems.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.869452

Item 43
Patent Number: US 6419784 B1 20020716

PROCESS FOR IMPROVING THE ADHESION OF POLYMERIC MATERIALS TO METAL SURFACES

Ferrier D

The process involves pretreating the metal surface with a pre-dip, which comprises an aqueous solution with pH of from 5 to 12 and then further treating the metal surface with an adhesion-promoting composition comprising an acid, an oxidiser and a corrosion inhibitor.

USA

Accession no.862344

Item 44
RubberChem 2002, Proceedings of a conference held Munich, Germany, 11th-12th June 2002.
Shawbury, Rapra Technology Ltd., 2002, paper 17, p.131-46, 29 cm, 012

COMPOUNDING EFFECTS ON PHYSICAL PROPERTIES AND RUBBER-METAL BONDING

Del Vecchio R J
Technical Consulting Services
(Rapra Technology Ltd.)

The effects are investigated of four categories of compounding variables on processability and properties of a carbon black reinforced NR compound, including rubber to metal bonding ability. Variables in the formulation included the use of plasticisers, antidegradants, curing agents and cure types. Results are discussed with reference to changes in physical properties, processing effects, and bonding properties. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE

Accession no.859585

Item 45
161st ACS Rubber Division Meeting - Spring 2002. Proceedings of a conference held Savannah, Georgia, 29th April-1st May 2002.
Akron, Oh., ACS Rubber Division, 2002, Paper 12, pp.9, 28cm, 012

FAILURE ANALYSIS OF RUBBER-TO-METAL BONDED ENGINEERED COMPONENTS

Polaski G
Lord Corp.
(ACS,Rubber Div.)

For successful bonding of rubber to metal in the manufacture of quality rubber engineered components, the steps required are proper substrate preparation, proper selection of adhesive, proper adhesive preparation, proper adhesive application and selection of suitable moulding conditions. When a bond failure occurs, each of these steps must be considered during failure analysis. The type of failure must be identified as the first step and then causes allocated to a specific type of failure. The root cause of the failure must then be identified and the problem corrected to prevent it from reoccurring. In some cases, various surface analyses may be conducted using sophisticated techniques to determine the nature of the failure and the possible cause.

USA

Accession no.856244

Item 46
Rubber and Plastics News
31, No.22, 3rd.June 2002, p.14-6
SILANES IMPROVE RUBBER-TO-METAL BONDING
Moore M J
Freudenberg-NOK General Partnership
Edited by: Herzlich H

Silanes, as one of the major classes of rubber-to-metal bonding agents are discussed, and an overview is presented of the reactions involved in the synthesis of this class, with particular reference to the chemistry of hydrolysis and condensation of alkoxysilanes. A review is also presented of the patent literature which reflects that numerous approaches have been taken to improve the performance of solvent-borne silanes. Recent efforts focusing on the development of aqueous offsets are outlined. Some of the technical issues encountered when using silane rubber-to-meal adhesives are discussed, including bath life of the silane, and the shelf life of the coated part. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.855699

Item 47
Kautchuk und Gummi Kunststoffe
55, No.5, 2002, p.227-31
ANALYSIS AND COMPARISON OF JOINTS BETWEEN RUBBER AND METAL AND BETWEEN RUBBER AND RUBBER
Tusek J
Ljubljana,Institut za Varilstvo d.o.o

An investigation was carried out with the aim of optimising the bonding of a rubber sleeve of a packer to a cap and optimising the shape and dimensions of the joints. The effect of the type of material (rubber or aluminium) used for the cap on the strength of the joint between the sleeve and the cap was examined by peel and shear testing. It was found that the packer caps should be made of rubber rather than metal and that joint length was important for the strength of the joint. 7 refs.

SLOVENIA

Accession no.854580

Item 48
Patent Number: US 6335391 B1 20020101
COPOLYMER LATEX FOR ADHESIVE FOR RUBBER/METAL ADHESION AND PROCESS FOR PRODUCING SAME
Matsumoto S; Hironaka T; Ozoe S; Sato T
Tosoh Corp.

This adhesive contains a copolymer consisting of (A) 90.0 to 97.0% by weight of 2,3-dichloro-1,3-butadiene units, (B) 1.5 to 5.0% by weight of 1,2-dichloro-1,3-butadiene units and (C) 1.5 to 5.0% by weight of 1,3-dichloro-1,3-butadiene units. It is prepared by polymerising a monomer mixture consisting of the above monomers in the presence of a free-radical initiator, preferably a redox catalyst system, by emulsion polymerisation. It has good mechanical stability and exhibits enhanced adhesion for rubber/metal adhesion.

JAPAN; USA

Accession no.852220

Item 49
Journal of Adhesion
76, No.3, 2001, p.223-44
INFLUENCE OF CURE CONDITIONS ON THE ADHESION OF RUBBER COMPOUND TO BRASS-PLATED STEEL CORD. II. CURE TIME
Gyung Soo Jeon; Gon Seo
Chonnam,National University

The effect of cure time on the adhesion between brass-plated steel cord and rubber compounds was studied. The physical properties of a rubber compound, as well as the adhesion properties, were examined using specimens cured for a predetermined time at constant cure temp. In order to observe the effect of the extent of cure on the adhesion interphase by Auger electron spectroscopy, vulcanisation of the rubber compound and thin brass film was carried out at various cure times. The extent of cure for the adhesion samples of rubber near the adhesion interphase and in the bulk rubber were also measured using force modulation mode of atomic force microscopy in order to confirm the magnitude of the weak boundary layer. 19 refs. (Pt.I, ibid, p.201-21)

SOUTH KOREA

Accession no.851480

Item 50
Journal of Adhesion
76, No.3, 2001, p.201-21
INFLUENCE OF CURE CONDITIONS ON THE ADHESION OF RUBBER COMPOUND TO BRASS-PLATED STEEL CORD. I. CURE TEMPERATURE
Gyung Soo Jeon; Gon Seo
Chonnam,National University

The effect of cure temp. on the adhesion between brass-plated steel cord and rubber compounds was studied. The physical properties of a rubber compound, as well as the adhesion properties, were examined using specimens cured at a predetermined cure time and temp. derived from a rheocurve. In addition, vulcanisation of the rubber compound in contact with a thin brass film was carried out at various temps. and Auger electron spectroscopy was used to examine the effect of cure temp. on the adhesion interphase. The extents of cure of adhesion samples of rubber near the adhesion interphase and in the bulk rubber were measured using the force modulation technique of atomic force microscopy. The reason why the adhesion property decreased significantly at very high temp. is discussed. 19 refs.

SOUTH KOREA

Accession no.851479

Item 51
Journal of Adhesion
75, No.3, 2001, p.299-324
OPTIMUM POLYMER-SOLID INTERFACE DESIGN FOR ADHESION STRENGTH: CARBOXYLATION OF POLYBUTADIENE AND MIXED SILANES SURFACE MODIFICATION OF ALUMINUM OXIDE
Ilsoon Lee; Wool R P
Delaware,University

Polybutadiene was chemically modified to add carboxyl sticker groups and aluminium oxide surfaces were treated with silanes to add amino receptor groups. Weak polybutadiene-aluminium interfaces were thus changed into strong carboxylated polybutadiene-AlS (where S was silane) interfaces. The fracture energy of these interfaces showed an optimum behaviour as a function of sticker and receptor concentrations. The design strategy for an optimum polymer-solid interface was generalised, being a function of sticker concentration, receptor concentration and sticker-receptor interaction strength. 31 refs. (Adhesion Society Inc., 23rd Annual Meeting, Myrtle Beach, South Carolina, USA, Feb.2000)
USA
Accession no.851465

Item 52
Gummi Fasern Kunststoffe
55, No.1, Jan.2002, p.42-7
German
RUBBER TO METAL BONDING WITH METALLIC CO-AGENTS
Costin R; Nagel W

Commercial adhesion promoters containing zinc methacrylate and dimethacrylate salts are described. The products are used for the promotion of adhesion between peroxide-cured elastomers and metals. It is reported that the adhesion promoters can be used as internal additives to the rubber compound, as externally applied pastes, or as adhesive strips. These species are reported to form ionic crosslinks between individual molecules within the elastomer, as well as to form bonds between the elastomer and the substrate. 2 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.
Accession no.849751

Item 53
Industria della Gomma
45, No.6, July/Aug.2001, p.16-9
Italian
PHOSPHATISATION TECHNOLOGIES FOR RUBBER-TO-METAL BONDING
Granata A
Henkel

An examination is made of the different stages in the phosphatisation process applied to metal surfaces to promote adhesion in rubber-to-metal bonding, including degreasing, pickling, phosphatisation itself and passivation. Reference is made to some chemical products developed by Henkel for use in this process.
HST
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.849046

Item 54
International Journal of Adhesion and Adhesives
21, No.6, 2001, p.481-5
METHOD FOR CONTINUOUS MONITORING OF BOND FORMATION BETWEEN RUBBER AND REINFORCED WIRE
Yea-Yang Su; Shemenski R M
Amercord Inc.; RMS Consulting

An in-situ, continuous monitoring system was designed to detect the rate of adhesive bond formation between rubber and steel reinforcement during the vulcanisation process. The system was suitable for studying steel-belted tyres, which often have a bronze coating plated onto the tyre bead wire. Parameters such as oxide chemical structure and thickness were investigated to assess the rate of bond formation during vulcanisation and their effect on adhesion. Results proved that this monitoring technique was an efficient, reproducible and reliable technique for studying the interfacial interactions occurring between steel reinforcement and rubber during vulcanisation. 27 refs.
USA
Accession no.845875

Item 55
160th ACS Rubber Division Meeting - Fall 2001. Cleveland, Oh., 16th-18th October 2001, Paper 120, pp.7, 012
AN ALTERNATIVE TO PHOSPHATE PRE-TREATMENTS FOR USE IN RUBBER BONDING
Sievers B A; Bainter J C; Restifo C M; Jazenski P J
Circle-Prosco Inc.; Rohm & Haas Co.
(ACS,Rubber Div.)

A ferrous substrate pretreatment was developed for rubber bonding applications. The coating was zirconium-based and contains no constituents in the formulation such as zinc or phosphates that could be covered by local, state and/or federal regulations. Operating conditions for the bath were similar to those for traditional phosphate baths, using either a spray or immersion application after the substrate had been cleaned and rinsed. Compared with traditional phosphate baths, operating baths operated for longer periods of time before dumping was required. As the coating was resistant to flash rusting, no post-sealer rinse was necessary. In tests designed to evaluate the adhesion of rubber to pretreated steel samples for use in seals and anti-vibration mounts, the new coating performed as well as various phosphate coatings. This environmentally-compliant coating could, therefore, easily be used to replace existing phosphate treatments and provide a longer bath life while requiring only minor processing changes in the pretreatment line.

USA

Accession no.843041

Item 56

160th ACS Rubber Division Meeting - Fall 2001. Cleveland, Oh., 16th-18th October 2001, Paper 119, pp.36, 012

ADHESION FAILURE IN BONDED RUBBER CYLINDERS. II. FATIGUE LIFE PREDICTION OF EXTERNAL RING-SHAPED CRACKS USING TEARING ENERGY APPROACH

Leicht D C; Rimnac C; Mullen R

Lord Corp.; Case Western Reserve University

(ACS,Rubber Div.)

The strain energy release rate (tearing energy) was determined for bonded rubber discs having external ring cracks at the rubber-to-metal bond and an attempt was made to develop a method for predicting the fatigue life. Finite element analysis was used to determine the tearing energy as a function of crack lengths for discs of various dimensions (shape factors). The crack configurations considered were an external-ring shaped crack located at the outside circumference of either one or both rubber-to-metal bonds. The fatigue crack propagation behaviour was characterised for a generic filled NR material. Bonded rubber discs are often used as adhesion test specimens, e.g. in ASTM D 429 1999, Method A. 17 refs.

USA

Accession no.843040

Item 57

160th ACS Rubber Division Meeting - Fall 2001. Cleveland, Oh., 16th-18th October 2001, Paper 105, pp.11, 012

SILANES AS RUBBER-TO-METAL BONDING AGENTS

Moore M J

Freudenberg-NOK General Partnership

(ACS,Rubber Div.)

The use of silanes as rubber-to-metal bonding agents is discussed. The chemistry of hydrolysis and condensation of alkoxysilanes is reviewed and the patent literature is surveyed. Methods of achieving stability of silanes in aqueous solution are outlined. Some of the technical aspects of using silane rubber-to-metal adhesives are discussed. 13 refs.

USA

Accession no.843029

Item 58

160th ACS Rubber Division Meeting - Fall 2001. Cleveland, Oh., 16th-18th October 2001, Paper 104, pp.23, 012

NEW METAL TREATMENT PROCESS GIVES SUPERIOR FLEXIBILITY IN SWAGE TESTING

Cowles R; Kucera H; Rearick B; Sullivan J

Lord Corp.

(ACS,Rubber Div.)

The manufacture of rubber to metal bonded bushings typically involves a swage operation, a process that compresses the bonded assembly including the rubber. This compression markedly improves the dynamic fatigue life of the part. The current state-of-the-art in the manufacturing of bushings allows for no more than 4% compression. A new process is described which allows for swaging beyond 10% without compromising bond integrity, while at the same time providing superior corrosion protection over conventional processes. A new test method is outlined which clearly reveals these improvement. 2 refs.

USA

Accession no.843028

Item 59

160th ACS Rubber Division Meeting - Fall 2001. Cleveland, Oh., 16th-18th October 2001, Paper 101, pp.19, 012

ENVIRONMENTALLY PREFERRED ADHESIVES FOR RUBBER TO METAL BONDING

Carney B P; Green C C; DiBacco J A

Lord Corp.

(ACS,Rubber Div.)

The development by Lord Corp. of low lead and low selenium versions of some of the industry's most widely used solventborne adhesives for rubber to metal bonding is described. The performance of the selenium and low selenium adhesives was shown to be equivalent under all test conditions. In the primary adhesion testing, both low lead adhesives outperformed the standard adhesives. Hot tear testing was equivalent for both standard and low lead adhesives. Salt spray results showed that the low lead formulation was superior to the standard adhesive. Boiling water tests were also conducted.

USA

Accession no.843025

Item 60

160th ACS Rubber Division Meeting - Fall 2001. Cleveland, Oh., 16th-18th October 2001, Paper 3, pp.26, 012

EFFECTS OF PROCESSING PARAMETERS ON THE PERFORMANCE OF AUTODEPOSITABLE COATINGS FOR RUBBER TO METAL BONDING

Rearick B A; Cowles R S; Williams J B

Lord Corp.

(ACS,Rubber Div.)

The application of autodepositable organic coatings to metals prior to rubber to metal bonding is discussed. The metals to be coated pass through various processing steps which include alkaline cleaning, acid pickling, immersion in the coatings, dehydration and curing. The effects of these processing steps on the performance of the coatings are considered and comparison is made with conventional rubber to metal bonding techniques. 2 refs.

USA

Accession no.842944

Item 61

Industria della Gomma

45, No.4, May 2001, p.48-50

Italian

OPTICAL METHODS FOR QUALITY ASSURANCE OF COMPOSITE RUBBER PRODUCTS

Steinbichler H

Steinbichler Optotechnik GmbH

The principles of holographic, shearographic and electronic speckle pattern interferometry are examined, and the application of these techniques to the quality control of tyres and other composite rubber products, rubber/metal components and reinforced plastics aircraft components is discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.842560

Item 62

Industria della Gomma

45, No.4, May 2001, p.17-21

Italian

ADHESION OF VULCANISABLE THERMOPLASTIC ELASTOMERS TO VARIOUS SUBSTRATES

Tagliabue L; Delanaye J L

Advanced Elastomer Systems

The adhesion of Advanced Elastomer Systems' Santoprene thermoplastic elastomers, based on PP/EPDM blends, to glass, metals, plastics, EPDM and fabrics is discussed. Surface treatment techniques for adhesion promotion and types of primers and adhesives used to bond Santoprene to different substrates are examined.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

Accession no.842555

Item 63

European Rubber Journal

184, No.2, Feb.2002, p.18-21

BONDING PREPARATION SAVES TIME

Weih M; Rearick B

Lord Corp.

The first step in the process for using rubber-to-metal adhesives is to prepare the metal substrate for bonding. The traditional methods for preparing steel substrates include either grit blasting or phosphatising. In response to environmental concerns and improved performance requirements, Lord has introduced a system called MetalJacket for rubber to metal bonding. This is based on an autodepositable organic coating system. The MetalJacket system combines the functions of pretreatment, priming and corrosion protection. Optimised film thicknesses give coatings that are corrosion resistant, tough and meet OEM paint requirements. 2 refs.

USA

Accession no.842347

Item 64

Newtown, Pa., 1999, pp.2. 27 cms. 30/11/01

PLV 2000, PLV 2100 HIGH PERFORMANCE LIQUID VITON ADHESIVES AND COATINGS WITH EXCELLENT CHEMICAL- AND HEAT-RESISTANT PROPERTIES

Pelseal Technologies LLC

Property data are presented for PLV 2000 and PLV 2100 fluoroelastomer high performance adhesives and coatings from Pelseal Technologies LLC. The two-component products have been used in a variety of industrial applications, including: door gasket adhesives on industrial ovens, coatings for fuel injection hoses in cars, adhesives for splicing and bonding rubber belts, coatings for equipment subjected to corrosive liquids, coatings for metal and rubber rollers subject to high temperature, coatings for electrical cable harnesses, adhesives for bonding rubber gaskets to metals and for repairing jet engines.

USA

Accession no.840471

Item 65

Rubber Bonding 2001. Conference Proceedings. Cologne, Germany, 20th-21st November 2001, Paper 16

REACTION KINETICS OF RUBBER-TO-METAL BONDING AGENTS AND ITS IMPLICATIONS ON BOND DURABILITY

Perrson S; Goude M; Olsson T

Metso Minerals; Lulea,University of Technology

(Rapra Technology Ltd.; European Rubber Journal)

The introduction of the dynamic mechanical thermal analyser (DMTA) as a tool to characterise the curing behaviour of rubber-to-metal bonding agents has opened a new avenue for studying the different reaction schemes of the primers, adhesives and rubbers which form the rubber-to-metal bond. It is believed that the onset of cure (scorch time), the cure rate and the cure level of the layers forming the bond have to be matched in some way in order to obtain strong and durable bonds in the shortest possible cure time. The objective is to investigate the peel creep properties of some well-characterised rubber-to-metal bonds from a cure state point of view. Experimental results are presented on how the mechanical durability of rubber-to-metal bonds of a sulphur-cured NR/BR compound bonded to carbon steel is affected by different cure levels of the rubber, ranging from t2 to t135, in five steps. The peel test is carried out in warm water at 35 deg.C under a peeling load of 120N. Suggestions as to how to improve the long-term durability of rubber-to-metal bonds are discussed. 4 refs.

EUROPEAN UNION; SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.839866

Item 66

Rubber Bonding 2001. Conference Proceedings. Cologne, Germany, 20th-21st November 2001, Paper 15

RUBBER BONDING BETWEEN EPDM SHEETS (AND THERMOSET SHEETS) WITH VARIOUS PERCENT PEROXIDE

Vergnaud J M
Saint Etienne,University
(Rapra Technology Ltd.; European Rubber Journal)

There is a great difference between sticking two media along a very thin surface and curing them together. In the first case, even when bonding takes place, the surface is very thin, while in the second case some matter diffuses through the two media creating a third medium whose properties are intermediate between the first two media. Thus two sheets of EPDM with different % curing agent (2-10-20) are cured together. The best curing conditions are determined using a numerical model, taking into account not only heat transfer but also the kinetics of cure of each rubber defined by MDR and calorimetry. Strong adhesion is obtained between these sheets, proved by excellent mechanical properties and by swelling experiment carried out in toluene. In spite of more than 100% swelling, the rate and extent of which depending largely on the % curing agent, a change in the shape of the two-layer materials is shown, but the two layers do not separate. The hardness of the by-layer systems also varies progressively through their thickness, resulting from the diffusion of the curing agent through the surface of these media. A similar study is carried out in repairing an old broken thermoset piece with a new fresh uncured resin and curing them together, following a previous treatment provoking diffusion of the resin into the old thermoset. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.839865

Item 67

Rubber Bonding 2001. Conference Proceedings. Cologne, Germany, 20th-21st November 2001, Paper 14

POST VULCANISATION BONDING, PV BONDING

Worthington K
Compounding Ingredients Ltd.; Synair Corp.
(Rapra Technology Ltd.; European Rubber Journal)

Post-vulcanisation bonding processes are defined and the benefits and potential difficulties involved in such processes are outlined. The potential technologies for post-vulcanisation bonding processes, and the possible available bonding systems, are reviewed, followed by some examples of where post-vulcanisation bonding can be used effectively.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE

Accession no.839864

Item 68

Rubber Bonding 2001. Conference Proceedings. Cologne, Germany, 20th-21st November 2001, Paper 13

ADHESION OF RUBBER TO BRASS - INFLUENCE OF COBALT ON INTERFACE MORPHOLOGY

Fulton W S
Rhodia Industrial Specialties Ltd.
(Rapra Technology Ltd.; European Rubber Journal)

The strength of the bonding interface between brass-coated steel cord and rubber compound is one of the most important factors governing the performance and durability of car and truck tyres. Interfacial strength is closely related to the structure of the bonding layer and any changes brought about during the lifetime of a tyre. The structure of a tyre-cord interface is investigated by novel electron microscopic methods, more traditional X-ray photoelectron spectroscopy profiling and X-ray diffraction techniques, to reveal the morphology before and after ageing. Fine ion-beam etching of a tyre cord previously embedded in a belt compound creates specimens thin enough to visualise the bonding layer structure in the electron microscope. More importantly, it is possible to examine the effect that cobalt adhesion promoters has upon the interface morphology as the suppressed growth of crystalline dendrites normally associated with the ageing process. XPS profiling of the interface reveals that different types of adhesion promoter influence the amount and distribution of cobalt ions in the bonding layer. Such techniques coupled with X-ray diffraction also demonstrate the influence that cobalt has on the structure of the interface and the subsequent crystallinity. 27 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.839863

Item 69

Rubber Bonding 2001. Conference Proceedings. Cologne, Germany, 20th-21st November 2001, Paper 11

AUTOMATION OF RUBBER INJECTION PRESSES

Steinl P
LWB Steinl GmbH & Co.KG
(Rapra Technology Ltd.; European Rubber Journal)

Especially for the production of rubber to metal bonded parts, it is more and more important to guarantee high and stable quality as well as low costs for the manufactured part. LWB Steinl has developed rubber injection presses to become fully automatic machines, enabling the producer to meet current requirements. During the last five years LWB designed machines suitable for large and very complex parts, together with one of the world leading manufacturers of rubber to metal bonded parts for the automotive industry. However, the decision to choose automation has to be taken after evaluation of a lot of components and is not the right one for all manufacturers. The background of automation, advantages and disadvantages as well as the 'step-by-step' automation of rubber injection machines are presented. Other aspects include automation: conditions machine-wise; motives for automation; automation and its costs; development of automation; comparison of expenses; and customised solutions.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.839861

Item 70

Rubber Bonding 2001. Conference Proceedings.
Cologne, Germany, 20th-21st November 2001, Paper 9

KEY ELEMENTS IN THE INTERFACE OF RUBBER TO METAL BONDS

Dehnicke S; Kisner D; Lang H
Rohm & Haas Deutschland GmbH; Chemetall GmbH
(Rapra Technology Ltd.; European Rubber Journal)

Due to stringent technical requirements on modern rubber-to-metal composites, the majority of in-mould bonded rubber components use a two-coat, primer plus coversement bonding agent system. The most important development in these bonding agent systems was the recent change from lead-containing to lead-free bonding agent formulations for automotive applications. This change was accompanied by detailed examination into the presence and function of heavy metals in the different bonding agent layers. Based on selected analytical results from EDX and wavelength dispersive X-ray measurements on cross sections of rubber to metal bonded composites, contributions are given to the understanding of bond formation in general. A comparison of lead-containing and remaining lead-free bonding agent formulations is presented. Typical performance parameters from rubber to metal bonding applications are also presented. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.839859

Item 71

Rubber Bonding 2001. Conference Proceedings.
Cologne, Germany, 20th-21st November 2001, Paper 6

BONDING PROPERTIES OF SILICA FILLED NATURAL RUBBER COMPOUNDS TO VARIOUS SUBSTRATES

Ansarifar M A; Zhang J; Bell A; Ellis R J
Loughborough,University
(Rapra Technology Ltd.; European Rubber Journal)

Bonding properties of a sulphur cure system-based NR compound containing 60 pph rubber by weight precipitated amorphous white silica to steel, aluminium and nylon 6,6 is studied by means of peel tests. The compound also contains 7 pph bis(3-triethoxysilylpropyl-) tetrasulphane bifunctional organosilane to prevent the silica from interfering with the cure reaction in the rubber. When rubber is peeled at an angle of 90 deg. either at a constant rate of grip separation or under constant load, peeling energies up to 24 kJ/sq.m are measured. Under constant load, bond failure occurs in a time-dependent manner, and is cohesive within the rubber somewhere between 17 and 700 mu m from the covercoat. Two modes of failure are observed in these tests. Slow mode, where peel rate is ~6.5 x 0-7 to 7 x 10-5 mm/s, and fast mode, where the rate reaches approximately 240 mm/s. Notably, the bond strength of the rubber to these substrates is almost similar. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.839856

Item 72

Rubber Bonding 2001. Conference Proceedings.
Cologne, Germany, 20th-21st November 2001, Paper 4

INVESTIGATION OF THE KINETICS OF BOND FORMATION, CORROSION RESISTANCE AND ENVIRONMENTAL RESISTANCE OF A NEW AQUEOUS, HEAVY METAL-FREE, METAL TREATMENT SYSTEM FOR RUBBER-TO-METAL BONDING WHICH COMBINES THE FUNCTIONS OF CHEMICAL PRETREATMENT, RUBBER-TO-METAL PRIMING AND CORROSION PROTECTION IN ONE PROCESS

Weih M A; Rearick B
Lord Corp.
(Rapra Technology Ltd.; European Rubber Journal)

In order to maximise the bond strength, corrosion resistance and environmental durability of rubber-to-metal bonded components used in automotive applications, it is necessary to perform several separate and distinct processes. These include: cleaning and chemically pretreating metals by zinc phosphatisation or plating to provide a consistent surface for bonding; priming with a conventional solvent-based rubber-to-metal primer to maximise adhesion to the metal substrate; and post-treating parts after bonding with a paint or plating process to obtain the necessary corrosion resistance mandated by the automotive companies. A new metal treatment system is developed, combining the separate functions above into a single dip application process. This system is aqueous, heavy metal-free, provides a uniform self-limiting film thickness, and is applied before the bonding process, with no post-bonding treatment required. An investigation into the kinetics of the reactions, which lead to these desirable properties, is presented. 2 refs.

USA

Accession no.839854

Item 73

Structural Adhesives in Engineering VI. Conference Proceedings.

Bristol, 4th-6th July 2001, p.265-8, 012

AN ASSESSMENT OF COLD-CURING ADHESIVES FOR USE IN A MARINE ENVIRONMENT

Bowditch M R; Hiscock D; Lane J M; Masters H J

DERA

(IOM Communications Ltd.)

Four cold-curing epoxide adhesive systems for bonding a PU and a polychloroprene rubber to carbon steel were evaluated in a search for materials suitable for use by the Royal Navy. It was found that two of the four adhesive systems examined were unaffected by exposure to seawater at 33C for six months. The general effect of cathodic protection was to exacerbate the effects of water immersion, although one adhesive system was surprisingly resistant. Heat ageing at 80C over a period of 14 days had no significant long-term detrimental effect on any of the materials investigated. All the primer/adhesive systems showed a marked and consistent loss of joint strength when debonded at the higher temp. of 80C.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.838240

Item 74

Journal of Adhesion Science and Technology

15, No.8, 2001, p.967-91

RUBBER-TO-METAL BONDING BY SILANES

Jayaseelan S K; Van Ooij W J

Cincinnati,University

The bonding of sulphur-vulcanised rubber compounds to metals was studied. It was shown previously that bis(triethoxysilyl)ethane and vinyltriethoxysilane worked for bonding peroxide-cured rubber compounds to metals. These silanes were found not to work with sulphur-cured rubber compounds. For the latter case, a mixture of bis(trimethoxysilylpropyl)amine and bis(tri ethoxysilylpropyl)tetrasulphide was found to work and results are presented of experiments in which brass, steel and electrogalvanised steel were bonded to a typical tyre cord skim compound with and without a cobalt additive. This silane treatment was found to be as effective as or better than brass adhesion to cobalt-containing rubber compounds. The superior corrosion protection offered by the silanes was also demonstrated using DC corrosion and polarisation resistance measurements. The silane process reported behaved similarly with all metal substrates. The structure of the silane film on a metal substrate was studied and a model proposed for a possible mechanism of the adhesion of rubber compounds with silane-coated metals. 21 refs.

USA

Accession no.836282

Item 75

Industria della Gomma

45, No.2, March 2001, p.16-21

Italian

HIGHER PERFORMANCE REQUIRED OF PRIMERS

Dehnicke S

Chemetall GmbH

An examination is made of the properties of Megum phenolic resin based primers (Chemetall) and their use in rubber-to-metal bonding. Results are presented of studies of adhesion and corrosion resistance and of the influence of different metal surface treatment techniques.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.835427

Item 76

Thirty-ninth Annual Conference on Adhesion and Adhesives.

Oxford, 4th April 2001, Paper 9

ROLE OF PRIMER IN RUBBER TO NYLON 6,6 BONDING APPLICATIONS

Ansarifar M A; Zang J; Bell A; Ellis R J

Loughborough,University

(Oxford,Brookes University,Joining Technology Research Centre)

Primers are often used in rubber-to-metal bonding applications to protect the bonded area against corrosion in service. Their role in rubber to nylon 6,6 bonding applications is studied by means of peel tests. Test pieces in the form of bonded strips are prepared by vulcanising a conventional accelerator/sulphur compound of NR with a sulphur to accelerator ratio of about 4:17, containing 60 parts per hundred rubber by weight (phr) High Abrasion Furnace colloidal carbon black in contact with nylon 6,6 plates. Proprietary bonding systems - organic solvent-based Megum, 3276 (primer) and Megum 101 (covercoat), or water-based Megum W23501 (primer) and Megum W23126 (covercoat) referred to, respectively, as System A or System B, are used. The rubber is peeled under constant load at an angle of 90 deg. in ambient temperature. Failure occurs in a time-dependent manner along the bond following a cavitation-like process in the rubber in the highly stressed region of the peel front adjacent to the bond plate, and is of mixed modes for both systems. Some failures are cohesive in the primer layer and interfacial between nylon and primer, and some are cohesive in the rubber. Visual examination of the peel front zone, where large cavities are present over an extensive region, shows unbroken strands of rubber in-between these cavities.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.835092

Item 77

International Polymer Science and Technology

28, No.8, 2001, p.T/24-33

ADHESION OF RUBBER TO METAL

Ikeda Y

The bonding of rubbers to metals during vulcanisation is reviewed, with respect to individual technological developments and the outputs of research, with particular emphasis on the direct bonding of rubber to various metals or alloys during vulcanisation. Experimental results discussed indicate that the important adhesion factor in direct vulcanisation bonding is the formation of a sulphide layer at the interface due to reaction of the metal with sulphur in the rubber, and that some interaction occurs between this sulphide layer and rubber. 50 refs. (Article translated from Nippon Gomu Kyokaishi, No.4, 2000, p.180).

JAPAN

Accession no.834235

Item 78

K2001: Product Information.

Messe Duesseldorf, 2001, p.36

LEAD-FREE, ONE-COAT RUBBER TO METAL BONDING

CIL

CIL has introduced a new lead-free, one-coat bonding system, Cilbond 24, for rubber and metal anti-vibration components. Traditional rubber-to-metal bonding systems consist of two products, a primer and a top-coat. The company's one-coat system reduces process and labour time, as well as VOC emissions. Also, only one product needs to be stocked, and the single spraying or dipping operation minimises material losses. The system will bond a wide range of elastomers including NR, SBR, CR, BR and Vamac, while providing good resistance to temperature, hot glycol and hot oil - so it can be effectively deployed in highly demanding applications such as engine mountings, suspension mountings, torsional vibration dampers, hoses, gaskets and seals. The UK company also manufactures one- and two-component, castable polyurethane elastomer systems, polymeric puncture-proofing systems for industrial tyres, mould release agents, and in-mould coatings for polyurethanes. This abstract includes all the information contained in the original article.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.833659

Item 79

Tire Technology International

Sept. 2001, p.23/6

KEEP THEM PEELED

Ansarifar M A; Zhang J; Bell A; Ellis R J

Loughborough,University

Peel tests were carried out to determine the bond strength of NR to steel, glass fibre-reinforced nylon 66 and aluminium either at a constant rate of grip separation or under constant load and the results of the tests compared. The data obtained revealed that there were differences in the mechanisms of bond failure when the NR was peeled at a constant rate or under constant load and that the constant load peel test method served as a more accurate and effective means of assessing rubber to metal bond failure and measuring bond strength than the constant rate peel test.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.833589

Item 80

Tire Technology International

Annual Review, 2001, p.58-61

MAXIMISE STEEL CORD ADHESION WITH RESORCINOL FORMALDEHYDE RESINS

Lawrence M A; deAlmeida J

INDSPEC Chemical Corp.

The performance capabilities of a styrenated resorcinol-formaldehyde resin, called Penacolite B-20-S, in a typical steel skim tyre NR formulation were investigated using a design of experiments approach. The effects of sulphur, resin and cobalt salt in various amounts on unaged, steam-aged and humidity-aged steel cord adhesion were evaluated and the results compared with those for a cobalt-only system. Using the data obtained, an optimum formulation for maximised adhesion was determined. 4 refs.

USA

Accession no.833087

Item 81

Popular Plastics and Packaging

46, No.10, Oct. 2001, p.17

INNOVATIVE EXTRUSION PROCESS BONDS THERMOPLASTIC ELASTOMERS TO METALS WITHOUT ADHESIVES

Quanex Corp. is reported to be the first processor to chemically bond Santoprene thermoplastic elastomer to various coiled metals using its Roll Trusion technology and enhanced-bonding TPEs from Advanced Elastomer Systems LP.

ADVANCED ELASTOMER SYSTEMS LP; QUANEX CORP.

USA

Accession no.832807

Item 82

Journal of Adhesion Science and Technology

15, No.7, 2001, p.823-39

THERMOPLASTIC FILM ADHESIVES BASED ON PHENOL-FUNCTIONAL ACRYLIC COPOLYMERS: SYNTHESIS, MECHANICAL AND ADHESION PROPERTIES

Gouri C; Nair C P R; Ramaswamy R

Vikram Sarabhai Space Centre

Acrylic polymers possessing varying amounts of pendant phenol groups were synthesised by the free radical copolymerisation of N-(4-hydroxyphenyl)maleimide with butyl acrylate and acrylonitrile and were characterised. These thermoplastics were shown to form good film adhesives for different adherends (metal to metal bonding and rubber to metal bonding) and their mechanical and adhesion properties were evaluated as a function of the phenol content. The dependence of the mechanical, thermal and adhesion properties on the composition and the effect of the addition of selected fillers on these properties were also investigated. 22 refs.

INDIA

Accession no.829521

Item 83

Journal of Applied Polymer Science

81, No.11, 12th Sept.2001, p.2597-608

REACTIVE BONDING OF NATURAL RUBBER TO METAL BY A NITRILE-PHENOLIC ADHESIVE

Achary P S; Gouri C; Ramaswamy R

Vikram Sarabhai Space Centre

Modification, by addition of up to 20 parts toluene diisocyanate-nitrosophenol (TDI-NOP), of a nitrile-phenolic rubber bonding agent used in the vulcanisation bonding of a natural rubber compound to a steel substrate was examined primarily in terms of peel strength and micrography of the torn surface. Peel strength increased with increasing TDI-NOP content to a plateau level at which failure changed from interfacial failure of the bond to cohesive tearing of the rubber. Explanation of the mechanism of bonding and rupture, and the contribution of the TDI-NOP are suggested, and preparation methods of bonding agent and TDI-NOP additive are given. The TDI-NOP additive was characterised using elemental analysis, infrared spectroscopy, calorimetry and thermogravimetric analysis. 26 refs.

INDIA

Accession no.829359

Item 84

Macplas

25, No.223, Nov.2000, p.98-100

Italian

ADHESIVES FOR THE THIRD MILLENNIUM

Plasczynski T

Lord Corp.

A review is made of developments in adhesives for use in rubber-to-metal bonding, including solvent-based, water-based and 100% solids formulations. Consideration is also given to the selection of adhesives to meet the requirements of different rubbers and substrates, factors influencing adhesion, and methods used in the surface preparation of metals for bonding.

USA

Accession no.828687

Item 85

Industria della Gomma

44, No.10, Dec.2000, p.37-42

Italian

WHEN RUBBER HAS A HEART OF METAL

De Tuoni E

A review is presented of aspects of rubber-to-metal bonding discussed at a conference held in Milan by Assogomma on 27th November 2000. These included developments in primers and water-based adhesives, methods for the surface preparation of metal substrates, techniques used in testing, analysis and quality control, approaches to the prevention of bond failure problems, and the bonding of thermoplastic elastomers to metals and other substrates.

ASSOGOMMA

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE; WORLD

Accession no.828668

Item 86

Industria della Gomma

44, No.10, Dec.2000, p.16-22

Italian

GUIDE TO THE SOLUTION OF RUBBER-TO-METAL BONDING PROBLEMS

Peters D

Par Chemie

Consideration is given to the different steps involved in rubber-to-metal bonding, including surface preparation of metal substrates, the application of primers and adhesives, and moulding, vulcanisation, curing and post-treatment processes. Factors which can lead to weak adhesion and bond failure are discussed, and approaches to the identification and correction of such problems are outlined.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.828666

Item 87

Rubber to Metal Bonding. Proceedings of a one-day seminar held Shawbury, 30th January 1997..

Shawbury, 1997, paper 7, pp. 7. 012

INSERT MOULDING - AUTOMATIC MANUFACTURING OF RUBBER-TO-PLASTIC MOULDED COMPONENTS

Arning M
Engel Vertriebs GmbH
(Rapra Technology Ltd.)

The automation of the production of rubber to metal and rubber to plastic moulded components is discussed, with reference to reducing production costs and improving productivity and quality. Basic features of Engel moulding machines which can assist in these aims are described, and include the use of FIFO-injection units, tiebarless machines, microprocessor-based process control, and the use of predictive software for predicting cure times, demoulding moments, and automatic control of the cure time for rubber to metal bonded parts. The use of peripheral equipment for an automated work cell for rubber to metal bonded products is examined, and examples are described of automated parts manufacturing. The Combimelt method of producing rubber to plastic bonded components is also detailed.

AUSTRIA; EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.827809

Item 88

Rubber to Metal Bonding. Proceedings of a one-day seminar held Shawbury, 30th January 1997..
Shawbury, 1997, paper 6, pp. 3. 012

WATER BASED BONDING AGENTS - THE FUTURE WITH THE ENVIRONMENTAL PROTECTION ACT

Woodcock R
Dunlop Metalastik
(Rapra Technology Ltd.)

The growth of water-based bonding agents in response to environmental regulations is examined. It is argued that the only long term answer to emission control is solvent elimination, and the experiences to date of Dunlop Metalstik with water-based bonding agents are described with particular reference to the effect of a thinner film, prebake resistance, the use of primers, the product range currently available, and the disadvantages of aqueous products in rubber to metal bonding applications.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.827808

Item 89

Rubber to Metal Bonding. Proceedings of a one-day seminar held Shawbury, 30th January 1997..
Shawbury, 1997, paper 5, pp. 5. 012

PROBLEM SOLVING IN RUBBER TO METAL BONDING

Worthington K
Compounding Ingredients Ltd.
(Rapra Technology Ltd.)

Typical applications are examined in which rubber to metal bonding failures are possible, and possible solutions are examined. Examples of problem solving include glycol resistance in a hydromount test, and fuel resistance of a turbo injection inlet manifold gasket. Retreading a tyre with a PU precured tread is examined, with reference to the selection of a suitable bonding agent. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.827807

Item 90

Rubber to Metal Bonding. Proceedings of a one-day seminar held Shawbury, 30th January 1997..
Shawbury, 1997, paper 4, pp. 12. 012

ELASTOMER TO SUBSTRATE BONDING

Rooke M B
Henkel Industrial Adhesives
(Rapra Technology Ltd.)

Rubber to substrate bonding is discussed, with reference to the use of controlled product design techniques in the evaluation of product failure. Consideration is given to the preparation of metallic and polymeric substrates by mechanical and chemical methods, the preparation of bonding agents and their selection criteria. Application methods are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.827806

Item 91

Rubber to Metal Bonding. Proceedings of a one-day seminar held Shawbury, 30th January 1997..
Shawbury, 1997, paper 3, pp. 8. 012

AQUEOUS CHEMICAL PRETREATMENTS FOR RUBBER TO METAL BONDING

Bell A T
Chemetall Ltd.
(Rapra Technology Ltd.)

Surface pretreatments prior to the bonding of rubbers to metals are discussed, with reference to both chemical and mechanical techniques. In particular, the various aqueous chemical pretreatments, used for the preparation of substrates prior to the application of the bonding agent, are described. The influence of mechanical surface pretreatments and of phosphate surface pretreatments on adhesion to steel is compared in terms of tensile strength and fracture, and factors to be considered in the selection of an appropriate process are examined.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.827805

Item 92

Rubber to Metal Bonding. Proceedings of a one-day seminar held Shawbury, 30th January 1997..
Shawbury, 1997, paper 2, pp. 4. 012

WET BLAST PREPARATION AND THE

SUBSEQUENT PHOSPHATING PROCESS AND RELATED EQUIPMENT

Denman C
Abrasive Developments Ltd.
(Rapra Technology Ltd.)

Advantages are described of a wet blast phosphating process developed by Abrasive Developments Ltd. of the UK in conjunction with their Japanese licensee, Yamashita Rubber Company. The latter manufactures anti-vibration rubber and bonds it to supporting metal parts exclusively for Honda Motor Company. The Vaqua process, which together with the equipment, is described, is claimed to deliver high quality components from an automatic machine that combines both the cleaning and phosphating processes. The process is reported to increase the strength of adhesive bonding between the anti-vibration rubber and the metal parts, improve the corrosion resistance of the metal parts, whilst providing quality within acceptable costs. Comparisons are made with conventional pretreatments.

YAMASHITA RUBBER CO.LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; JAPAN; UK; WESTERN EUROPE

Accession no.827804

Item 93

Rubber to Metal Bonding. Proceedings of a one-day seminar held Shawbury, 30th January 1997..
Shawbury, 1997, paper 1, pp. 4. 012

BONDING OF RUBBER, THE INDUSTRIAL OVERVIEW

Lindsay J
BTR Peradin Ltd.
(Rapra Technology Ltd.)

An overview is presented of the rubber to metal bonding process, which covers history, rubber compounding, inserts preparation, bonding agents, mould design and moulding. Particular consideration is given to surface preparation techniques and the choice of bonding systems. This latter takes into consideration the polymer to be bonded, the substrate, the modulus of the rubber, the shape factor, and environmental concerns.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.827803

Item 94

Shawbury, Rapra Technology Ltd., 2001, pp.x, 386, 25cm, 9(12)4

HANDBOOK OF RUBBER BONDING

Edited by: Crowther B

This book is the first for many years to be solely devoted to the subject of rubber bonding. The book presents a series of papers written by a variety of authors with practical expertise within the field who have been engaged in improving the bonded product to meet the ever increasing demands placed on composites and components manufactured from rubbers bonded to metals, fabrics, fibres and plastic substrates. Chapter titles include: Substrate preparation methods; Rubber to metal bonding; Rubber to metal and other substrate bonding; Bonding rubber to metals with waterborne adhesive systems; Rubber to rubber bonding; Rubber to Brass bonding; Review of tyre cord adhesion; Rubber to metal bonding using metallic coagents; Rubber to fabric bonding; Bonding rubber with cyanoacrylates; Bonding silicone rubber to various substrates; failures in rubber bonding to substrates. Each chapter is well referenced.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; INDIA; UK; USA; WESTERN EUROPE

Accession no.826525

Item 95

International Journal of Adhesion and Adhesives
21, No.3, 2001, p.233-9

CURE-ADHESION OF RUBBER TO ELECTROLESS PD-P ALLOY DEPOSIT: EFFECT OF P CONTENT IN ALLOY

Ikeda Y; Nawafune H; Mizumoto S; Sasaki M; Nagatani A; Nishimori A; Yamaguchi K; Uchida E; Okada T
Konan,University; Hyogo Prefecture,Industrial Research Institute; Ishihara Chemical Co.Ltd.

The cure-adhesion of rubber (NR and polybutadiene) to electroless plating film of palladium-phosphorus(Pd-P) alloy and the adhesion mechanism were investigated. The adherents in the cure-adhesion had high adhesion force and adhesion failure was the cohesive failure of the rubber. The peel strength decreased with an increasing P content in plating film of Pd-P alloy. When the P content increased in the alloy, the reaction between Pd and sulphur in rubber was depressed because the oxide film was formed readily. In the evaluation of adherence of rubber and metal, the solderability was superior to the analysis by ESCA. ESCA and Rutherford backscattering spectroscopy analyses on the adhesion interface suggested that high bond-durability was achieved when about 30 nm thickness of sulphide layer was formed in the interface. Reflection electron diffraction analysis of the sulphide layer proved the formation of palladium sulphide. 13 refs.

JAPAN

Accession no.825021

Item 96

159th ACS RUBBER DIVISION MEETING - SPRING 2001. Held Rhode Island. 24th-27th April 2001..
Akron,Oh., 2001, Paper No.18, pp.17. 012

CURE STUDIES OF PHENOLIC BONDING AGENTS USING TGA, FTIR AND CONTACT ANGLE

Moore M J
Freudenberg-NOK
(ACS,Rubber Div.)

The cure of phenol-formaldehyde resin rubber-to-metal adhesives was studied by TGA, IR spectroscopy and surface energy measurements. The possible benefits of baking of coated metal inserts prior to moulding were considered. IR spectra revealed the formation of quinone methide groups that could play a role in the bonding mechanism. Solventborne and aqueous adhesives were compared and the effect of their differences on bonding was examined. Surface energy measurements provided a rapid method for assessing differences between solvent and water-based novolac dispersions. 5 refs.

USA

Accession no.824936

Item 97

International Polymer Science and Technology

28, No.7, 2001, p.T/11-9

INDIRECT BONDS BETWEEN RUBBER AND OTHER MATERIALS

Iizumi S

The technology for bonding rubbers to other materials, and in particular, to metals is discussed. Bonding technologies are classified as direct and indirect methods. The former involves bonding during vulcanisation, whereas in indirect bonding, the uncured rubber is presented to the metal surface after the latter has been coated with a cure adhesive. Both techniques are described and discussed with reference to trends affecting developments in technology. In particular, the development of cure adhesives and the development of surface treatment technology for metals are examined. 11 refs. (Article translated from Nippon Gomu Kyokaishi, No.4, 2000, p.172)

JAPAN

Accession no.824291

Item 98

Journal of Adhesion Science and Technology

15, No.6, 2001, p.689-701

PROMOTION EFFECT OF A CHLOROTRIAZINE DERIVATIVE ON THE ADHESION BETWEEN RUBBER COMPOUNDS AND A BRASS-PLATED STEEL CORD

Jeon G S; Seo G

Damyang,Provincial College; Chonnam,National University

The effect of a chlorotriazine derivative, as an adhesion promoter, on the adhesion between rubber compounds and brass-plated steel tyre cord was investigated. The physical properties, cure characteristics and adhesion of the chlorotriazine derivative-loaded rubber compounds were determined and the adhesion interphases characterised. Depth profiles of copper and sulphur and zinc and oxygen for unaged and humidity-aged rubber compound/brass film adhesion samples as a function of chlorotriazine derivative are illustrated. 25 refs.

SOUTH KOREA

Accession no.823101

Item 99

Journal of Adhesion Science and Technology

15, No.4, 2001, p.483-98

P-HYDROXY-BENZOIC ACID AS AN ADHESION PROMOTER FOR RUBBER COMPOUNDS TO A BRASS-PLATED STEEL CORD

Gyung Soo Jeon; Gon Seo

Damyang,Provincial College; Chonnam,National University

The adhesion between p-hydroxybenzoic acid(POB)-containing rubber compounds and a brass-plated steel cord was investigated in order to understand the role of POB as an adhesion promoter. The cure rate slowed down when POB was added to the rubber compound, but changes in the physical properties were not significant. An improvement in adhesion was seen with a low loading of POB in the range of 0.5 to 1 phr, while an adverse effect was observed only with a high loading at 4 phr and a long ageing time of 15 days. The adhesion interphase between a rubber compound and a thin brass film studied using atomic emission spectroscopy showed an acceleration of the copper sulphide formation by POB incorporation, resulting in an enhancement of the adhesion. A higher POB loading, however, as well as a longer ageing time led to a large increase in the migration of copper into the rubber and excessive growth of the zinc oxide layer, resulting in a decreased adhesion property. 17 refs.

SOUTH KOREA

Accession no.820613

Item 100

Journal of Adhesion Science and Technology

15, No.4, 2001, p.467-81

ENHANCED ADHESION OF STEEL FILAMENTS TO RUBBER VIA PLASMA ETCHING AND PLASMA-POLYMERIZED COATINGS

Kang H M; Chung K H; Kaang S; Yoon T H

Kwangju,Institute of Science & Technology; Suwon,University; Chonnam,National University

Zinc-plated steel filaments were coated with radiofrequency plasma polymers of acetylene or butadiene in order to enhance adhesion to rubber compounds. Plasma polymerisation was carried out as a function of the plasma power, deposition time and gas pressure. In order to maximise adhesion, argon plasma etching was performed and carrier gases such as argon, nitrogen and oxygen were used. Plasma polymer coatings were characterised by FTIR spectroscopy, Alpha-Step thickness measurement and a dynamic contact angle analyser. The adhesion of steel filaments was evaluated using a tire cord adhesion test. The best results were obtained from a combined process involving argon etching and acetylene plasma polymer coating with argon carrier gas. These samples exhibited a pull-out force of 285N, which was comparable with that for brass-plated steel filament. 23 refs.

KOREA

Accession no.820612

Item 101

Luntai Gongye
21, No.4, 2001, p.215-9
Chinese

EFFECT OF COBALT SALT ON ADHESION STRENGTH BETWEEN CORD COMPOUND AND BRASS-PLATED STEEL CORD IN RADIAL TIRE

Liang Li; Guo Yang
Anhui Kaiyuan Tire Co.Ltd.

The effect of type and concentration of cobalt salt on the properties of NR compound and the adhesion strength between the cord compound and the brass-plated steel cord in radial tyres was investigated. The results obtained showed that the cobalt type had little effect on the compound properties. The adhesion strength between the cobalt naphthenate-containing compound or cobalt stearate-containing compound and the brass-plated steel cord decreased significantly as the overcure time increased. The compounds with different types of cobalt salts had better heat resistance after hot air ageing and the compounds with cobalt neodecanoate or cobalt boroacylate had higher adhesion strength retention after steam ageing. A higher original adhesion strength could be obtained, but the hot air ageing properties and steam ageing properties decreased significantly as the level of cobalt neodecanoate increased and the optimum balanced adhesion properties were obtained when 0.7 to 1.2 phr of cobalt salt was used.

CHINA

Accession no.817785

Item 102

Rubber and Plastics News
30, No.17, 19th March 2001, p.14/21

SEM/EDX ANALYSIS OF STEELCORD-RUBBER INTERFACE

Leyden J J
Akron Rubber Development Laboratory Inc.

In a controlled laboratory experiment the effects of heat, humidity and salt solution ageings on steelcord adhesion were measured using ASTM D 2229-99 test methodology. Tested cords were analysed by SEM/EDX for transition metal and sulphur content at both 20KV and 10KV excitation voltages. SEM/EDX results were compared to EDX spectra from a sampling of 11 brands of new and worn steel radial tyres. The effects of the various accelerated ageings on steelcord adhesion at 95% confidence level were noted. The SEM/EDX spectra were comparable to results obtained on steelcord removed from the 11 brands of industry tyres. 4 refs.

USA

Accession no.814589

Item 103

Polymer Testing
20, No.3, 2001, p.339-50

STATIC ELASTOMER-TO-METAL TEST (DEBONDING) FACILITY FOR USE IN AN INDUSTRIAL ENVIRONMENT

Lawrence C C; Lake G J
East London,University

A new machine that is designed for the indirect testing of failure in rubber-to-metal bonds is described in detail. It incorporates all the necessary health and safety factors to make it suitable for use in an industrial situation, including when non-specialist staff are employed. The method was designed to be transferable between laboratories and industry. Observation of crack growth and failure using a time-lapse video system showed that these were very complex. The extremely complex mechanisms of the debonding processes can be observed more accurately using the machine. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.813863

Item 104

Rubber and Plastics News
30, No.12, 8th Jan.2001, p.12-5

NEW METHOD IMPROVES RUBBER-TO-METAL BONDING

Cowles R S; Kucera H W; Mowrey D H; Sullivan J E
Lord Corp.

While developing novel aqueous chemistries for advanced rubber-to-metal primers, a breakthrough occurred in the Lord laboratories which led to the development of a successful system that extended the functionality of its traditional products to include: an alternative to phosphatising for preparing the metal surfaces; extended corrosion protection beyond the bonded area; and improved processing for preparing the metal and a means of applying the necessary coating chemistry uniformly on complex parts with minimal waste. This technology was introduced to the market in October 1999 under the MetalJacket trade name. The data presented in this paper show how parts treated with the aqueous MetalJacket system demonstrate excellent environmental resistance and flexibility. In the swaging of bushings, the MetalJacket technology, with its fracture toughened metal treatment, passes 16% diameter reduction in swaging with failure only in the rubber and no visible fracture of the metal treatment. 1 ref.

USA

Accession no.803716

Item 105
International Polymer Science and Technology
27, No.12, 2001, p.T/50-3
DEVELOPMENTS OF METHODS FOR IMPROVING THE BOND STRENGTH BETWEEN THE ELEMENTS OF PLIED-UP RUBBER-CORD COMPOSITES
Vashchenko Y B; Sokolova G A; Shcherbakov A B; Onishchenko Z V
Ukraine,State Chemico-Technological University

Methods are proposed for increasing the bond strength between the elements of plied-up rubber-cord composites by using highly effective additives. Procedures are described using UV spectroscopy, which make it possible to select the most appropriate adhesion promoting additives. The use of adhesion promoters, surface treatment of the metal cord, and modification of the rubbers are considered with respect to improvements in rubber to metal bonding. Compositions were developed based on sulphur-containing emulsions in oils, containing activating additives. A dimensionless parameter is used as a model criterion of interphase interaction, and the relationship between this parameter and the adhesion of plied-up elastomeric systems was established, which makes it possible to predict the behaviour of adhesive substances under real conditions. 12 refs. (Translated from Kauchuk i Rezina, No.3, 2000, p.24).

UKRAINE

Accession no.803072

Item 106
International Polymer Science and Technology
27, No.12, 2001, p.T/47-9
COHESIVE AND ADHESIVE STRENGTH OF RUBBER-METAL CORD SYSTEMS MODIFIED WITH OLIGOMERIC ALKENYLATED ALKYLRESORCINOLS
Talantov S V; Rossinskii A P
Vyatka,State Technical University

The replacement of scarce resorcinol with more accessible, cheaper and less toxic alkenylated oligomeric alkylresorcinols in tyre formulations is investigated. Tests were carried out for the modification of resins of the AP series in the coating rubber mix for the metal cord breaker and in the tread rubber mix. The modifiers investigated are products of the phosphoric acid alkenylation by 1,3-pentadiene of shale alkylresorcinols with a 5-methylresorcinol content of 50-90%, condensed by urotropin or paraformaldehyde resin. Performance improvements are reported, with particular reference to the adhesive strength of the metal cord systems, and the cohesive strength of the elastomer phase, especially in layers adjacent to the brass surface. 3 refs. (Translated from Kauchuk i Rezina, No.3, 2000, p.21)

RUSSIA

Accession no.803071

Item 107
Kautchuk und Gummi Kunststoffe
53, No.11, Nov.2000, p.651-5
RUBBER-METAL BONDING AS AN ELECTROMECHANICAL PROCESS
Hummel K; Filimonov Ahobisch J; Rodriguez F J S
Graz,Technische Universitat

Rubber-brass bonding during vulcanisation has already been previously discussed as a result of ionic reaction mechanisms. If electrically charged species (e.g. metal and sulphide ions) are formed, the bonding process should be influenced by an electric field. An experimental set-up for the application of a voltage during vulcanisation and the preparation of test specimens for bonding strength measurements is described. Electric conductivity is brought about by the carbon black component. Experiments with SBR mixtures/brass show that an electric field influences the bonding process and that under suitable conditions an improvement of the bonding strength is observed. Unexpectedly, rubber-metal bonding is also observed with NR mixtures/aluminium when a voltage is applied. 9 refs.

AUSTRIA; EUROPEAN UNION; WESTERN EUROPE

Accession no.802620

Item 108
Chemical and Engineering News
79, No.1, 1st Jan.2001, p.12-4
FIRESTONE'S TIRE PROBLEM
Reisch M S

We are told that US tyre manufacturing giant, Firestone, has admitted that design and manufacturing problems contributed to tyre failures resulting in 148 traffic accident deaths in the USA. This article discusses in detail the possible causes of failure of the three brands of tyres - the Firestone ATX, ATXII, and Wilderness AT. It is argued that the failures were due to a combination of design faults, poor rubber to metal bonding, and underinflation

FIRESTONE; CALIFORNIA,UNIVERSITY; US,GOVERNMENT; US,NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION; FORD MOTOR CO.; BRIDGESTONE/FIRESTONE; BRIDGESTONE CORP.

JAPAN; SAUDI ARABIA; SOUTH AMERICA; USA

Accession no.802406

Item 109
Revue Generale des Caoutchoucs et Plastiques
77, No.785, April 2000, p.58-60
French
RESEARCH AND THE ADHESION OF ELASTOMERS
Vallat M F; Coupart A
CNRS; SNECMA

Factors influencing the adhesion of rubbers are discussed, and the situation of research into this subject in France is examined with reference to topics discussed at a round table meeting held in association with a conference on adhesion which took place at La Bourboule, France.

ICSI; LRCCP; MICHELIN & CIE.; BAYER FRANCE SA

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.800861

Item 110
Patent Number: US 6107380 A1 20000822
FLUOROSILICONE PRIMER FREE OF VOLATILE ORGANIC COMPOUNDS
Evans E R
General Electric Co.

Disclosed is a primer composition for bonding silicone elastomers to metals, which is free of volatile organic compounds, and comprises an epoxy alkoxy silane, a titanium ortho alcoholate or ortho ester, a silicon ortho alcoholate or ortho ester and a volatile silicone compound.

USA

Accession no.800036

Item 111
Patent Number: US 6080268 A1 20000627
ADHESIVE FOR BONDING ELASTOMERS TO METALS
Smith K C; Tripathy B S
Federal-Mogul World Wide Inc.

Elastomers are securely bonded to metal substrates using an aqueous adhesive solution containing a silane adhesive in combination with a phosphonium quaternary salt additive. The additive concentration is preferably between 15 and 40% of the silane concentration. The concentration of the silane and additive in the water base is preferably 2.7%, on a weight basis.

USA

Accession no.795523

Item 112
158th. ACS Rubber Division Meeting - Fall 2000. Conference preprints.
Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 100
TECHNIQUES FOR BONDING RUBBER TO METAL USING METALLIC COAGENTS
Costin R; Nagel W
Sartomer Co.
(ACS,Rubber Div.)

Saret 633 and 634 are metallic coagents consisting of zinc diacrylate and zinc dimethacrylate respectively. They are used to create strong adhesive bonds between a variety of rubbers and untreated metal substrates. As coagents, they are readily compounded into the rubber stock where they crosslink into the rubber when cured with peroxides. Thus, they are seen to function as adhesion promoters in addition to crosslinkers to enhance both the adhesive and mechanical properties of the cured rubber. They can also be used in an adhesive strip to bond both sulphur and peroxide stocks to metal during curing. A further technique demonstrated, is to apply a dispersion of the metallic coagent as a reactive adhesive between the rubber stock and metal prior to curing.

USA

Accession no.794198

Item 113
158th. ACS Rubber Division Meeting - Fall 2000. Conference preprints.
Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 68
ADHESION FAILURE IN BONDED RUBBER CYLINDERS. PART 1: INTERNAL PENNY-SHAPED CRACKS
Leicht D C; Yeoh O H; Gent A N; Padovan J; Mullen R L
Lord Corp.; Akron,University; Case Western Reserve University
(ACS,Rubber Div.)

Details are discussed of a study conducted of the strain energy release rate (tearing energy) for bonded rubber disks having internal penny-shaped cracks at the rubber-to-metal bond. Finite element analysis was used to determine the tearing energy as a function of crack length for disks of various dimensions. The crack configurations considered were located at the centre of either one or both rubber-to-metal bonds. The rubber was assumed to be linearly elastic and nearly incompressible. The normalised peak tearing energy is found to be approximately related to the square of the disk shape factor. 15 refs.

USA

Accession no.794170

Item 114
158th. ACS Rubber Division Meeting - Fall 2000. Conference preprints.
Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 7
PLASMA POLYMERIZED PRIMERS FOR RUBBER-TO-STEEL BONDING
Bertelsen C M; Boerio F J; Kim D K
Cincinnati,University; Goodyear Tire & Rubber Co.
(ACS,Rubber Div.)

The use of plasma polymerised films as primers for structural adhesive bonding and rubber-to-metal bonding is investigated. Plasma polymerised acetylene films were deposited onto steel and ferroplate substrates using a microwave reactor. Results obtained from infrared spectroscopy showed that the molecular structure of the films depended strongly on the total pressure in the reactor. High pressure conditions were found to favour the formation of acetylenic and olefinic functional groups rather than methyl and methylene groups, and films deposited under these conditions were more effective primers for rubber to metal bonding. In addition, films having a thickness of only a few tens of nanometers were found to be more effective as primers than thicker films. Reactions between natural rubber and plasma polymerised acetylene films were simulated using a model rubber compound in which squalene was substituted for NR. Analysis of the model rubber compound as a function of reaction time with plasma polymerised acetylene films showed evidence for the formation of sequences of conjugated double bonds in squalene due to crosslinking and double bond migration. Evidence was obtained for attachment of pendant groups at the alpha-methylenic and methyl groups. 7 refs.

USA

Accession no.794119

Item 115

158th. ACS Rubber Division Meeting - Fall 2000. Conference preprints.
Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 5

NEW DEVELOPMENTS IN RUBBER-STEEL BONDING PROCESSES

Van Ooij W J
Cincinnati,University
(ACS,Rubber Div.)

The bonding of sulphur vulcanised rubber compounds to metals is investigated, with reference to the use of a mixture of bistrimethoxysilylpropyl amine and bistriethoxysilylpropyl tetrasulphide for imparting adhesion between various sulphur-cured rubber compounds and different methods. Results are presented of experiments in which brass, steel and electrogalvanised steel were bonded to a typical tyre cord skim compound, with and without cobalt additive. The new silane treatment was found to be as effective or better than brass adhesion to cobalt-containing rubber compounds. The superior corrosion protection offered by the silanes was also demonstrated using DC corrosion and polarisation resistance measurements. The structure of the silane film on a metal substrate is studied, and a model is proposed for a possible mechanism of adhesion of rubber compounds with silane-coated metals. 21 refs.

USA

Accession no.794117

Item 116

Journal of Adhesion

73, No.1, 2000, p.43-63

ADHESION BETWEEN RUBBER COMPOUNDS AND COPPER-FILM-COATED STEEL PLATES

Pyong Lae Cho; Gon Seo; Gyung Soo Jeon;
Seung Kyun Ryu
Chonnam,National University; Damyang,Provincial College; MicroTech

Three copper film-coated steel plates with different thicknesses of copper film (30-90 nm) were prepared and their adhesion properties to natural rubber compounds were examined. The high adhesion of copper-coated plates to the rubber compound containing resinous bonding additives was obtained at normal and over-cure conditions. The copper-coated plate containing an amount of copper coating sufficient to plate the surface with a uniform copper layer showed better adhesion that that having a small amount of copper coating on its surface. The stability against green humidity ageing and the cause of the high adhesion of the copper-coated plate were studied in comparison with those of the brass plate. 14 refs.

SOUTH KOREA

Accession no.793679

Item 117

Journal of Adhesion

72, Nos.3-4, 2000, p.293-315

BONDING OF NATURAL RUBBER TO STEEL: SURFACE ROUGHNESS AND INTERLAYER STRUCTURE

Cook J W; Edge S; Packham D E
Bath,University

Two aspects of adhesion produced by the vulcanisation bonding of a simple NR compound to mild steel are examined. Adhesion is measured using a 45 deg. peel test. When the NR is bonded using a proprietary bonding agent (Chemlok 205/220), to ‘smooth’ steel (acid etched) or ‘rough’ steel (phosphated) high values of peel energy and good environmental resistance to water are obtained, with failure cohesive largely within the rubber. The highest values of peel energy are associated with a phosphated surface which consists of plate-like crystals which direct the stresses away from the substrate in a way which produces a failure surface within the rubber which shows extensive tearing and cracking. The nature of the layer formed in the interfacial region by interaction between bonding system and rubber is investigated using a chlorinated rubber as a model compound representing the adhesive and uncompounded NR to represent the rubber. When a blend of the two is heated in air at 150 deg.C, evidence is found of a solid state chemical reaction in which carbonyl groups are incorporated into the blend which become visually homogeneous. Further evidence points to the relevance of this change to adhesion in rubber-to-metal bonding. 34 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.791454

Item 118

Rubber Bonding 2000. Conference proceedings.
Amsterdam, Netherlands, 15th-16th May 2000, paper 19

RUBBER TO METAL BOND TESTING USING STRUCTURAL TESTING TECHNIQUES

Bradley S
Diagnostic Instruments Ltd.
(Rapra Technology Ltd.)

Testing rubber to metal bonded products presents diverse technical difficulties. In most cases, a shear or tensile load is applied to the product, and the effects of that load are observed. This subjective assessment is open to misinterpretation and errors. The observer can only see surface effects, any internal faults are hidden from view. This may mean that life-reducing faults can be sent into service. In some high deflection spring designs, in order adequately to stress the rubber section, a very high tensile or shear load is required. This load is far greater than can be expected in service, and can, under certain circumstances, cause rupture and failure of the product during the bond test. A non-destructive testing method for bonded products has been used successfully for some years. A typical example of this is the testing of brake pads. The pad is excited by a vibration impulse, and the emitted sound signature is analysed usinga Fast Fourier Transform (FFT) analyser. The sound signature is proportional to the structural integrity of the brake pad. This applies structural testing methods to the product. The technique is widely used to describe dynamic characteristics of spring/damper systems; the application of the same to rubber to metal bonded product assemblies is proposed.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.790045

Item 119

Rubber Bonding 2000. Conference proceedings. Amsterdam, Netherlands, 15th-16th May 2000, paper 18

BONDLINE RUBBER TO METAL ADHESIVE FAILURE WITH ROTARY PEEL TESTING AND IMPLICATIONS FOR COMPONENT DESIGN

Campion R P; Thomson B
Materials Engineering Research Laboratory Ltd.
(Rapra Technology Ltd.)

In an attempt to minimise contributions from rubber tear and bending during peel adhesion testing, a double-peel arrangement is developed: a rubber strip is bonded to each side of a metal plate, with tabs located at opposite ends for gripping. The test is rotary in nature; a full sweep of angles from 35 to 155 deg. is possible. It is found for a non-fabric-backed NR (bonded to mild steel with Chemlok adhesives) that peel force is insensitive to peel angle over the range 45-85 deg.; moreover, 'clean' failure surfaces are observed. Increased forces associated with fabric-backed testpieces lead to considerable tearing of the elastomer layer. However, unreinforced testpieces in which one rubber layer is prevented from debonding, thereby concentrating the rotation (up to 90 deg. only) onto the other layer, leads to rubber-topcoat failure across the entire bonded surface. The efficiency of this testpiece configuration has been advanced by replacing the static bonded rubber layer with a metal hinge, giving rise to the hinged rotary peel test. A peeling force of 200 N has been measured reproducibly for the above NR/Chemlok system. Surface thickness measurements indicate the presence of a thin layer (a few gm) of rubber attached to the adhesive topcoat, a situation consistent with an interphasial (rather than interfacial) failure locus. Nevertheless, the failure is sufficiently near to the adhesive to facilitate durability examinations in various fluids likely to be met in service. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.790044

Item 120

Rubber Bonding 2000. Conference proceedings. Amsterdam, Netherlands, 15th-16th May 2000, paper 16

REPLACING STEEL WITH ALUMINIUM AND NYLON 6,6 IN RUBBER TO METAL BONDING APPLICATIONS

Ansarifar M A; Zhang J; Baker J; Bell A; Ellis R J
Loughborough,University; Chemetall Ltd.; Avon Vibration Management Systems Ltd.
(Rapra Technology Ltd.)

Traditionally, rubber has been bonded to steel for fixing purposes or to alter stiffness. Preliminary studies have shown that lightweight aluminium alloys and nylon 6,6 can replace steel in rubber to metal bonding applications without compromising integrity and strength of the bond. When a carbon black-filled NR compound is bonded to aluminium and nylon 6,6 substrates, using commercial bonding agents, and then peeled at an angle of 90% either at a constant rate of grip separation or under constant load, the bond strength is almost identical to that measured for some rubber to steel bonded test pieces, prepared by the same procedure and tested under similar conditions. Moreover, peeling energies up to 24 kJ/sq.m are recorded for these bonds, and bond failure occurs in a time-dependent manner within the rubber somewhere between 20 and 70 mu. m from the covercoat. The bond fails either slowly, where the peel propagates along or parallel to the interface at rates down to approximately 10 -66 mm/s, or rapidly, where the peel grows along the bond at rates reaching about 240 mm/s. Interestingly, these two modes of failure occur randomly and unexpectedly in a single peel test. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.790042

Item 121

Rubber Bonding 2000. Conference proceedings. Amsterdam, Netherlands, 15th-16th May 2000, paper 15

CARBON-SILICA DUAL PHASE FILLERS FOR RUBBER TO METAL ADHESION

Hardy D; Moneypenny H; Lanoye T; Mauer D
Cabot Corp.; Cabot Europe Ltd.; Bekaert NV SA
(Rapra Technology Ltd.)

A new generation rubber reinforcing agent, carbon-silica dual phase filler (CSDP filler), has been developed to provide the ability to enhance the physical properties of elastomers, especially reduced hysteresis. Characterisation of the CSDP filler determines that this filler consists of two phases, a carbon phase with a finely divided silica phase (domains) dispersed therein. In comparison with conventional carbon blacks, CSDP filler is characterised by high ash content, higher surface roughness and lower tinting strength. From the compounding point of view, dual phase fillers are characterised by higher filler-polymer interaction in relation to a physical blend of carbon black and silica at the same silica content, and lower filler-filler interaction in comparison with either conventional carbon black or silica having comparable surface area. CSDP fillers CRX 2000 and CRX 2002 are compared in an NR wire skim formulation to a REGAL 300 carbon black control for original and aged wire adhesion properties. The influence of the cobalt neodecanoate and boro-acrylate salts on properties is also investigated. 8 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; NETHERLANDS; WESTERN EUROPE

Accession no.790041

Item 122

Rubber Bonding 2000. Conference proceedings. Amsterdam, Netherlands, 15th-16th May 2000, paper 12

NEW RESINS TO IMPROVE ADHESION OF RUBBER TO BRASS COATED WIRE

Silberzan I; Lebraud S; Stuck B L

Elf Atochem SA; Sovereign Chemical Co.; CECA SA

(Rapra Technology Ltd.)

Over the years, resorcinol or resorcinol-formaldehyde resins have been widely used in combination with methylene donors as a system for bonding rubber compounds to brass coated steel wire. This is the common adhesion means for adhesion in steel-belted radial passenger and truck tyres and other brass coated wire reinforced rubber compounds. However, resorcinol is a hazardous chemical that may generate some health concerns. CECA offers an alternative to impart good adhesion with new resins that contain very low amounts of free hazardous chemicals. The data presented show that these alternative resins make it possible to obtain good original and aged adhesion values as well as good reinforcement properties of rubber. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; USA; WESTERN EUROPE

Accession no.790038

Item 123

Rubber Bonding 2000. Conference proceedings. Amsterdam, Netherlands, 15th-16th May 2000, paper 9

EFFECTS OF METAL DEFLECTION ON RUBBER TO METAL ADHESION

Plasczynski T

Lord Corp.

(Rapra Technology Ltd.)

There are various test methods used for evaluating the adhesion of rubber to metal. While DIN, JIS and ASTM standardised test methods are widely used, they are somewhat limited in simulating the multiple stresses placed on the adhesive bondline of actual automotive parts. For example, there is a lack of an available standardised test method that can evaluate the adhesion of rubber in filled cylindrical shaped parts, such as automotive mounts and bushings. Of particular concern is the adhesion of rubber to metal in parts that are swaged or calibrated - a post-bonding procedure that compresses the outer metal tube. Studies have revealed that reducing the outside diameter of the adhesive bonded cylindrical part (swage or calibration) greatly enhances long term durability. Therefore, it is becoming commonplace to treat adhesive bonded cylindrical parts in this manner. This has created a need on the part of adhesive suppliers to deliver rubber to metal adhesives capable of accommodating metal deflection associated with the swaging process. Also required is a test method capable of evaluating the ability of adhesives and metal treatments to survive such metal deflections. Chemists can use this test to guide their efforts in developing adhesives and metal treatments. Design engineers can use this test method to save time and money by evaluating test specimens during the prototyping stages, instead of costly fabricated metals. Lastly, since this test allows for controlled variation of the degree of swaging, it can be tailored to simulate the amount of metal deflection (degree of swage) to which both the adhesive and metal treatments are exposed during part manufacture.

USA

Accession no.790035

Item 124

Rubber Bonding 2000. Conference proceedings. Amsterdam, Netherlands, 15th-16th May 2000, paper 6

BONDING OF TPVS TO METAL

Van Nieuwenhove E

Advanced Elastomer Systems NV/SA

(Rapra Technology Ltd.)

Thermoplastic vulcanisates combine thermoset properties with the ease of thermoplastic processing. They supply proven performance in many different markets where flexible materials are required, often with significant costs advantages. Applications include weatherstrips, window profiles, roofing membranes, tubes and hoses, pipe seals and a myriad of other applications. Existing TPV materials are described, together with new products and development work in the adhesion onto reinforcement materials and other substrates. Aspects covered include a definition and classification of thermoplastic vulcanisates; the key properties of TPVs, and products and developments in adhesion onto reinforcement materials. 2 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

Accession no.790032

Item 125
Rubber Bonding 2000. Conference proceedings.
Amsterdam, Netherlands, 15th-16th May 2000, paper 5
CURE KINETICS OF RUBBER-TO-METAL BONDING ADHESIVES
Persson S; Olsson T
Svedala Skega AB; Lulea,University of Technology
(Rapra Technology Ltd.)

Since their invention in the 1950s, curemeters have provided the rubber industry and others with valuable information on how the curing reactions of heat-curable rubber compounds are progressing during the vulcanisation stage. Since many rubber-to-metal bonds can loosely be described as heat curable rubbers, dissolved in suitable solvents, the same principle of cure metering should therefore apply for rubber-to-metal bonding adhesives as for ordinary rubber compounds. The dynamic mechanical thermal analyser (DMTA) is introduced as an instrument for characterisation of the curing of rubber-to-metal bonding agents. The materials studied are Megum 3270 (primer), Megum 100 (adhesive) and NR/BR (rubber). The method is reliable and necessary, and has excellent potential for optimisation of future bonding agents. 8 refs.

EUROPEAN UNION; SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.790031

Item 126
Rubber Bonding 2000. Conference proceedings.
Amsterdam, Netherlands, 15th-16th May 2000, paper 4
BONDING AGENT PRIMERS - THE ESSENTIAL LINK IN BONDING RUBBERS TO METAL AND PLASTICS
Dehnicke S; Bells A; Kistner D; Krtsch B
Chemetall GmbH; Chemetall Ltd.
(Rapra Technology Ltd.)

Rubber to metal bonded components are used extensively in virtually all modern transport systems. Rubber to metal bonding technology is, therefore, one of today's key technologies and will remain so into the foreseeable future. The technology involves bringing together unvulcanised rubbers, bonding agent coated metals and other rigid substrates during the vulcanisation process of the rubber. A strong bond is formed which is resistant to mechanical stress, variations in temperature and to a variety of adverse environmental conditions. Transport design and ever increasing requirements for high quality, bonded components which will last the service life of the vehicle, leads to ever greater demands on the performance of the bonding agent. Currently bonding agents are available which will successfully bond all types of natural and synthetic rubbers to a variety of metallic and non-metallic, rigid, semi rigid and/or flexible substrates. Theuse of the primer to bond rubbers to both metals and plastics is described.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; UK; WESTERN EUROPE

Accession no.790030

Item 127
Rubber Bonding 2000. Conference proceedings.
Amsterdam, Netherlands, 15th-16th May 2000, paper 2
NEW ADHESION SYSTEMS FOR BONDING ZINC COATED CORDS TO RUBBER
Mauer D; Lang P; Najari A; Garnier F
Bekaert NV SA; CNRS
(Rapra Technology Ltd.)

The development of an alternative approach for rubber to metal bonding is described. This new approach calls for the use of functionalised organosilanes as coupling agents between the polymeric phase and the metallic reinforcement. Organofunctional silanes are hybrid organic-inorganic compounds that have found widespread use as coupling agents in several industrial applications, e.g. GRP composites and in 'silica tyre' technology. Silane coupling agents are bifunctional compounds that act as a bridge between a mineral surface and a polymer. The first reactive group (the alkoxysilane group) is able to develop strong bonds with the hydrated oxide layer of the metallic surface. The second reactive group is specifically chosen to react with specific reaction sites in the polymeric phase. In the absence of specific reaction sites to react with, the organosilane may be selected to form an interpenetrating network (IPN) with the polymeric phase. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.790028

Item 128
Rubber Bonding 2000. Conference proceedings.
Amsterdam, Netherlands, 15th-16th May 2000, paper 1
RUBBER-TO-METAL BONDING BY SILANES
Jayaseelan S K; Van Ooij W J
Cincinnati,University
(Rapra Technology Ltd.)

The use of silanes for imparting adhesion of various sulphur-cured rubber compounds to different metals, and preliminary investigations on the mechanism of adhesion, are described. Recent results show the usage of a mixture of two non-hydrolysed silanes in a particular ratio. Usage of non-hydrolysed silanes is a new approach and there is no literature available on such applications. The silanes used are bis-(trimethoxysilylpropyl)amine and bis-(trieth oxysilylpropyl)tetrasulphide. 15 refs.

USA

Accession no.790027

Item 129
Progress in Rubber and Plastics Technology
16, No.2, 2000, p.87-115
RUBBER-METAL ADHESION
Van Der Aar C P O J; Van Der Does L;
Noordermeer J W M; Bantjes A; Albers A
Twente,University; Vernay Europa BV

A definition of adhesion is given and the various adhesion theories, especially the adsorption theory, are described.

With these adhesion theories in mind, an overview is presented of rubber-metal bonding. Several aspects are discussed, such as how rubber-metal bonding can be obtained, the influence of the rubber compound formulation on bonding, the necessary preparation of the metal prior to bonding and the optimum rubber compound processing for rubber-metal bonding. 139 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.787004

Item 130

International Journal of Adhesion and Adhesives

20, No.5, Oct. 2000, p.367-76

ADHESIVE BONDING OF AIRCRAFT STRUCTURES

Higgins A

British Aerospace Regional Aircraft Ltd.

The history of and details on adhesives employed in the construction of aircraft are presented. Aspects covered include the main adhesives used, a comparison of the properties of structural adhesives for metal to metal bonding, surface preparation procedures, bonding operations, bond quality assessment and methods for assessing new structural adhesives for aircraft. 9 refs. (Fifth Structural Adhesives in Engineering Conference, Bristol Jury's Hotel, 1-3 April, 1998)

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.784323

Item 131

Wilmington, De., c.2000, pp.8. 28cms. 12/7/2000

BONDING SYSTEMS FOR VAMAC

Hagman J F

DuPont Co.,Elastomers Div.

DuPont EA-450.2

This bulletin describes the effectiveness of several one-coat and two-coat adhesive systems that can be used in fabricating bonded composites of Vamac ethylene/acrylic elastomer and metal or Vamac. The preferred adhesive systems provide rubber tearing bonds to properly prepared substrates using conventional bonding techniques. The best systems also provide good bond stability under dynamic operating conditions, as well as after heat ageing and fluid exposure. 2 refs.

USA

Accession no.783716

Item 132

Patent Number: US 6051097 A1 20000418

AQUEOUS ADHESIVE COMPOSITION, AND BONDING PROCESS AND BONDED ARTICLE MAKING USE OF THE SAME

Higuchi K; Asai M

Shin-Etsu Chemical Co.Ltd.

An aqueous adhesive composition is provided which comprises a water-soluble condensation polymer obtained by subjecting a specific copolymer having an alkoxyl group and a specific alkoxysilane to hydrolysis-condensation, and an aqueous medium containing the condensation polymer. This composition can firmly bond non-sulphur-curable elastomer materials to various adherends such as metals; this has been hitherto difficult. A high-grade adhesion and superior heat resistance and oil resistance can be attained. No organic solvent is contained, promising environmental safety.

JAPAN; USA

Accession no.783517

Item 133

Macplas

24, No.214, Dec.1999, p.107-8

Italian

RUBBER-METAL ADHESION IN INDUSTRIAL APPLICATIONS

Lindsay J

BTR

Factors influencing the adhesion of metal and plastics inserts to rubbers are discussed. Methods used in the surface preparation of metal inserts are reviewed, and the selection of bonding agents and control of injection moulding conditions for effective bonding are examined.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.780281

Item 134

Macplas International

No.5, May 2000, p.146

RUBBER-TO-METAL BONDING

This article provides information on water-based bonding agents for rubber-to-metal applications. It discusses the similarities and differences of water-based agents to solvent-based ones, and also considers application methods. The article also tells us that a new guide to the use of these agents for rubber-to-metal bonding has been issued by Chemetall.

CHEMETALL

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.777469

Item 135

(Dusseldorf), c.2000, pp.8. 30cms. 13/6/2000

CHEMOSIL : ADHESIVES FOR BONDING RUBBER TO METAL OR OTHER SUBSTRATES

Henkel KGaA

Information is presented on the use of Henkel's Chemosil range of adhesives for bonding rubber to metal or other substrates. Chemosil bonds are characterised by good adhesion and resistance against corrosion, high temperatures, oils and solvents. The products can be used to bond many elastomers to almost all metals and their alloys, as well as to surface treated metals, many plastics, wood, glass and textiles. Guidelines cover adhesive storage, substrate preparation, selection of one- or two-coat systems, adhesive application, drying, and vulcanisation. A reference table lists recommended applications for each Chemosil grade, while a further table notes suitable mechanical or chemical substrate preparation methods for a range of metals and plastics.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.777368

Item 136
Adhesives Age
43, No.5, May 2000, p.28/35
VALUABLE PROPERTIES
Hoyt J K; Phillips P; Li C H; Riffle J S
Virginia,Tech

A new family of polar, nitrile containing polysiloxane adhesives and sealants was prepared from poly(3-cyanopropyl-methyl)siloxane (PCPMS) with the aim of reducing the tendency for the materials to swell in hydrocarbon fuels and improve adhesion to metal adherends via hydrogen bonding. Polydimethylsiloxane (PDMS) networks, and poly(methyl(3,3,3-trifluoropropyl) siloxane) (PMTFPS) networks, which represent the current area of study for polar organosiloxane sealants in industry, are compared to these novel PCPMS networks, and their potential as adhesive/sealant materials is evaluated based on thermal, swelling, mechanical and adhesive properties. 8 refs.

USA

Accession no.776544

Item 137
Rubber and Plastics News
29, No.19, 17th April 2000, p.14-5
METALLIC COAGENTS BOOST RUBBER-TO-METAL BONDING
Costin R; Nagel W
Sartomer Co.Inc.

The use is described of metallic coagents for increasing the adhesion of rubber to metal substrates and synthetic fibres. The metallic coagents discussed are zinc diacrylate and zinc dimethacrylate, which are commercially available as Saret 633 and 634. The metallic coagents offer several alternative ways of bonding rubber to metal which are less intensive and time consuming than conventional metal-reinforced rubber products. Details are given of three techniques by which they may be used to improve adhesion: as an internal adhesion promoter in an uncured rubber compound; in a thin adhesive strip that functions as a tie layer upon curing; and in a reactive dispersion that can be applied as a viscous liquid or paste to either the metal or rubber prior to curing. 2 refs.

USA

Accession no.773563

Item 138
International Polymer Science and Technology
26, No.11, 1999, p.T/43-T/44. (Translation of Kauchuk i Rezina, No.4, 1999, p.29)
BRASS PLATING OF STEEL PARTS BEFORE RUBBER COATING
Kuznetsov E A; Loginova E V; Orlova S V
Gaz Open Joint Stock Co.

The favourable effect of a brass plating electrolyte with 1,4-butyne diol on the adhesion of the brass plating to rubber is established. When the characteristics of a pyrophosphate electrolyte with and without the addition of 1,4-butyne diol were compared it was shown that the range of permissible current densities was broadened, a change in the appearance of the brass to yellow and smooth was apparent, and the electrolyte produced coatings with high adhesion to the steel base.

RUSSIA

Accession no.772338

Item 139
Kautchuk und Gummi Kunststoffe
53, No.4, April 2000, p.194-9
INFLUENCE OF MOULDING TEMPERATURE ON THE STRENGTH OF NATURAL RUBBER TO METAL BONDED JOINTS
Fernando M S D; Cudby P E F; Cook S
Malaysian Rubber Producers'Research Assn.

The influence of moulding temperature on the peel strength of a bonded joint is investigated for a sulphur cured semi-EV NR vulcanisate. A higher peel force is recorded at the higher moulding temperature. The effect of vulcanisation temperature on peel strength is thought to arise from a change in the physical properties of the rubber and modifications of the rubber near the bonded interface as a result of active species migration during vulcanisation. A series of parallel investigations are conducted to find supporting evidence for these findings. From these studies it is concluded that it is a combination of changes in the mechanical properties of the NR vulcanisate and any changes induced by the migration mechanisms that determines the final strength of the bonded assembly. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.771760

Item 140
International Polymer Science and Technology
26, No.5, 1999, p.27-31
NEW SYSTEMS FOR BONDING OF BREAKER RUBBERS TO METAL CORD WITHOUT USING RESORCINOL AND COBALT SALTS
Legocki P; Kavun S M
Moscow,Scientific Research Institute of the Tyre Industry

The mechanical and adhesion properties of a series of rubber mixes based on natural rubber were determined in this research. Maleic anhydride amino derivatives were used as coagents of hexachloro-p-xylene for a metal cord breaker. 9 refs. Translation from Kauchuk I Rezina, No.1, 1999, p.32.

RUSSIA

Accession no.771230

Item 141
Adhesion '99. Conference Proceedings.
Cambridge, UK, 15th-17th Sept.1999, p.425-30
DETERMINING THE ADHESIVE FRACTURE ENERGY OF BONDED JOINTS
Blackman B R K; Hadavinia H; Kinloch A J; Paraschi M
London,Imperial College of Science,Technology & Medicine
(IOM Communications Ltd.)

A new protocol for measuring the fracture energy of structural adhesive bonded joints in mode I is described. Good reproducibility of results was found for round robin tests on steel, aluminium and CFRP joints. For double cantilever beam (DCB) test specimens, simple beam theory based on a shear corrected beam formula significantly underestimated the fracture resistance values compared to corrected beam theory and experimental compliance methods. For tapered DCB specimens, the simple beam theory and experimental compliance calculations were within 10%. A strong dependence of fracture energy on substrate material was observed. Results obtained from mode II loading of adhesive joints using the end-loaded split test geometry are also presented. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.765336

Item 142
International Polymer Science and Technology
26, No.8, 1999, p.T/16-T/18. (Translation of Kauchuk i Rezina, No.2, 1999, p.23)
ADHESIVES FOR RUBBER-METAL PRODUCTS
Ushmarin N F; Kol'tsov N I
Chuvash,State University

Tests were carried out on the performance of various adhesives in the bonding of rubber to metal. The adhesives were a series of products from Henkel and also some produced in Russia, and the substrates were multicomponent rubber mixes based on general and special purpose rubbers. The rubber to steel bond strength using different adhesives was determined by the direct pull method by tension loading of cylindrical specimens of rubber, the bases of which were fastened by means of adhesive or brass to two metal discs. Results are given for the various elastomers and bonding agents, and it was concluded that the most universal and most effective adhesive for vulcanisates based on the rubbers studies was Chemosil 411. 2 refs.

RUSSIA

Accession no.764803

Item 143
Tire Technology International
Dec.,1999, p.4
WIRE - LESS COBALT

This article gives brief details of a new amino resin to be used in the production of tyres. American company Cytec claim that the use of Cyrez 138 and 132 for rubber to wire adhesion can eliminate the use of cobalt without any loss of tyre performance, thus eliminating the problems of using cobalt such as waste disposal, fuming, high costs and limited supply. This abstract includes all the information contained in the original article.

CYTEC INDUSTRIES INC.
USA

Accession no.761802

Item 144
Adhesion '99. Conference Proceedings.
Cambridge, UK, 15th-17th Sept.1999, p.257-62
MEASUREMENT OF RUBBER-TO-METAL BOND STRENGTH
Lawrence C C; Lake G J; Thomas A G
East London,University
(IOM Communications Ltd.)

The bond strength of NR/steel and SBR/steel joints bonded with a two-part adhesive was studied by a new test method involving combined pure and simple shear and which could produce failure very close to the rubber/bonding agent interface. Failure surfaces showed that rubber tended to be left on the outer edges of the bond, the central region often being bare. This suggested that dilatational stresses played a significant role in near-bond failure. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.761657

Item 145
Adhesion '99. Conference Proceedings.
Cambridge, UK, 15th-17th Sept.1999, p.251-6
FRACTURE MECHANICS APPROACH TO FAILURE OF RUBBER-RIGID SUBSTRATE JOINTS
Fernando M S D; Lake G J; Lawrence C C; Ostman E; Persson S; Southern E; Thomas A G

Tun Abdul Razak Research Centre; East London,University; Svedala-Skega AB; SK Bearings
(IOM Communications Ltd.)

A fracture mechanics approach based on strain energy release rate was applied to the study of failure in NR/steel joints bonded with solvent-, water- and isocyanate-based adhesives. The effects of different bonding systems, metal surface treatments, test geometries and environmental conditions were examined. Constant force peel tests at different peel angles in the range of 10-90 degrees showed peel rate-energy relationships that varied with angle, and the rate showed a strong dependence on energy at all angles. Constant deformation tests in simple shear gave results lying mainly towards the lower end of the range, while tests in pure shear showed the opposite trend. Variations in failure locus and fracture surface roughness with test geometry broadly paralleled the energy variations. Immersion in water had some effect on failure rate at room temperature and a much larger effect at elevated temperature. 14 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; SCANDINAVIA; SWEDEN; UK; WESTERN EUROPE

Accession no.761656

Item 146

Adhesion '99. Conference Proceedings.
Cambridge, UK, 15th-17th Sept.1999, p.243-9

PEEL TESTING OF ADHESIVELY BONDED JOINTS

Hadavinia H; Blackman B R K; Kinloch A J; Ring-Groth M; Williams J G
London,Imperial College of Science,Technology & Medicine
(IOM Communications Ltd.)

Peel tests were carried out on joints consisting of an aluminium peel arm bonded to an aluminium alloy substrate with a toughened epoxy resin adhesive. Values of adhesive fracture energy were calculated from the measured peel data using both analytical and finite element analysis (FEA) models. In the FEA approach, the fracture energy was evaluated both by a local analysis of displacements and traction forces at the crack tip using the crack closure integral method, and by a global energy balance of the whole model. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.761655

Item 147

Adhesion '99. Conference Proceedings.
Cambridge, UK, 15th-17th Sept.1999, p.217-22

SOME ENVIRONMENTAL FACTORS IN DEBONDING AT ELASTOMER-RIGID SUBSTRATE JOINTS

Aragon M L; Cain P A; Lake G J
Standard Products Ltd.; Cambridge,University; East London,University
(IOM Communications Ltd.)

A study was made of the effects of ozone and acetone exposure on NR/steel joints produced using a two-coat bonding system, and on steel plates coated with the bonding agent prior to joint formation. Results of peel tests were analysed by a fracture mechanics approach based on strain energy release rate. In the case of ozone, the required energy varied with peel angle and the rate showed about a fourth power dependence on energy. With acetone, the energy levels required to produce failure were much lower and substantially independent of peel angle, the rate again increasing as about the fourth power of the energy. For both types of exposure somewhat higher energies were required for filled than for unfilled vulcanisates. Both ozone and acetone exposure could cause near-bond failure in joints and exposure of coatings prior to bonding weakened the bonds subsequently formed. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.761650

Item 148

Adhesion '99. Conference Proceedings.
Cambridge, UK, 15th-17th Sept.1999, p.55-60

TIME DEPENDENT MECHANICAL FAILURE OF STRONG ELASTOMER-TO-METAL BONDS: CHEMICAL OR PHYSICAL MECHANISM?

Albihn P; Chapman A V; Lake G J; Lawrence C C
Swedish Institute for Fibre & Polymer Research; Malaysian Rubber Producers' Research Assn.; East London,University
(IOM Communications Ltd.)

Studies were made of chemical and physical factors influencing time dependent near-bond failure in NR/steel bonded joints. Chemical studies revealed no evidence to indicate that chemical modifications were substantially weakening the rubber adjacent to the bond. Video observations suggested that a cavitation-like process, probably arising from dilatational components in the stresses near an interface, could lead to time dependent mechanical failure near the bond. 10 refs.

TUN ABDUL RAZAK RESEARCH CENTRE
EUROPEAN COMMUNITY; EUROPEAN UNION; SCANDINAVIA; SWEDEN; UK; WESTERN EUROPE

Accession no.761623

Item 149

Adhesion '99. Conference Proceedings.
Cambridge, UK, 15th-17th Sept.1999, p.43-8

BONDING METALS TO RUBBER USING FUNCTIONAL AND NON-FUNCTIONAL SILANES

van Ooij W J; Jayaseelan S K
Cincinnati,University
(IOM Communications Ltd.)

Mixtures of bistrimethoxysilylpropylamine and bistriethoxysilylpropyl tetrasulphide were evaluated in the bonding of low carbon steel, electrogalvanised steel and brass to NR compounds. Peel strength values were determined, and reactions occurring at the silane/metal interface were investigated. A specific ratio of the silanes gave good adhesion to both high and low sulphur NR compounds, and showed potential for replacing solvent-based adhesives, brass coating and cobalt additives used in rubber-to-metal bonding. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE

Accession no.761621

Item 150
156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.
Orlando, Fl., 21st-23rd Sept.1999, paper 130

IMPROVING WIRE BELT ADHESION BY USE OF MODIFIED MELAMINE RESINS, WHICH REQUIRE NO ADDITIONAL COBALT OR RESORCINOL COMPONENTS

Hoff C M
Cytec Industries Inc.
(ACS,Rubber Div.)

Present day technology for achieving proper rubber-to-wire adhesion in wire coat skim stocks generally requires the presence of a methylene donor/methylene acceptor resin system. These systems typically consist of HMMM as the donor and a novolac resin as the acceptor. Cobalt is often added to these resin systems or is used by itself in conjunction with high levels of sulphur to obtain wire adhesion. Novolac resins such as resorcinol or resorcinol-formaldehyde resins, in many cases cause user-related problems including fuming, and waste disposal issues. Similarly, cobalt products have their own disadvantages including uncertainty of supply, their relative expense, and the heavy metal issue. Cytec has been working diligently to address these issues. Data are presented showing laboratory results comparing traditional resin adhesion systems with results obtained using one-component modified melamine resins. Experimental formulations, requiring no resorcinol, are tested with and without cobalt. The data show that, in most cases, cobalt can be eliminated with no adverse affects to physical properties or wire adhesion and rubber coverage. 8 refs.

USA

Accession no.759718

Item 151
156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.
Orlando, Fl., 21st-23rd Sept.1999, paper 128

SOLVING THE AGE OLD PROBLEM OF BOND FAILURES IN SWAGED CYLINDRICAL TUBEFORMS WITH THE USE OF A WATERBORNE AUTODEPOSITED FLEXIBLE METAL TREATMENT AND PRIMER/COATING SYSTEM

Plasczynski T F
Lord Corp.
(ACS,Rubber Div.)

ASTM D429 test methods are useful, but limited in replicating ‘real life’ stresses placed on the adhesive bond line. A test capable of evaluating adhesion to a rubber filled cylindrical tube form after swaging its outside diameter is discussed. Swaging is becoming a common engineering practice in the automotive industry as it has shown enhancement of cycle durability in adhesive bonded tube forms. Use of this newly-developed test method reveals some of the technical challenges associated with swaging. Solutions required to address these challenges are also discovered. This includes the need for new metal treatment technology. Emphasis is placed on a metal treatment and primer coating system that survives swaging, coupled with the previously mentioned swage test. An internally developed, autodeposited flexible metal treatment and primer/coating system meets two very important requirements for swaged car parts. These include extended salt fog resistance and survival of swages up to 16% without coating damage during the swage operation. This performance is achieved with a waterborne system that promises to redefine the way the industry processes metals prior to application of rubber to metal adhesives.

USA

Accession no.759717

Item 152
International Polymer Science and Technology
26, No.7, 1999, p.T/24-6. (Translation of Kauchuk i Rezina, No.2, 1999, p.20)

INFLUENCE OF A POLYSULPHIDE COBALT SALT SYSTEM ON THE ADHESION OF RUBBERS TO BRASS COATED METAL CORD

Prokof’ev Y A; Potapov E E; Sakharavoa E V; Salych G G
Lomonosov Institute of Fine Chemical Technology

Work was carried out to study the mechanism of the action of a Thiokol-cobalt salt system on the adhesion of rubbers to brass-coated metal cord. The kinetics of formation and breakdown of the Thiokol-cobalt complex was studied using the gravimetric method, and optical microscopy was used to assess the macrostructure of the complex compound formed by reaction of the two, and of the products of its breakdown. Under conditions of vulcanisation in the presence of sulphur, the compound formed breaks down. Cobalt sulphides are formed, collecting at the phase surface and being instrumental in the formation of an adhesively bonded joint, whilst active sulphur-containing fragments are formed which modify the rubber mix matrix and promote the formation of the phase interface in the rubber-brass system of an adhesive sulphide layer with optimum characteristics. 10 refs.

RUSSIA

Accession no.759577

Item 153
Rubber World
221, No.3, Dec.1999, p.18/69
EFFECT OF CURE SYSTEM ON NR BONDING
Halladay J R; Krakowski F J
Lord Corp.

Much literature has been published on bonding rubber to metal and testing rubber to metal bonds. This article continues the bond investigations by concentrating on the influence of sulphur and accelerator choices in natural rubber. To determine the effect of sulphur, two levels were chosen. Four different accelerators, and two solvent-based and two aqueous adhesive systems were chosen. The two test methods used for comparison were ASTM D 429 Method B and the proposed Method F buffer specimens. 13 refs.

USA

Accession no.758078

Item 154
China Rubber Industry
46, No.12, 1999, p.717-9
Chinese
PROMOTING EFFECT OF COBALT BORACYLATE ON ADHESION BETWEEN RUBBER AND BRASS-PLATED STEEL CORD
Jia Z; Yuxiang W; Huating L; Qijun P
Beijing,Research & Design Institute of Rubber Industry

The promoting effect of cobalt boracylate on the adhesion between rubber and brass-plated steel cord was investigated. The results showed that the adhesion between the rubber and brass-plated steel cord was significantly improved by adding cobalt boracylate RC-B16 and RC-B23, particularly after salt water ageing and thermal humidity ageing. The adhesion promoting effect of RC-B16 and RC-B23 was found to be comparable to that of Manobond C-16 and Manobond 680C respectively.

CHINA

Accession no.757710

Item 155
Tyres and Accessories
No.12, Dec.1999, p.22
WATER-BASED ADHESIVE PERFORMS WELL IN TEST

In a move to provide the retreading industry with total assurance that water-based adhesive is at least equal to, or better than, solvent-based adhesive, Dunlop Adhesives commissioned an independent test programme and evaluation to compare the two types of adhesives. During processing, there was no difference observed between the building tack provided by water-based adhesive and solvent-based adhesive. There is no evidence that the use of water-based adhesive in any way adversely affected the bond normally achieved between filler rubber and exposed areas of steel crown ply or tread material and buffed surface.

DUNLOP ADHESIVES LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.756709

Item 156
Rubber World
221, No.2, Nov.1999, p.50
AMINO RESIN TECHNOLOGY

Cytec Industries' amino resin technology achieves equal or better wire adhesion and rubber coverage for tyre applications without the addition of cobalt. Compared to conventional resin adhesion systems, experimental formulations are said to reveal that wire adhesion and rubber coverage can be achieved using one-component modified melamine resins, Cyrez 138 and Cyrez 132. This abstract includes all the information contained in the original article.

CYTEC INDUSTRIES INC.
USA

Accession no.754580

Item 157
International Polymer Science and Technology
26, No.2, 1999, p.11-3
REFINED METHOD FOR PREDICTING THE WORKING LIFE OF A METAL CORD BREAKER
Sakharov M E; Paritskaya Z A; Vlasko A V; Shvachich M V; Gamlitskii Yu A; Bass Yu P
Moscow,Tyre Research Institute

Methods of predicting the service behaviour of rubber-cord composite materials in tyres, based upon the results of laboratory testing, are briefly reviewed. Tensile tests were made on a variety of composites in which the type of cord, its diameter, and the angle between the cord and the applied stress were varied. The nominal tensile strength and the breaking elongation were determined, the results being processed statistically. Fatigue tests were also conducted. The specimens with the highest rubber-to-cord adhesion did not always have the highest fatigue strength, and it was concluded that composites using metal cord should be evaluated according to the results of fatigue rather than static tensile tests. 16 refs. Translation of Kauchuk i Rezina No.6, 1998, p.45

RUSSIA

Accession no.753439

Item 158
Eureka
19, No.9, Oct.1999, p.18
BOND BEATS THE ALUMINIUM BLUES

Most metals must be surface treated before they are joined to other materials to remove surface contamination. The oxide layer makes the joining process for aluminium more prone to error. Permabond's 6050 acrylic adhesive uses a special additive that allows untreated surfaces to stick to one another. An adhesion promoter etches through the contamination and the oxide layer. The adhesive will mainly be used as a way of joining composites to metals, it is briefly reported.

PERMABOND LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.751169

Item 159
155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.
Chicago, Il., 13th-16th April 1999, Paper 60, pp.11
BONDING RUBBER TO METALS BY SILANES
van Ooij W J; Jayaseelan S K
Cincinnati,University
(ACS,Rubber Div.)

A number of sulphur vulcanised rubber compounds were bonded to steel, aluminium and brass using a one- or two-step treatment of the metals with organofunctional and non-organofunctional silanes. Silane treatments which had proved successful for bonding peroxide vulcanised rubbers were not suitable for use with sulphur vulcanised rubbers. However, a mixture of two organofunctional silanes was effective for bonding both high and low sulphur compounds to the metal substrates studied. The degree of adhesion was independent of the cobalt level of the compounds, and the silane process provided superior adhesion after exposure of bonded specimens to boiling water. 16 refs.
USA

Accession no.749873

Item 160
155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.
Chicago, Il., 13th-16th April 1999, Paper 50, pp.41
ADHESION SYSTEMS FOR BELTS AND HOSE
Hewitt N L
PPG Industries Inc.
(ACS,Rubber Div.)

Studies were made of the influence of silica fillers, silane coupling agents, curing systems, resorcinol and phenolic resins and compounding and vulcanisation conditions on the adhesion of rubber belt and hose compounds to fabrics and cords. Results for the adhesion of polychloroprene, EPDM, chlorobutyl rubber and nitrile rubber indicate that increased silica content, resorcinol and phenolic resins, zinc oxide and magnesium oxide are the major sources of improved bonding. 3 refs.
USA

Accession no.749863

Item 161
155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.
Chicago, Il., 13th-16th April 1999, Paper 24, pp.7
CHEMLOK ADHESIVES FOR THE RUBBER ROLL INDUSTRY
Means J D
Lord Corp.
(ACS,Rubber Div.)

An examination is made of processes involved in the manufacture of rubber covered rollers, including metal core preparation, the selection and use of the adhesive bonding system, storage, handling and mixing of the adhesive, drying, handling and storage of the adhesive coated cores, and the roll building and vulcanisation processes. Specific reference is made to Lord's range of Chemlok adhesives, but the guidelines presented are applicable to solvent-based adhesives in general.
USA

Accession no.749841

Item 162
Industria della Gomma
43, No.2, March 1999, p.45-50
Italian
DEVELOPMENTS IN RUBBER-TO-METAL BONDING AGENTS

Technical developments in adhesives for rubber-to-metal bonding aimed at the reduction or removal of solvent emissions are reviewed. The performance characteristics of solvent-based and water-based systems are examined and compared.

CHEMETALL GMBH
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.742582

Item 163
Macplas
24, No.206, March 1999, p.98-100
Italian
ADHESIVES FOR RUBBER-TO-METAL BONDING
Zellner A
Chemetall GmbH

Developments in solvent- and water-based adhesives for use in rubber-to-metal bonding are reviewed, and analytical and testing techniques used to study their performance are described. The environmental advantages of water-based adhesives and modifications to solvent-based systems aimed at reducing their environmental impact are discussed.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.740610

Item 164
Kauchuk i Rezina (USSR)
No.1, 1999, p.32-5
Russian
NEW SYSTEMS FOR BONDING BELT RUBBERS TO STEEL CORD WITHOUT RESORCINOL AND COBALT SALTS
Legotsky P; Kavun S M
Duslo Ltd.; Moscow,Tire Industry Research Institute

Following a brief review of systems in used for bonding of belt rubbers to steel cord, a new system is suggested for use with brass-plated cord and natural rubber or SKI-3 polyisoprene-based rubbers. The new system contains adducts of maleic acid and 4-aminodiphenylamine with Hexol ZVI. Optimum contents of this system for NR-based rubbers are given. 9 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

RUSSIA

Accession no.738756

Item 165
Patent Number: US 5882799 A 19990316
POLYMERIC COUPLING AGENTS FOR THE ADHESION OF MACROMOLECULAR MATERIALS AND METAL SUBSTRATES
Roseboom F; van der Aar C P J; Bantjes A; Feng M
Vernay Laboratories Inc.

These include covulcanisable groups, such as alkenyl, epoxide, acrylate and/or acrylamide, and metal-complexing groups, such as carboxylic, oxime, amine, hydroxamic and/or iminodiacetic groups. They are particularly useful as adhesives for adhering rubbers to metals.

USA

Accession no.735939

Item 166
Kautchuk und Gummi Kunststoffe
52, No.5, May 1999, p.322/8
STEEL CORD ADHESION. EFFECT OF 1,3-BIS(CITRACONIMIDOMETHYL)BENZENE AND HEXAMETHYLENE-1,6-BIS(THIOSULPHATE), DISODIUM SALT, DIHYDRATE
Datta R N; Ingham F A A
Flexsys BV

Results of studies are examined regarding factors affecting the adhesion of steel cord to rubber. The adhesion is balanced with improved aged compound characteristics and reduced compound heat build-up through the use of 1,3-bis(citraconimidomethyl)benzene, and hexamethylene-1,6-bis(thiosulphate) disodium salt dihydrate. This combination of chemicals not only improves the properties of steel cord skim compounds, but also can be used effectively to replace the bonding system based on resorcinol and hexamethoxymethylmelamine, it is found. 19 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.735014

Item 167
Rubber World
220, No.1, April 1999, p.61
WATER-BASED BONDING

This short item highlights “Megum” water-based bonding agents from Alcan Rubber & Chemical of the USA. The agents are available for rubber-to-metal and rubber-to-plastic mould bonding. Brief details are provided of their properties.

ALCAN RUBBER & CHEMICAL INC.
USA

Accession no.733887

Item 168
Shawbury, Rapra Technology, 1996, pp.96. 12 ins. 20/2/96. Rapra Review Rept. No. 87, vol.8, no.3, 1996.
NALOAN
RUBBER TO METAL BONDING
Crowther B G
Rapra Technology Ltd.
Edited by: Dolbey R
(Rapra Technology Ltd.)
Rapra.Review Rept.No.87

Developments in the rubber to metal bonding industry are reviewed and addressed from the standpoint of factory practices. Bonding theory is explained, and methods of bonding rubbers to metals are discussed. Bonding agent systems are examined, with particular reference to waterborne adhesive systems. The production of bonded parts is described and metal pretreatments are included, followed by the manufacture of rubber to metal bonded components by compression moulding and injection moulding. Post vulcanisation bonding is also discussed, and a section is devoted to metal reinforced rubber products and bonding mechanisms in tyre and non-tyre applications. 377 refs. This document is available only by purchase from Rapra Technology.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.733688

Item 169
New York, N.Y., Marcel Dekker, 1999, pp.ix,404. 145.00. 8(10)
ADHESION PROMOTION TECHNIQUES
Edited by: Mittal K L; Pizzi A

This book presents the state of the art in improving bond strength between different materials for many manufacturing processes - reviewing the suitable chemistry or morphology for enhanced adhesion to metal, plastic and wood surfaces. It discusses mechanisms such as viscoelastic energy dissipation, weak boundary layers and interphase, mechanical interlocking, and those based on electrostatic, thermodynamic, diffusion, and chemical bonding theories. Also included are uses of energy saving, ecologically clean anticorrosion micro-organisms in treatment of polymer surfaces and acid-base interactions in adhesion.

Accession no.733188

Item 170
Materiaux et Techniques
86, Nos.9/10, Sept./Oct.1998, p.59-61
TESTING AND ANALYSIS OF RUBBER-TO-METAL BONDED PARTS
Jacks J
Acadia Polymers Inc.

The shortcomings of techniques such as Fourier transform IR spectroscopy and energy dispersive X-ray analysis in the study of failure in rubber-to-metal bonded parts are discussed. Results are presented of a study in which SEM and X-ray photoelectron spectroscopy were used in the failure analysis of a rubber-to-steel bonded component which had failed after exposure to hydrocarbon oil at 150C. The results suggested premature curing of the adhesive as the most likely cause of failure.
USA

Accession no.732508

Item 171
Macplas
23, No.202, Oct.1998, p.130-2
Italian
RUBBER-METAL SEALS FOR INDUSTRIAL AND AUTOMOTIVE APPLICATIONS
Beghini L
RFT SpA

Performance requirements for rubber-metal seals used in a number of industrial and automotive applications are examined, with particular reference to resistance to high temperatures and lubricants. Aspects of the bonding of rubbers to metal and plastics inserts in seal manufacture are also discussed.
EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.732481

Item 172
Materials World
7, No.5, May 1999, p.266-8
SCIENCE AND ART OF RUBBER TO METAL BONDING
Lindsay J

Developments in the technology of rubber to metal bonding allows the production of a uniform, high quality product that is free from failure. This comprehensive article supplies a detailed assessment and explanation of the rubber to metal bonding process, describing in detail the three essential elements which form the core of the bonding process - selection of the polymer base, the bonding agents and the substrate, together with the various processing routes depending on the selection of materials.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.730771

Item 173
Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 20. 012
BONDING OF SURFACE PROTECTION MATERIALS MADE FROM RUBBER ON METALLIC SURFACES
Busse G
Tip Top Stahlgruber Otto Gruber GmbH
(Rapra Technology Ltd.; European Rubber Journal)

Rubber-metal composites for producing functional surfaces are becoming increasingly important. This applies in particular to protection against wear and corrosion - types of stresses which may curtail the useful life of unprotected technical products, plant components, vessels and pipework in an often critical manner which is also serious from the safety point of view. Linings and coatings made from modern high-performance rubber materials that are mechanically and chemically resistant serve to reduce or prevent wear and corrosion. Apart from by hot vulcanisation, rubber-metal composites can also be produced by bonding the two materials. In hot vulcanisation, the two surfaces are as a rule joined under pressure and temperature, with vulcanisation of the elastomer structural component taking place at the same time. Bonding is a technically and economically advantageous securing method. 5 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.725098

Item 174
Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 19. 012
STUDIES IN RUBBER TO METAL ADHESION
Cook J W; Edge S; Packham D E
Bath,University
(Rapra Technology Ltd.; European Rubber Journal)

Two fundamental aspects of the adhesion produced by the vulcanisation bonding of a simple NR compound to mild steel are examined. Adhesion is measured using a 45 deg. peel test. When the NR is bonded, using a proprietary bonding agent (Chemlok 205/220), to ‘smooth steel’ (acid etched) or to ‘rough’ steel (phosphated) similar values of peel energy (around 5 kJm-2) are obtained, with failure cohesive within the rubber, so it appears that for these, surface topography per se has little effect on peel energy. These topographical differences appear to have little effect on the bond durability, as little or no deterioration of adhesion is observed after immersion of coated steel in water for periods up to 60 days. The nature of the layer formed in the interfacial region by interaction between bonding system and rubber is investigated using a chlorinated rubber as a ‘model compound’ representing the adhesive and uncompounded NR to represent the rubber. When a blend of the two is heated in air at 150 deg.C, evidence is found of a solid state chemical reaction in which carbonyl groups are incorporated into the blend which became visually homogeneous. Further evidence points to the relevance of this change to adhesion in rubber to metal bonding. 18 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.725097

Item 175

Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 18. 012

THE INFLUENCE OF MOULDING TEMPERATURE ON THE STRENGTH OF NATURAL RUBBER TO METAL BONDED JOINTS

Fernando M S D; Cudby P E F; Cook S
Tun Abdul Razak Research Centre
(Rapra Technology Ltd.; European Rubber Journal)

Bond formation in a rubber to metal assembly is a complex subject and is influenced by the nature of the metal and how its surface has been prepared, the composition of the adhesive, primer, elastomer, the filler type or level and the cure system. Proprietary chemical bonding agents are used in these bonding operations and these consist of reactive ingredients suspended or dissolved in organic solids. Commonly used bonding systems consist of a primer and an adhesive and are cured during vulcanisation of the rubber. Post vulcanisation bonding is also used in some instances. Bonded units are subjected to quality control tests after production and in such tests, failure often occurs in the rubber close to the bonded interface. It has been suggested that during vulcanisation a boundary layer is created in the rubber near the interface with properties that differ from those of the bulk rubber. The formation of this modified rubber layer near the bond line is a result of diffusion of certain species from the bonding agent to the rubber during vulcanisation. The influence of moulding temperature on the bond strength is assessed for a sulphur-cured NR vulcanisate as a means of addressing the proposed mechanisms that occur in the interfacial regions of a bonded rubber to metal assembly. Experimental data are presented which elucidate the role of the different mechanisms involved in the formation of a reliable bond and the resulting creation of a boundary layer near the interface, which determines the locus of failure, that is so often observed in quality control tests and in some types of service failures. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.725096

Item 176

Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 14. 012

SUBSTRATE PREPARATION FOR BONDING

Holcroft R
Abrasive Developments Ltd.
(Rapra Technology Ltd.; European Rubber Journal)

Abrasive Developments has, in conjunction with its Japanese licensee, developed a wet blast phosphating plant that raises quality standards within the industry. The solution achieved delivers high quality components from an automatic machine that combines both the cleaning and phosphating processes. The cleaning section benefits from the unique degreasing and surface treatment properties of the VAQUA process. Wet blast phosphating (WBP) was first developed some 15 years ago in co-operation with Yamashita Rubber. Yamashita has two main objectives to achieve from the development of a Wet Blast Phosphating plant: the increase in the strength of adhesive bonding between the anti-vibration rubber and the metal parts, and the improvement of corrosion resistance of the metal parts and hence useful life under any weather conditions. In addition to these objectives, the demand for this type of component from the automotive industry as a whole has increased and the requirement was for phosphating prior to bonding whilst still keeping cost at an acceptable level. To achieve the improved quality and reduced cost requirements, the WBP plant has to operate continuously and automatically process the metal parts for phosphating.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.725092

Item 177

Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 10. 012

DEVELOPMENT OF RUBBER METAL BONDING AGENTS DURING THE LAST 25 YEARS

Ozelli R N
Par Oberflachenchemie GmbH
(Rapra Technology Ltd.; European Rubber Journal)

The development of rubber/metal parts in the last 20-25 years in Europe has been strongly dependent on the car industry. 75% of all rubber/metal parts were produced for the car industry. In the last 20 years the market has shown showing the following trends: high speed cars with small engines; where the engine mount is required to act in conditions where the temperature and the dynamically resistance of parts are higher. Better stabilisation is required so softer rubber compounds are used where previously the standard compound hardness was 50-60 Shore A, and today is 25 Shore A. New engine mounts with liquid 'Hydro-Lager' developed in Germany use 'Glycol + mix' (ethylene and propylene glycol). Consequently there are new problems for the production of rubber/metal parts. There has also been a call for rubber companies to make the production rational and increase the quality and quantity, giving rise to a significant improvement in rubber metal bonding, high temperature vulcanisation and short time. The major developments over the last 20 years are summarised: vulcanisation times are shorter and temperatures higher, softer rubber compounds, higher bonding quality and pollution problems.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.725088

Item 178

Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 8. 012

FACTORS AFFECTING RUBBER TO METAL BOND STRENGTH AND FAILURE MODE

Del Vecchio R J; Halladay J R

Technical Consulting Services; Lord Corp.

(Rapra Technology Ltd.; European Rubber Journal)

Designed experiments are used to evaluate multiple combinations of compound type, compound quality, bonding adhesives and ASTM bond test methods to determine what effects these variables have on the strength of the rubber to metal bond and also how it fails under tension. Data on failure loads, type of failure and percent retained elastomer on the surface are used to compare and contrast how bonds can be characterised and evaluated. Conclusions are drawn about the meaning of data from different test methods and the validity of the common assumption that failure mode is the single most significant criterion of bond quality. 8 refs.

USA

Accession no.725086

Item 179

Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 7. 012

ADHESIVES FOR THE NEW MILLENNIUM

Polaski G

Lord Corp.

(Rapra Technology Ltd.; European Rubber Journal)

Many rubber moulded goods require a metal component in order to support the rubber article or enhance attachment of the rubber to an engineering component. For example, an automotive engine mount may consist of a block of rubber for absorbing shock and vibration and by adhering steel plates to it, allows the assembly to be connected to the frame of the car. Other bonded items include bridge bearing pads, military tank track pads, bushings, transmission and brake fluid seals, pump impellers and flex bearings in helicopters rotor assemblies and the nozzles of the solid rocket motors used in the space shuttle programme. At first glance, the procedure is relatively simple; apply adhesive to the metal component, place the coated metal in a mould and combine with the rubber. The bonding then takes place with heat and pressure at the same time as the vulcanisation of the rubber. However, it is a statistical process employing many variables all of which need to be managed in order to produce a level of adhesion that allows the final part to function. In most cases, this level of adhesion is such that the bond is stronger than the rubber substrate resulting in failures that are cohesive in the rubber substrate and not in the adhesive nor between the adhesive and either substrate.

USA

Accession no.725085

Item 180

Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 6. 012

LIFE PREDICTION FOR RUBBER/METAL BONDS: THE ROLE OF ELEVATED TEMPERATURE IN ACCELERATED TESTING

Stevenson A; Thomson B

Materials Engineering Research Laboratory

(Rapra Technology Ltd.; European Rubber Journal)

There is increased interest in methods for quantitative prediction of the life of rubber-to-metal bonds. Increased warranty periods for automotive components mean that premature failures have become more costly and high profile for vehicle manufacturers. Increased demands on the performance of components means that the likelihood of premature failure may increase unless a rational method of life prediction is applied at the development stage. In addition there is a trend motivated by impending legislation in Europe and the USA to discontinue usage of long established solvent based primers and bonding agents and replace them with the water based systems whose durability is much less well established. The problems that occur with rubber-to-metal bonds in service are not usually of a short-term nature unless manufacturing mistakes are made. They may typically become apparent only after 1-5 years' service when there has been extended exposure to service environments, such as salt water. The problem then arises of how to perform realistic tests without waiting 1-5 years for the results. A joint industry research project has been underway at MERL since 1995 to investigate this problem and develop accelerated test methods that can be verified against long term test data of up to 15 years duration. Some results of testing with wet exposure at a range of temperatures up to 95 deg.C are presented. The difficulties of developing a methodology for the life prediction of rubber-to-metal bonds are outlined. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.725084

Item 181
Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 5. 012
PROGRESS IN RUBBER TO SUBSTRATE BONDING
Rooke M B; Schurmann K
Henkel Ltd.; Henkel KgaA
(Rapra Technology Ltd.; European Rubber Journal)

Rubber to substrate bonding was invented in the middle of the 19th century when NR was bonded to brass. This process of bonding rubber to a substrate during the vulcanisation of the rubber is still the basis of most rubber bonding today. Applications for bonded items as anti-vibration components quickly became established in the growing automotive industry of the 20th century particularly from the late 1930s, using brass plated steel as the substrate. Polyisocyanates were also used for bonding in the 1940s and bonding proceeded in this way until the 1950s. Brass plating as a means of bonding continued into the early 1960s. The use of brass plated substrates had two main disadvantages. Firstly, the high sulphur required for bonding gave poor heat ageing of the rubber and secondly the brass plating process required the use of solutions that contained cyanide. Recent developments in rubber-to-substrate bonding described include environment and solvent use, methods of reduction in solvent emissions, substrates and their preparation, and bonding agent preparation, selection and application.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.725083

Item 182
Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 4. 012
RECENT DEVELOPMENTS IN COBALT ADHESION PROMOTERS
Fulton W S; Gibbs H W; Hawkins I M; Labarre D
Rhodia Ltd.; Rhodia Recherches
(Rapra Technology Ltd.; European Rubber Journal)

Currently accepted bonding mechanisms of rubber to brass-coated steel cord are reviewed along with the effect that ageing has upon the rubber-metal interface. The influence of cobalt on bond strength and particularly on the retention of strength after ageing is also discussed. Recent studies on real and model systems are described, which confirm the key role of cobalt in maintaining the adhesion between NR and brass-coated steel tyre cord. These studies have led to the development of a new range of compounds which show improved adhesion relative to conventional cobalt carboxylates. Results obtained from the new cobalt compounds are presented for comparison. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; UK; WESTERN EUROPE

Accession no.725082

Item 183
Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 3. 012
TECHNIQUES FOR BONDING RUBBER TO METAL USING METALLIC COAGENTS
Costin R; Nagel W
Sartomer Co.
(Rapra Technology Ltd.; European Rubber Journal)

The use of metallic coagents as crosslinkers for peroxide cured elastomers has previously been reported. They are effective crosslinkers for both saturated and unsaturated elastomers, and can be used over a wide concentration range to tailor mechanical properties for a variety of applications. It has been found that, in addition to improving the mechanical properties of rubber, they also increase the adhesion of rubber to metal substrates and synthetic fibres during vulcanisation. The metallic coagents discussed are zinc diacrylate and zinc dimethacrylate, commercially available as Saret 633 and Saret 634. Conventional metal-reinforced rubber products require both an adhesive to bond the metal to the rubber and a separate curing system to increase the mechanical properties of the rubber. This entails an intensive, time-consuming series of procedures. Metallic coagents offer several alternative ways of bonding rubber to metal that are far less intensive and time consuming. The metallic coagents may be used in different ways to form strong rubber-to-metal bonds without the use of external adhesives or a separate curing step. Any procedure that places the metallic coagents and peroxide between the metal surface and rubber with applied pressure may be used. There are three techniques for applying this technology for rubber-to-metal adhesion. 2 refs.

USA

Accession no.725081

Item 184
Rubber Bonding Conference. Conference proceedings. Frankfurt, 7th-8th Dec.1998, paper 2. 012
PRACTICAL SOLUTIONS FOR THE FUTURE
Dehnicke S
Chemetall GmbH
(Rapra Technology Ltd.; European Rubber Journal)

The bonding of rubber to metals, plastics and other substrates under vulcanisation conditions has become an increasingly important industrial process. Rubber bonded components are used in many diverse applications in which the properties of ferrous and non-ferrous metals, plastics and rubbers are combined to produce unique composite components. Typical industrial applications of rubber bonded components include vibration damping and noise suppression; thermal and electrical insulation; chemical and abrasion resistance; fluid and gas scaling. Aspects covered include the development of bonding agents, lead-free type I and II covercements and water-based bonding agents.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.725080

Item 185
Journal of Materials Science
33, No.21, 1st Nov.1998, p.5095-102
POLYPHENYLETHERSULFONE(PES) ADHESIVE FOR EPDM ELASTOMER-TO-STAINLESS STEEL JOINTS IN A HYDROTHERMAL ENVIRONMENT
Sugama T
Brookhaven National Laboratory

A hot melt PES adhesive was used to bond EPDM, which could be used for protection of geothermal drill pipes, to a stainless steel substrate. These joints were then exposed for up to 70 days in steam at 200C to evaluate the durability of the bond. Although the preparation and modification of the EPDM and stainless steel surfaces played an important role in ensuring a strong bond in the EPDM-to-stainless steel adhesive joint system, the susceptibility of the PES adhesive to hydrothermal oxidation led to conformational transformation of its sulphone group into a fragmental sulphonic acid derivative during the exposure. Furthermore, a prolonged exposure time caused the decomposition of polyphenylethersulphonic acid derivative, forming two additional derivatives, aryl radical and sulphuric acid. Hot sulphuric acid favourably reacted with iron in the stainless steel to yield a water-soluble ferric sulphate reaction product. This reaction product generated at the interfaces between PES and stainless steel, caused a decrease in peel strength. In fact, the loss of adhesion occurred in the stainless steel adjacent to the PES. 11 refs.
USA

Accession no.715540

Item 186
International Polymer Science and Technology
25, No.6, 1998, p.17-20
INFLUENCE OF THE TYPE OF METAL IN THE INORGANIC ACTIVATOR ON THE ADHESION OF VULCANISATES BASED ON NR TO METAL CORD
Kostrykina G I; Sudzilovakaya E N; Koshel G N; Sergeeva N L; Galybin G M
Russia,Yaroslavl',State Technical University

Details are given for carbon black-filled NR used for coating brass-plated metal cord. The influence of adhesion activators on physicomechanical properties of vulcanisates is discussed. 2 refs. Translated from Kauch.i.Rezina, 1, 1998, p.14
RUSSIA

Accession no.714280

Item 187
Industria della Gomma
42, No.3, April 1998, p.23-7
Italian
RUBBER-TO-METAL BONDING AGENTS FOR THE 21ST CENTURY
Zellner A
Chemetall GmbH

The characteristics of water-based adhesives used in rubber-to-metal bonding are examined, and analytical techniques for studying the composition and performance of water- and solvent-based bonding agents are described. The environmental advantages of water-based systems, methods for the pretreatment of metal substrates and problems associated with mould fouling are discussed.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.710668

Item 188
Industria della Gomma
42, No.3, April 1998, p.17-22
Italian
WATER-BASED PRODUCTS FOR RUBBER/ METAL ADHESION
Alberts H W; Giannone C
Henkel KGaA

The use of water-based adhesives in rubber-to-metal bonding in the manufacture of vibration dampers is examined. Environmental aspects of these adhesives, their film forming characteristics and spraying techniques used in their application are discussed. Results are presented of studies of the performance of two water-based adhesives and a solvent-based adhesive in bonding NR, EPDM and nitrile rubber to steel.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.710667

Item 189
Slovak Rubber Conference '97. Conference proceedings.
Puchov, 20th-21st May 1996, p.325-8. 4
A CONTRIBUTION TO THE MECHANISM OF RUBBER-STEEL CORD ADHESION
Jona E; Pajtasova M; Ondrusova D; Simon P; Duris S
Slovak Technical University; Matador AS
(Matador AS)

For the successful use of steel cords in radial tyres, a good rubber-to-metal bond is vital. Good adhesion generally requires the use of two main groups of adhesion promoters: resin former (SRH-silica, melamine system, resorcinol) and a metal salt. The bonding mechanism is found to be dependent on the chemical composition and the surface structure of the brass, the composition of the cure mixture and the sulphidisation conditions. A DSC study of the interactions between sulphur, N-dicyclohexylbenzothi azole-2-sulphenamide (DCBS), zinc oxide, and copper II dodecanoate and copper II hexadecanoate as adhesion promoters is reported. 7 refs.
SLOVAK REPUBLIC; SLOVAKIA

Accession no.708409

Item 190
Kauchuk i Rezina (USSR)
No.1, 1996, p.48-50
Russian
INCREASING THE STABILITY OF RUBBER-METAL CORD BOND STRENGTH BY ANTI-CORROSION TREATMENT
Beilinova L A; Lakiza O V; Danilenko V O; Kizim N D

The authors investigated the corrosion protection effect of coatings based on industrial oils containing dispersed organic additives on the retention of rubber-to-metal cord bond strength in natural rubber. 4 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

RUSSIA

Accession no.706876

Item 191
Industria della Gomma
42, No.1, Jan./Feb.1998, p.16-9
Italian
DEVELOPMENTS IN RUBBER/METAL COMPONENTS FOR INDUSTRIAL APPLICATIONS
Cerruti M
CF Gomma SpA

The structure, functions and mechanical performance of rubber/metal components for engine mountings and vehicle suspensions are examined. Turnover and employment figures are presented for CF Gomma, a manufacturer of such products.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.706055

Item 192
Patent Number: US 5776294 A 19980707
PEROXIDE-CURED ELASTOMERS WITH IMPROVED METAL ADHESION
Nagel W R
Sartomer Co.

Curable elastomers crosslinked with the aid of metal salts of alpha,beta-ethylenically unsaturated carboxylic acids and, optionally, an alkyl aminoalkyl phenol vulcanisation inhibitor are disclosed. Cured rubber articles having markedly improved adhesion to metals and synthetic fibres are obtained.

USA

Accession no.704826

Item 193
Patent Number: US 5741393 A 19980421
SOLVENTLESS CARBOXYLATED BUTADIENE-VINYLIDENE CHLORIDE ADHESIVES FOR BONDING RUBBER TO METAL
Hargis I G; Miranda R A; Wilson J A
GenCorp Inc.

An adhesive composition using as the primary binder an emulsion of butadiene-vinylidene chloride copolymer is disclosed. The composition is particularly suited for binding rubber to metal in a variety of uses such as vibration damping devices. The adhesive composition has resistance to hot water and or water glycol solutions.

USA

Accession no.703156

Item 194
Industria della Gomma
41, No.8, Oct.1997, p.28-9
Italian
RUBBER TO METAL BONDING: PROBLEMS AND SOLUTIONS
Baffico R
Assogomma

An examination is made of metal surface preparation techniques and solvent- and water-based adhesives used in rubber to metal bonding, and details are given of the programme of a seminar on this subject held by Assogomma on 27th November 1997.

BTR PLC; CHEMETALL GMBH; HENKEL; BONDER SPA; RFT SPA; CF GOMMA SPA
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; UK; WESTERN EUROPE

Accession no.702480

Item 195
Tyretech '98. Conference proceedings.
London, 15th-16th June 1998, paper 2. 6T1
INFLUENCE OF COBALT SALT ON ADHESION BETWEEN STEEL CORD AND RUBBER
Labarre D; Duffour T; Hawkins I; Tessier L; Sartre A; Bomal Y; Gibbs H W; Wilson J C
Rhodia Research; Rhodia Ltd.
(Rapra Technology Ltd.; European Rubber Journal)

For successful use of steel cords in radial tyres, the attainment and maintenance of good rubber to metal bonds is vital. Cobalt systems are used, alone or in combination with resin systems, in the rubber compound for the promotion and maintenance of good adhesion between brass and rubber. Today they appear to be the most efficient additives and are considered essential in the manufacture of steel radial tyres. In general, existing levels of adhesion are satisfactory, but improved performance is still required in some areas. Principal development targets are to maintain existing adhesion levels at lower cost and with enhanced physical properties, and to offer better adhesion retention in some areas such as high humidity for tropical climates or multiple retreading for truck tyres. Recently, novel cobalt adhesion promoters have been developed which perform better at lower levels than existing promoters, especially after steam ageing. A background to the rubber-brass adhesion mechanism is presented, and the effects of cobalt salts, including different results from model system studies carried out in the laboratory, are described. The adhesion data obtained from Rhodia's new adhesion promoters are discussed. It is shown that the new promoters give the best balance of initial/steam aged adhesion and that this best balance is obtained for a lower level of cobalt. 13 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; UK; WESTERN EUROPE

Accession no.697363

Item 196

Adhesive Technology

15, No.2, June 1998, p.30-2

TESTING RUBBER-TO-METAL BONDED PARTS

Jacks J

Acadia Polymers Inc.

The use of X-ray photoelectron spectroscopy and scanning electron microscopy to deduce that the failure of a rubber-to-metal bonding application is caused by premature crosslinking of the adhesive is described. By eliminating other possible causes of debonding, such as contamination, a more robust manufacturing process is developed.

USA

Accession no.689881

Item 197

Rubber World

218, No.3, June 1998, p.18/34

AQUEOUS ADHESIVES AS AN ALTERNATIVE TO CONVENTIONAL RUBBER-TO-METAL ADHESIVES

Dehnicke S

Chemetall GmbH

This article provides a short, but up-to-date introduction into the current activities in modern rubber-to-metal adhesives. The focus is on water-based bonding systems. Taking examples from three very different fields of application in the automotive sector, aqueous and solvent-based adhesive systems are presented and described in detail, particularly with regard to their method of application.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.688515

Item 198

Patent Number: US 5656687 A 19970812

USE OF MALEATED STYRENE-ETHYLENE-BUTYLENE-STYRENE TRIBLOCK POLYMER FOR IMPROVED ADHESION

Segatta T J

Goodyear Tire & Rubber Co.

There is disclosed a method for adhering rubber to reinforcing materials which comprises embedding a textile fibre or metal reinforcing material in a vulcanisable rubber composition comprising rubber, a vulcanising agent, reinforcement, a methylene donor, a methylene acceptor and a maleic anhydride functionalised triblock copolymer having polystyrene endblocks and poly-(ethylene/butylene) midblocks.

USA

Accession no.688208

Item 199

Tire Technology International

1998, p.63-6

RESORCINOL RESINS FOR WIRE BONDING

Peterson A

INDSPEC Chemical Corp.

Dry bonding systems for steel and synthetic fabric reinforcements are formulated with resorcinol and resorcinol novolak resins which have been formulated with minimum levels of free resorcinol to help eliminate fuming associated with resorcinol. Steel radial passenger and truck tyre performance depends in part on the strength and durability of the cord to rubber bonds that comprise these products. This comprehensive article supplies a detailed analysis of optimisation and adhesion mechanism studies with brass plated steel cord showing the beneficial effects of precondensed resorcinol novolak resin bonding systems mixed directly into the ply compounds which help to ensure satisfactory adhesion performance. 10 refs.

USA

Accession no.685061

Item 200

153rd ACS Rubber Division Meeting - Spring 1998. Conference preprints.

Indianapolis, In., 5th-8th May,1998. Paper 70. 012

ADHESION OF EPDM AND FLUOROCARBON ELASTOMERS TO METALS BY USING WATER SOLUBLE POLYMERS

Van der Aar C P J; Van der Does L; Bantjes A; Martin J; Roseboom F

Twente,University; Vernay Laboratories Inc.; Vernay Europa BV

(ACS,Rubber Div.)

New aqueous bonding systems are described for the adhesion of EPDM and fluorocarbon elastomers to a variety of metals. The water-soluble polymeric coupling agents are obtained by chemical modification of polyacrylic acid and polyvinylamine. These polymeric coupling agents can form either physical, covalent or ionic bonds across the polymer metal interface. During moulding, co-vulcanisation with the rubber occurs and a thermally stable and chemically resistant layer with high cohesive strength is formed. In case of polyacrylic acid, hydroxamic acid moieties are introduced to increase the metal affinity and unsaturated moieties for co-vulcanisation are obtained by reacting the carboxylic acid moieties with allyl glycidylether. The amine groups of polyvinylamine are partially converted to iminodiacetic groups for improved metal affinity and also reacted with allylglycidylether to obtain the desired unsaturation. By using these water-soluble polymeric coupling agents, the formed bonds of EPDM and fluorocarbon elastomers to a variety of metals can successfully withstand specific autoclave tests and fuel ageing. 27 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; USA; WESTERN EUROPE

Accession no.683279

Item 201

153rd ACS Rubber Division Meeting - Spring 1998. Conference preprints.

Indianapolis, In., 5th-8th May,1998. Paper 5. 012

TECHNIQUES FOR BONDING RUBBER TO METAL USING METALLIC COAGENTS

Costin R; Nagel W

Sartomer Co.Inc.

(ACS,Rubber Div.)

Metallic coagents are effective crosslinkers for both saturated and unsaturated elastomers and can be used over a wide concentration range to tailor mechanical properties for a variety of applications. It was found that, in addition to improving the mechanical properties of rubber, they also increase the adhesion of rubber to metal substrates and synthetic fibres during vulcanisation. The metallic coagents discussed are zinc diacrylate and zinc dimethacrylate, which are commercially available under the tradenames of Saret 633 and Saret 634, respectively. 2 refs.

USA

Accession no.683225

Item 202

Rubber Chemistry and Technology

70, No.4, Sept./Oct.1997, p.541-8

EFFECT OF VARIOUS BONDING AGENTS ON THE SULFIDATION OF BRASS-PLATED STEEL CORDS IMMERSED IN SQUALENE MIXTURES

Hamed G R; Paul R

Akron,University

Brass-plated steel cords were immersed at elevated temps. in various squalene mixtures containing sulphur curing agents and commercially-available bonding agents. Squalene is a low molec.wt. analogue of NR. Copper sulphide growth was characterised by SEM and energy-dispersive X-ray analysis. The bonding agents caused early sulphide growth, even prior to ‘scorch’, but mitigated sulphide overgrowth upon humid ageing. Both effects were expected to improve joint durability. 22 refs. (Fall ACS Rubber Division Meeting, Louisville, Oct.1996)

USA

Accession no.679124

Item 203

Rubber and Plastics News

27, No.16, 9th March 1998, p.12-7

EVALUATION OF RUBBER-TO-METAL BONDING

Del Vecchio R J; Halladay J R

Technical Consulting Services; Lord Corp.

This article describes designed experiments that were used to evaluate combinations of compound type and quality bonding adhesives, and ASTM bond test methods, to determine what effects these variables have on the strength of the rubber-to-metal bond, and how it fails under tension. Data on failure loads, type of failure, and percent-retained elastomer on the surface, are used to compare and contrast how bonds can be characterised and evaluated. Results are presented and discussed, and conclusions drawn. 9 refs.

USA

Accession no.677360

Item 204

Professional Engineering

11, No.4, 25th Feb.1998, p.44

RUBBER-TO-METAL BONDING REVISITED

An accelerated test method should lead to improved bond strengths between rubber and metal components. Current methods for accelerating bond failure expose the bond to wet conditions at high temperatures, because failure had been assumed to be the result of a chemical reaction accelerated by heat. This is now known to be an oversimplification and the high temperature can, in some cases, reduce the bond failure rate. Other acceleration factors have been discovered to be more significant in bond failure than temperature. These include mechanical strain, salinity, oxygen content and pH. A MERL study included a range of different adhesive systems using NR, polychloroprene, nitrile rubber and hydrogenated nitrile rubber. Results compare well with 14-year exposure tests under non-accelerated conditions. The test method will affect the design of antivibration mounts, bridge bearings, seismic mounts for buildings, offshore platforms and other flexelements. The next phase of the project will look at the effect of manufacturing variables on bond strength. This abstract includes all the information contained in the original article.

MATERIALS ENGINEERING RESEARCH LABORATORY LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.676174

Item 205

Rubber World

217, No.2, Nov.1997, p.44

ADHESION RESIN SYSTEM

It is briefly reported that Cytec Industries has introduced a one-component, lower-cost, environmentally-safe adhesion resin system for bonding brass-plated steel cords to tyres. The company will produce liquid and powder forms of the products, Cyrez CRA 138 and Cyrez CRA 132. The structure of the new resin in the melamine family contains self-condensing sites which enable crosslinking without the use of an acceptor.

CYTEC INDUSTRIES INC.
USA

Accession no.664895

Item 206
Kautchuk und Gummi Kunststoffe
50, No.11, Nov.1997, p.778/85
IMPROVED TYRE SAFETY AND LIFE BY A NEW WIRE/RUBBER ADHESION SYSTEM
Orjela G; Harris S J; Vincent M; Tommasini F

In the dual layer coating, NiZn which is difficult to draw, tends to flow into the ZnCo inner layer coating or wear off during the drawing process. Ni does not participate in the wire/rubber adhesion bond contrary to the state-of-the-art and therefore is not necessary for wire/rubber adhesion. A single layer of ZnCo is sufficient in which Co is concentrated at the Fe interface and imparts better corrosion performance. Drawability of the ZnCo can be obtained by reducing the thermal treatment of the wire during drawing by using a plating morphology with mixed crystal orientation, avoiding W-carbide dies in the last drawing process (and elimination welding), and using thermally stable lubricants. Prototype passenger tyres with the new adhesion system are tested in the laboratory and in field tests up to 110,000 km, showing superior corrosion resistance. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; ITALY; UK; WESTERN EUROPE

Accession no.662341

Item 207
Luntai Gongye
17, No.11, 1997, p.662-4
Chinese
INFLUENTIAL FACTORS ON ADHESION BETWEEN RUBBER AND BRASS-PLATED STEEL CORD
Lingjun C
Dongfeng Gold Lion Tire Corp.

The influence of sulphur, zinc oxide, accelerator, carbon black and processing on the adhesion between rubber and brass-plated steel cord is investigated by the orthogonal design method and the comparative test. The results show that the sulphur type has little influence on the adhesion; the adhesion improves as the level of zinc oxide increases; the adhesion with 1.0 phr of CZ is greater than that with 1.3 phr of DZ; the adhesion increases with high structure carbon black; the mixing method and the curing time have significant influence on the adhesion.

CHINA

Accession no.661782

Item 208
Adhesives Age
40, No.11, Oct.1997, p.36-8
SEM AND XPS TESTING AND ANALYSIS OF RUBBER-TO-METAL BONDED PARTS
Jacks J
Acadia Polymers

This article examines the analysis of failure of bonding rubber to metal, looking in particular at scanning electron microscopy (SEM) testing, and X-ray photo-electron spectroscopy (XPS) testing. A case study example is discussed, and conclusions are drawn.

USA

Accession no.661039

Item 209
IRC '97. Conference proceedings.
Kuala Lumpur, 6th-9th Oct.1997, p.1037-40. 012
DIRECT ADHESION BETWEEN RUBBERS NICKEL PLATINGS AND NICKEL PLATINGS DURING CURING USING TRIAZINE THIOLS SYSTEM
Hirahara H; Mori K; Oshi Y; Sasaki Y; Omura S
Iwate,University; Toa Denka Co.Ltd.
(Rubber Research Institute of Malaysia)

Direct adhesion between nickel platings and rubbers is successful using 1,3,5-triazine-2,4,6-trithiol sodium salt (TTN). Peel strength in the adherends is influenced by amount of TTN. The decrease in peel strength after post cure is attributed to decrease of interfacial bonds between nickel and rubbers in the adherends. From Kraus plots in the nickel powder-rubbers composites containing TTN, first order bonds are confirmed to form in the interface between the nickels and rubbers. The concentration of sulphur of TTN at nickel plating-rubbers adherends interface are observed to increase from XMA and XPS analysis. The above results suggest that TTN works as a binder which bonds between nickel platings and rubbers. Nickel plating-rubbers adherends possess excellent oil, water and heat resistance. 3 refs.

JAPAN

Accession no.658849

Item 210
IRC '97. Conference proceedings.
Kuala Lumpur, 6th-9th Oct.1997, p.632-3. 012
ELECTRON SPIN ECHO STUDY OF THIOKOL RUBBER TO COPPER ALLOY BONDING
Nefed'ev E S; Mirakova T Y; Kadirov M K; Petrov O V; Orlinskii S B; Rakhmatullin R M; Aupov M I
Kazan,State Technological University; JSC
(Rubber Research Institute of Malaysia)

It has long been established that brass-plated metal surfaces have a promoted adhesion to NR. It is believed that the high adhesion strength between rubber and brass is caused by a presence of copper sulphide film formed during sulphur vulcanisation. In the case of polysulphide-based sealants, the formation of copper sulphide is accompanied by that of $(CuS4)2+$ paramagnetic complexes, the concentration of which is found to correlate inversely with adhesion strength. An attempt is made to determine a structure of sulphur-contained ligands as well as dynamics of the complex by the ESE method. 3 refs.

RUSSIA

Accession no.658345

Item 211

IRC '97. Conference proceedings.
Kuala Lumpur, 6th-9th Oct.1997, p.477-83. 012

DEVELOPMENT AND TESTING OF ENGINE DIPSTICK FOR NATIONAL CAR INDUSTRY

Lye C B; Siew Chet P; Tan E
Rubber Research Institute of Malaysia; Malaysia Auto Products Sdn.Bhd.
(Rubber Research Institute of Malaysia)

A Malaysian entrepreneur, with the assistance of the Rubber Research Institute of Malaysia, has developed a moulding technology using a polyacrylate rubber suitable for the production of the car engine dipstick. To ensure durability and adhesion of the rubber to metal, a novel method of testing is developed. This method is able to distinguish various failure modes of the metal-to-rubber bonding. It can be used as a screening tool to differentiate bond strength, bonding material or even rubber grades. Over 800,000 units are produced with less than five defects or rejects. 6 refs.

MALAYSIA

Accession no.658327

Item 212

152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 49, pp.19. 012

ADHESION OF NATURAL RUBBER TO STEEL SUBSTRATES: THE USE OF PLASMA POLYMERIZED PRIMERS

Boerio F J; Tsai Y M; Kim D K
Cincinnati,University; Goodyear Tire & Rubber Co.
(ACS,Rubber Div.)

A study was made of the mechanisms responsible for adhesion at the interface between NR and a plasma polymerised polyacetylene primer deposited on a steel substrate. Interactions between NR and the primer were simulated using model systems containing squalene or squalane, carbon black, sulphur, stearic acid, N,N-dicyclohexyl benzothiazole sulphenamide, cobalt naphthenate and diaryl-p-phenylenediamine. The primer films were analysed before and after reaction with the model systems using reflection-absorption and transmission IR spectroscopy. There was little reaction of the squalane based system with the primers, but extensive reaction was observed for the squalene based systems. It was concluded that an intermediate formed in the reaction was responsible for crosslinking between squalene and the primer in the model system, and for adhesion at the NR/primer interface in an actual bond. 12 refs.

USA

Accession no.658303

Item 213

152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 25, pp.31. 012

RUBBER-METAL BONDING STUDIES USING DESIGNED EXPERIMENTS

Del Vecchio R J; Halladay J R
Technical Consulting Services; Lord Corp.
(ACS,Rubber Div.)

Designed experiments were used to evaluate the effects of multiple combinations of compound type (NR or SBR), compound quality, bonding adhesive (solvent-based or aqueous) and ASTM bond test methods on the strength of rubber-to-metal bonds and their failure under tension. Data on failure loads, type of failure and percent retained elastomer on the surface were used to compare and contrast how bonds could be characterised and evaluated. Conclusions were drawn concerning the meaning of data from different test methods and the validity of the common assumption that failure mode is the single most significant criterion of bond quality. 8 refs.

USA

Accession no.658279

Item 214

152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 24, pp.15. 012

DOUBLE-PEEL RUBBER/METAL ADHESION TEST: A NOVEL MEANS OF MEASURING RELIABLE PEEL ENERGY LEVELS

Campion R P
Materials Engineering Research Laboratory Ltd.
(ACS,Rubber Div.)

A double-peel arrangement was developed for peel adhesion testing of rubber-to-metal bonded specimens. The rotary test, which allowed a full sweep of angles from 35 to 155 degrees in one test, was applied to NR/steel specimens. It was found that peel force was insensitive to peel angle between approximately 45 and 85 degrees. With unreinforced test specimens the contributions from unwanted modes were minimised in this range, and good interfacial failure surfaces were observed. Increased forces associated with fabric-backed specimens led to considerable tearing, making such specimens unsuitable for this type of rotary peel testing. Unreinforced specimens in which one rubber layer was prevented from debonding, thereby concentrating the rotation (up to 90 degrees only) onto the other layer, led to complete interfacial failure across the entire metal length. 7 refs.

MERL LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE

Accession no.658278

Item 215
152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 23, pp.20. 012

APPLICATION CHARACTERISTICS OF AQUEOUS ADHESIVES

Rearick B A
Lord Corp.
(ACS,Rubber Div.)

A survey is made of handling procedures and spraying and dipping techniques applicable to aqueous adhesives used in rubber-to-metal bonding. Methods used in the surface preparation of metals for bonding are also examined. 3 refs.

USA

Accession no.658277

Item 216
152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 22, pp.23. 012

ENGINEERING FOR ADHESION: KINETICS OF THE DURABLE BOND

Hofmann N L
Morton International Inc.
(ACS,Rubber Div.)

A model of the processes leading to the achievement of the durable bond at the rubber-metal interface during the moulding of rubber-to-metal bonded articles was developed on the basis of experiments with a low sulphur content NR compound. The bonding process was correlated with rubber cure at the interface. During immersion testing in hot glycol at 130C, there existed a post curing process which in many cases would eventually halt the debonding process. The model could be extended to the more general and more realistic non-isothermal case to treat the general moulding situation. By coupling analysis of the heating of the bonding surface with kinetic knowledge of the adhesive reactions, the moulding process could be designed to obtain the desired level of adhesion. 4 refs.

USA

Accession no.658276

Item 217
152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 21, pp.33. 012

WIRE ADHESION: A REVIEW OF PRESENT DAY TECHNOLOGY AND A LOOK TO THE FUTURE

Hoff C M
Cytec Industries Inc.
(ACS,Rubber Div.)

One-component melamine resins capable of forming a network without the need for a co-reactant such as resorcinol were evaluated as adhesion promoters in the bonding of rubbers to steel cords, and their performance was compared to that of some classical two-component methylene donor-methylene acceptor systems. The one-component systems gave good original and aged adhesion, equivalent tensile and dynamic mechanical properties and superior cut growth resistance. 8 refs.

USA

Accession no.658275

Item 218
Rubber Technology International
1997, p.100-4

AQUEOUS CHEMICAL PRETREATMENTS FOR RUBBER-TO-METAL BONDING

Zellner A
Chemetall GmbH

The purpose of substrate preparation is to provide and maintain a clean, stable substrate bonding surface prior to the application of the bonding agent systems and to remove oil and grease that could prevent the bonding agent from properly wetting the substrate surface. In addition, contamination such as oxidative rust, which may fracture and cause bond delamination during the in-service application of the bonded component, has to be removed and re-oxidation or recontamination of the freshly prepared substrate bonding surface has to be prevented. Steel is the most commonly used substrate for rubber-to-metal bonding. Substrate preparation methods can either be mechanical, chemical or a combination of both. The choice is influenced by considering a number of factors including substrate composition, size, number and shape of components and the in-service application of the bonded component. The resistance of the bonded component to adverse environments and to under-bond corrosion can be affected by the substrate pretreatment process used. Steel substrates that have been phosphated before bonding agent application, using recommended pretreatment methods, give bonded components which are resistant to severe in-service environmental conditions. The various aqueous chemical pretreatments used for the preparation of substrates prior to the application of the bonding agent are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.657649

Item 219
Patent Number: EP 798344 A2 19971001
FLUOROSILICONE RUBBER COMPOSITION AND METHOD OF ADHERING IT TO A SUBSTRATE
Irie M
Dow Corning Toray Silicone Co.Ltd.

This composition, which has excellent curability and adhesion to various substrates when combined with a specific primer, comprises a specific polyorganosiloxane, a silica filler, a polyorganohydrogensiloxane and an organic peroxide. It is adhered to a primed substrate, such as metal.
JAPAN

Accession no.656403

Item 220
Composite Interfaces
5, No.1, 1997, p.31-40
EFFECT OF ADHESION PROMOTER LAYER THICKNESS ON THE ADHESION STRENGTH BETWEEN SILICONE RUBBER AND ALUMINIUM
Banhegyi G; Ducso C; Lohner T
Furukawa Electric Institute of Technology; Budapest,Research Institute for Materials Science

The effect of adhesion promoter layer thickness on the peel strength was investigated on aluminium/adhesion promoter/silicone rubber samples. The thickness of the primer layer was determined by ellipsometry and mechanical step-height measurement on reference silicon-wafers. 14 refs.
EASTERN EUROPE; HUNGARY

Accession no.655723

Item 221
Progress in Organic Coatings
30, No.4, April 1997, p.247-53
INTERFACIAL CHEMISTRY OF HUMIDITY-INDUCED ADHESION LOSS OF CHLORINATED RUBBER ON RUSTED STEEL SUBSTRATES
Feliu S; Fierro J L G; Maffiotte C
CSIC

The effect of the exposure to humidity of a chlorinated rubber coating applied to pre-rusted mild steel was investigated. Interfacial and adhesion properties are discussed using X-ray photoelectron spectroscopy. 9 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; SPAIN; WESTERN EUROPE

Accession no.649512

Item 222
Patent Number: US 5589532 A 19961231
SOLVENTLESS BUTADIENE-VINYLIDENE CHLORIDE ADHESIVES CONTAINING MACROMONOMERS FOR THE BONDING OF RUBBER TO METAL
Hargis I G; Kovalchin J P; Sharma S C; Weinert R J; Wison J A
GenCorp Inc.

These water-based adhesives are made from a latex, which includes at least one conjugated diene and a macromonomer containing at least two ethylene oxide repeat units. The bonded materials may be used as vibration damping devices.
USA

Accession no.647509

Item 223
Journal of Adhesion
63, Nos 1-3, 1997, p.199-214
INVESTIGATION OF POLYIMIDESILOXANES FOR USE AS ADHESIVES BY ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS
Zhuang H; Gardella J A; Incavo J A; Rojstaczer S; Rosenfeld J C
New York,State University; Occidental Chemical Corp.

Angle-dependent ESCA was used to examine the air facing surface composition of polyimidesiloxanes with different processing variations and of varying PDMS content and block length. The interaction mechanism and the failure mechanism involved in bonding PDMS and metal substrate were also determined based on ESCA results. 24 refs.
USA

Accession no.647104

Item 224
Advanced Materials and Processes
152, No.1, July 1997, p.14
ADHESIVE SECURES SHOCK-ASSEMBLY MOUNTING

A rubber-toughened ethyl cyanoacrylate structural adhesive is used to attach a butyl-type rubber washer to a steel nut in an automotive shock absorber mounting assembly. ND Industries' 342400 Instant Superglue has good peel and shock resistance, and provides a more flexible bond than that of the rigid, glass-like bond of standard superglues. It also accommodates the inconsistencies of varying rubber cures, and is not affected by the presence of mould release agents characteristic of moulded butyl rubber parts. This abstract includes all the information contained in the original article.

ND INDUSTRIES INC.
USA

Accession no.645235

Item 225
Advanced Materials and Processes
151, No.6, June 1997, p.47-8
TESTING BONDED PARTS
Jacks J
Acadia Polymers Inc.

The robust nature of rubber-to-metal bonded parts qualifies them for applications in critical systems operating in hostile environments. Although it is imperative to determine the root cause of failure if a part becomes disbanded in critical applications, the multiple constituents of rubber compounds make analysis difficult by traditional methods. Furthermore, when parts fail at the adhesive bond interface, analysis of the system often becomes even more complex. It is described how X-ray photoelectron spectroscopy and scanning electron microscopy can be used in such a situation to deduce that the most likely cause of a bond failure was premature crosslinking of the adhesive.
USA

Accession no.642046

Item 226
China Synthetic Rubber Industry
20, No.3, 1997, p.181-5
Chinese
ONE-COAT ADHESIVES FOR BONDING RUBBER-TO-METAL THROUGH VULCANISATION
Ding Lipeng; Ma Xingfa; Wang Zhongping; Wu Chongguang
Shandong,Non-Metallic Materials Institute

The composition, formulation, preparation and application of one-coat adhesives for bonding rubber to metal through vulcanisation are reviewed. The types and function of components in the adhesives, including film-forming agents, adhesion synergists, adhesion promoters, coupling and curing agents, fillers and solvents, are discussed. 29 refs.
CHINA

Accession no.636610

Item 227
Rubber World
215, No.6, March 1997, p.62
STRUCTURAL ADHESIVE

ND Industries was asked to solve a problem with a special automotive shock absorber mounting assembly that required the secure attachment of a butyl type rubber washer to a steel nut assembly that had been plated. The company selected its 2434000 Instant Superglue, an ethyl cyanoacrylate with higher peel and shock resistance than other grades. The material is typically hand applied, but the company is offering a high production application system to apply and dispense the structural adhesive and attach the components.

ND INDUSTRIES INC.
USA

Accession no.636328

Item 228
European Rubber Journal
179, No.4, April 1997, p.30-1
BONDING PROBLEMS BEING SOLVED
White L

Water-based rubber-to-metal bonding systems are beginning to take over, but detailed attention to procedures is essential, was the message at a recent seminar on rubber-to-metal bonding organised by Rapra Technology. The advantages and disadvantages of water-based systems were examined. Other topics discussed included solvent emission regulations, metal surface preparation, changes in environmental test specifications, accelerated durability testing and degreasing.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.631580

Item 229
Patent Number: US 5536774 A 19960716
USE OF MALEATED STYRENE-ETHYLENE-BUTYLENE-STYRENE TRIBLOCK POLYMER FOR IMPROVED ADHESION
Segatta T J
Goodyear Tire & Rubber Co.

Rubber is adhered to reinforcing materials by embedding a textile fibre or metal reinforcing material in a vulcanisable rubber composition comprising rubber, a vulcanising agent, reinforcement, a methylene donor, a methylene acceptor and a maleic anhydride functionalised triblock copolymer having PS endblocks and poly-(ethylene/butylene) midblocks.
USA

Accession no.630899

Item 230
International Polymer Science and Technology
23, No.11, 1996, p.T/78-83
MELAMINE IN THE RUBBER INDUSTRY
Afanas'ev S V

A survey is made of applications of melamine derivatives in the rubber industry, with particular reference to their uses as adhesion promoters, accelerators and scorch retarders. 43 refs. (Translation of Kauchuk i Rezina, No.4, 1996, p.45).
RUSSIA

Accession no.629932

Item 231
Journal of Adhesion
61, Nos.1-4, 1997, p.247-70
ADHESION OF NATURAL RUBBER COMPOUNDS TO PLASMA-POLYMERISED ACETYLENE FILMS
Tsai Y M; Boerio F J; Kim D K
Cincinnati,University; Goodyear Tire & Rubber Co.

The properties of plasma-polymerised acetylene films as primers for rubber-to-metal bonding is described. Miniature lap joints were prepared using rubber as an 'adhesive' to bond together pairs of steel adherends primed with plasma polymerised films. The initial strength of the lap joints was determined as a function of the carrier gas used in the film deposition and the substrate surface pretreatment. The results were compared with those obtained from similar joints prepared from brass substrates. Preliminary durability test results are also reported. 16 refs.
USA

Accession no.629105

Item 232
Journal of Adhesion
60, Nos.1-4, 1997, p.71-93
INFLUENCE OF THE CATION IN ORGANOMETALLIC BOROACYLATE ADHESION PROMOTERS ON THE ADHESION BETWEEN STEEL CORD AND SKIM RUBBER COMPOUND
Chandra A K; Mukhopadhyay R; Bhowmick A K
J.K.Industries Ltd.; Indian Institute of Technology

The effect of transition metal cations (Co, Ni and Zn ions) associated with organometallic boroacylate adhesion promoters on the adhesion between brass-coated steel cord and rubber skim compound under the influence of various environments, which simulated tyre service conditions, was studied. Incorporation of adhesion promoters individually in the steel cord-skim formulation led to increases in crosslink density, Young's modulus and cord pull-out force. The adhesion energy was enhanced significantly with the addition of Co adhesion promoter. The performance of the promoter was influenced by the ease of dissociation of the transition metal ion from the promoter, its participation in the rubber curing and the modification of the interfacial film responsible for adhesion. During aerobic ageing, Co followed by Ni was found to be effective, whereas Co and, particularly, Zn salts provided resistance to thermal ageing. Against salt and steam ageing, cobalt boroacylate was very effective, followed by Zn salts. 32 refs.
INDIA

Accession no.625081

Item 233
Patent Number: US 5520768 A 19960528
METHOD OF SURFACE PREPARATION OF ALUMINIUM SUBSTRATES
Crook R A; Poulter L W; Schulte K J; Sinclair J W
Thiokol Corp.

The process, which improves bond strength, fracture toughness, durability and failure mode of adhesive bonds and decreases the sensitivity of aluminium or aluminium alloy substrates to processing variables, such as humidity, temperature and hence processing timelines, involves treating the aluminium surface with a solution of an alkali metal metasilicate followed by a solution of an organofunctional silane.
USA

Accession no.622883

Item 234
Leicester, 1989, p.5. 30cms. 14/6/96
CYANOACRYLATE ADHESIVES
Bostik Ltd.
Information Sheet No.B586/4

Details are given of Bostik's range of cyanoacrylate adhesives. These are single part, fast curing adhesives which bond in seconds without the need for heat or catalysts and which are capable of joining metals, rubber, ceramics and most plastics to themselves or each other, giving a high tensile strength bond. Five viscosities are available, each designed for a particular application requirement. Grade 7431 is a very low viscosity formulation designed to penetrate hair line cracks while grade 7432 is a low viscosity, general purpose adhesive with good wettability. Grade 7433 is of medium viscosity and is intended for use on vertical surfaces requiring very small amounts of adhesive. The higher viscosity grades, 7434 and 7435, are for bead application.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.621184

Item 235
Rubber India
48, No.8, Aug.1996, p.45-53
RUBBER-TO-METAL BONDING AGENTS
Milczarek R; Zellner A
Oakite Products Inc.; Chemetall GmbH

This article forms the second of a two-part series discussing rubber-to-metal bonding agents. This instalment looks at: solvent emissions, methods to reduce emissions, exhaust air cleaning, water-based bonding agents, requirements of water-based agents, primer, cover cements, and one-coat bonding agents. A summary is also included.
INDIA

Accession no.612364

Item 236
Patent Number: US 5503698 A 19960402
BONDING METHOD EMPLOYING ORGANOMETALLIC INTERCONNECTORS
Goldberg M J; Ito H; Kovac C A; Palmer M J; Pollak R A; Poore P A
International Business Machines Corp.

A chemical solder is described that includes an organometallic complex or compound which thermally degrades within a predetermined temperature range to a metal and volatile compounds. The solder also includes a polymeric matrix that decomposes within the same temperature range to volatile fractions, thereby leaving only the metal. A method for bonding first and second bodies is disclosed wherein the above chemical solder is disposed between these bodies and heat is applied to elevate the solder to the predetermined temperature range to thermally degrade the organometallic compound and to decompose the polymeric matrix. The remaining metal bonds the first and second bodies.
USA

Accession no.611917

Item 237
150th ACS Rubber Division Meeting. Fall 1996. Conference Preprints.
Louisville, Ky., 8th-11th Oct.1996, Paper 87, pp.31. 012
EFFECT OF VARIOUS BONDING AGENTS ON THE SULPHIDATION OF BRASS PLATED STEEL CORDS IMMERSED IN SQUALENE MIXTURES
Hamed G R; Paul R
Akron,University,Institute of Polym.Science
(ACS,Rubber Div.)

The effect of various commercially established bonding agents on brass-squalene sulphidation was investigated. Brass plated steel cords were immersed in mixtures of squalene, a low molecular weight analogue of NR, with curing and bonding agents. Copper sulphide growth was characterised by SEM, optical microscopy and energy dispersive X-ray analysis. Mixtures containing bonding agents caused rapid initial formation of a high surface area copper sulphide prior to scorch, giving enhanced interaction between sulphide and rubber, and slow continued sulphide growth on ageing. 21 refs.
USA

Accession no.611842

Item 238
150th ACS Rubber Division Meeting. Fall 1996. Conference Preprints.
Louisville, Ky., 8th-11th Oct.1996, Paper 86, pp.16. 012
ENGINEERING FOR ADHESION: STRENGTH AND DURABILITY OF RUBBER-METAL BONDS
Hofmann N L
Morton International Inc.
(ACS,Rubber Div.)

NR/polybutadiene compounds of low, medium and normal sulphur content were bonded to steel using four adhesive formulations, of unidentified composition, one of which was a traditional formulation while the others were developed for improved heat and fluid resistance. The peel strength of the bonds was measured, and effects of hot water and glycol immersion on bond durability were examined. The durability of the rubber-metal bonds was highly dependent on the adhesive interface temperature during the moulding process. The data suggested the existence of more than one bonding reaction and mechanism.
USA

Accession no.611841

Item 239
150th ACS Rubber Division Meeting. Fall 1996. Conference Preprints.
Louisville, Ky., 8th-11th Oct.1996, Paper 85, pp.16. 012
AQUEOUS ADHESIVES AS AN ALTERNATIVE TO CONVENTIONAL RUBBER-TO-METAL ADHESIVES
Dehnicke S
Chemetall GmbH
(ACS,Rubber Div.)

Applications of Megum aqueous adhesives and primers (Chemetall) in rubber-to-metal bonding are described, with particular reference to the manufacture of automotive components such as vibration dampers, gaskets and metal-reinforced profiles.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.611840

Item 240
150th ACS Rubber Division Meeting. Fall 1996. Conference Preprints.
Louisville, Ky., 8th-11th Oct.1996, Paper 83, pp.45. 012
NEW AQUEOUS TOPCOAT FOR BONDING RUBBER TO METAL
Plasczynski T; Warren P
Lord Corp.
(ACS,Rubber Div.)

Chemlok 8210 aqueous adhesive (Lord Corp.) combined with a number of Chemlok aqueous primers was used to bond NR, SBR, polychloroprene and nitrile rubber to grit blasted and zinc phosphate treated steel. Adhesion was measured after pre-baking and exposure to various aggressive environments. The results demonstrated that the aqueous adhesive system provided levels of adhesion and environmental resistance equivalent to or better than those obtained using solvent-borne adhesives. 2 refs.
USA

Accession no.611838

Item 241
Rubber World
214, No.6, Sept.1996, p.53
ADHESION PROMOTERS

Proprietary metal organic adhesion promoters have both primary and secondary amine functionality, it is briefly reported. B-516.5 is recommended for use in EPDM, urethanes, SBR and NR. Both B-516.5 and B-516.5W from Chartwell International are said to have excellent compatibility when added to most latex and other water-borne polymers directly.

CHARTWELL INTERNATIONAL INC.
USA

Accession no.610572

Item 242
Patent Number: WO 9520061 A1 19950727
German
PROCESS FOR THE JOINT PRETREATMENT OF STEEL, GALVANISED STEEL, MAGNESIUM AND ALUMINIUM BEFORE THEIR BONDING TO RUBBER
Beiersdorf W-D; Gruber W; Scheer H; Foll J; Gies B; Kuhm P; Schuller F-J
Henkel KGAA

A process for producing a rubber-metal bond on steel, galvanised steel, aluminium and/or magnesium is disclosed, in which the metal components are pretreated with aqueous acid solution containing at least 4-20 g/l phosphate ions, 0.1-1 g/l fluoride and 0.04-1 g/l nitrate ions and preferably as further components 0.05-5 g/l molybdate ions and 0.5-2 g/l non-ionic tensides.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.606584

Item 243
Patent Number: US 5478654 A 19951226
SOLVENTLESS CARBOXYLATED BUTADIENE-VINYLIDENE CHLORIDE ADHESIVES FOR BONDING RUBBER TO METAL
Hargis I G; Miranda R A; Wilson J A
Gencorp Inc.

An adhesive composition using as the primary binder an emulsion of butadiene-vinylene chloride copolymer is disclosed. The composition is particularly suited for binding rubber to metal in a variety of uses such as vibration damping devices. The adhesive composition has resistance to hot water and/or water glycol solutions.

USA

Accession no.599932

Item 244
Journal of Adhesion Science and Technology
10, No.7, 1996, p.593-616
FRACTURE MECHANICS STUDY OF NATURAL RUBBER-TO-METAL BOND FAILURE
Muhr A H; Thomas A G; Varkey J K
Malaysian Rubber Producers' Research Assn.; London,University,Queen Mary & Westfield College; Rubber Research Institute of India

Bond strength test methods that were amenable to a fracture mechanics interpretation (peel, rod pull-out and simple shear) were investigated experimentally. Equations for calculating fracture energies from these test pieces were presented. For strong bonds, the calculated fracture energies were not independent of the test geometry. This was attributed to different morphologies of the failure surfaces, the fracture energy decreasing with increasing sharpness of the effective crack tip. Fracture surfaces observed for peel at low angles and for simple shear were taken to correspond to sharp crack tips, in contrast to the rough fracture surfaces formed in the rubber for the other test geometries. Application of fracture mechanics to the simple shear test piece was complicated by the need ideally to use the retraction energy in the calculations and by the observation that failure did not initiate from artificially introduced cuts placed where initiation was expected to occur. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; INDIA; UK; WESTERN EUROPE

Accession no.599410

Item 245
Materials World
4, No.7, July 1996, p.382-4
RUBBER TO METAL BONDS: DURABILITY AND FAILURE
Lake G
Malaysian Rubber Producers' Research Assn.

Vulcanised rubber is bonded to metal in many applications. This may be for fixing purposes or to increase stiffness. An increase in overall strength or fatigue resistance may also result. For most applications, though not all, the integrity of the bond is essential for maintenance of adequate life. Perhaps the earliest method developed for bonding was through the introduction of an interlayer of ebonite (highly crosslinked, hard rubber) between the bulk rubber and the metal. Brass (as a coating on steel) has also been employed for many years. Both methods are still in use today, for example for tank or pipe linings in the former case and steel tyre cord in the latter. Epoxy or other conventional adhesives are also sometimes used. However, for many engineering applications, bonding is now achieved by means of special bonding agents which can be painted or sprayed on to the metal. Hitherto these have been mainly solvent-based, although there is now pressure to change to water-based materials.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.599044

Item 246
Journal of Materials Science
31, No.10, 15th May 1996, p.2667-76
X-RAY PHOTOELECTRON SPECTROSCOPY AND AUGER ELECTRON SPECTROSCOPY OF THE INFLUENCE OF CATIONS AND ANIONS OF ORGANOMETALLIC ADHESION PROMOTERS ON THE INTERFACE BETWEEN STEEL CORD AND RUBBER SKIM COMPOUNDS
Chandra A K; Mukhopadhyay R; Konar J; Ghosh T B; Bhowmick A K
J.K.Industries Ltd.; Indian Institute of Technology

The influence of cations and anions of the adhesion promoters on the interface between brass-coated steel cord and NR skim compounds was studied by auger electron spectroscopy and X-ray photoelectron spectroscopy at three different etching times. Cobalt stearate, cobalt boroacylate and nickel boroacylate were used as organometallic adhesion promoters. A model, based on the results, was proposed to show the difference in activity of the cations and anions. 32 refs.
INDIA

Accession no.592082

Item 247
Journal of Adhesion Science and Technology
10, No.5, 1996, p.473-90
CHARACTERISATION OF RUBBER-BRASS BONDING LAYERS BY ANALYTICAL ELECTRON MICROSCOPY(AEM)
Hofer F; Grubbauer G; Hummel K; Kretzschmar T
Graz,Technische Universitat

AEM was applied to characterisation of rubber-brass bonding layers. Two specimen preparation techniques were used, the extraction of the bonding layers parallel to the substrate and the preparation by cryo-ultramicrotomy of cross-sections perpendicular to the brass surface. The bonding layers were characterised by means of TEM, scanning TEM, electron diffraction, energy dispersive X-ray analysis, electron energy loss spectrometry and electron spectroscopic imaging. The application of these techniques to bonding layers was demonstrated for typical examples and is discussed critically. 27 refs.
AUSTRIA; WESTERN EUROPE

Accession no.591298

Item 248
Journal of Adhesion Science and Technology
10, No.5, 1996, p.461-71
RUBBER-BRASS BONDING: MORPHOLOGY OF CROSS-SECTIONS THROUGH THE BONDING LAYERS AS A POSSIBLE BASIS FOR CLASSIFICATION
Hummel K; Hofer F; Kretzschmar T
Graz,Technische Universitat

The morphology of cross-sections through the bonding layers perpendicular to the brass surface in rubber-brass bonding, observed by TEM, was used as a means of bonding layer classification. Previous experimental results with a simplified cure mixture (consisting of 1,4-polybutadiene, elemental sulphur, N,N-dicyclohexyl-2-benzothiazylsulphenamide and, in some cases, zinc oxide) and brass foils were considered. In almost all cases, a ‘central layer’ was found. It consisted of two sublayers with different contents of copper sulphides. Varying deposits of sulphides existed at the brass surface and also above the central layer in the direction of the rubber bulk. The various types of bonding layer with a different type of architecture were discussed in relation to previous results obtained by analytical electron microscopy and bonding strength measurements. 16 refs.
AUSTRIA; WESTERN EUROPE

Accession no.591297

Item 249
Rubber World
214, No.1, April 1996, p.41-6
RUBBER-TO-METAL BONDING AGENTS
Milczarek R; Zellner A
Oakite Products Inc.; Chemetall GmbH

This article, the second instalment of a two-part series, discusses solvent emissions and methods of reducing such emissions from standard bonding agents. Solvent emission is reduced to zero when using water-based bonding agents. These alternative systems, primer plus cover cement, are evaluated by looking at selected examples and test results are presented. NBR, as well as acrylate, epichlorohydrin and fluorinated rubber (FKM) compounds showed excellent results when combined with aqueous systems. This is demonstrated taking the example of FKM with three crosslinking systems which are typical for this elastomer.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.589675

Item 250
Rubber World
213, No.6, March 1996, p.59
RUBBER-TO-METAL ADHESIVES

It is briefly reported that Morton International has introduced Thixon P-6-7S and Thixon OSN-7S lead-free rubber-to-metal adhesives. Thixon P-6-7S can be used as a vulcanising metal primer for all Thixon cover coat adhesives. It bonds to various metals and also bonds rubber to fibres such as rayon, polyester and nylon. Thixon OSN-7S is a general purpose one-coat adhesive that bonds various elastomers to metals and also bonds NR, BR, IR, CSM, SBR, CR and ACM.

MORTON INTERNATIONAL INC.
USA

Accession no.587342

Item 251
Rubber World
213, No.6, March 1996, p.26-31
RUBBER-TO-METAL BONDING AGENTS
Milczarek R
Oakite Corp.

By means of rubber-to-metal bonding agents, these two materials can be combined to make durable composites suitable for use as structural components without additional fasteners. During vulcanisation of the elastomer, crosslinking also occurs in the adhesive film. This chemical reaction together with the corresponding intermediate reactions generates suitable reaction partners for the bonding process. The history of rubber-to-metal bonding technology is outlined. Normally, modern bonding systems are used as two-coat systems. Methods to characterise the activity or suitability of a bonding agent for a specific application are described. These include solubility following thermal pretreatment, differential scanning calorimetry and examination of the phase boundary using x-ray methods.
USA

Accession no.587338

Item 252
Rubber and Plastics News
25, No.17, 11th March 1996, p.14-7
COAGENTS FOR RUBBER-TO-METAL ADHESION
Costin R; Nagel W R
Sartomer Co.

Metallic coagent-peroxide systems were shown to provide the best properties of peroxide and sulphur cures, yielding high tensile and tear strength, good heat-aged properties with the benefit of good adhesion. The use of Saret metallic coagent systems, in particular, Saret 633, an anhydrous zinc diacrylate containing a non-nitroso scorch retarder and Saret 634, an anhydrous zinc dimethacrylate are demonstrated to improve performance properties for adhesive application. They eliminate the need for external adhesives and a separate curing step, developing bonds at the rubber-metal interface during the curing step, and producing crosslinks in the rubber during curing.
USA

Accession no.586794

Item 253
China Synthetic Rubber Industry
19, No.2, 1996, p.115-6
Chinese
ADHESIVE R-4 FOR BONDING OF RUBBER AND METAL
Liao Ming; Yang Zhongwen
Shanghai,Institute of Rubber Articles

The formulation and preparation of adhesive R-4 for bonding of rubber to metal are described. It is shown that R-4 provides good bonding of rubber compounds such as butyl rubber and EPDM to many metals and some plastics and fabrics.
CHINA

Accession no.586448

Item 254
IRC '95 Kobe International Rubber Conference. Conference proceedings.
Kobe, 23rd-27th Oct.1995, p.107-11. 012
RUBBER TO METAL BONDING
Van Ooij W J
Cincinnati,University
(Japan,Society of Rubber Industry)

The mechanism of bonding metals to rubber, with emphasis on brass-plated steel tyre cords, is reviewed. Some new developments for bonding NR to metals are presented and discussed. These are the use of a non-copper containing Zn/Ni/Co alloy proposed and demonstrated to out perform brass plated steel and thin films of plasma-polymerised acetylene used for bonding steel to rubber. 12 refs.
USA

Accession no.586132

Item 255
148th ACS Rubber Division Meeting. Fall 1995. Conference Preprints.
Cleveland, Oh., 17th-20th Oct.1995, Paper 119, pp.35. 012
NEW WATER-BORNE RUBBER-TO-METAL BONDING ADHESIVES
Plasczynski T; Mowrey D H
Lord Corp.
(ACS,Rubber Div.)

Chemlok 8282, an aqueous adhesive developed by Lord Corp., was used in combination with Chemlok aqueous primers for bonding a number of rubbers to metal surfaces. The effects on adhesion of pre-bake exposure, immersion in hot ethylene glycol and boiling water and salt fog exposure were investigated. The results showed that the performance of the aqueous adhesive rivalled that of solvent-borne systems.
USA

Accession no.583041

Item 256
148th ACS Rubber Division Meeting. Fall 1995. Conference Preprints.
Cleveland, Oh., 17th-20th Oct.1995, Paper 112, pp.22. 012
DEVELOPMENT OF A NEW ONE-COAT ENVIRONMENTALLY RESISTANT AQUEOUS RUBBER-TO-METAL ADHESIVE
Dorrington P
Morton International
(ACS,Rubber Div.)

Environmental factors which have led to the replacement of solvent-based adhesives with water-based systems are reviewed, and details are given of Thixon 2500, a one-coat aqueous adhesive developed by Morton International for use in rubber-to-metal bonding. The adhesion, prebake resistance and boiling water resistance of this adhesive are examined in comparison with two solvent-based adhesives, Thixon 2000 and Thixon OSN-2, and results are presented of studies of property changes on long-term ageing.

USA

Accession no.583035

Item 257

Journal of Adhesion

55, Nos.1-2, 1995, p.151-63

INFRARED SPECTROSCOPY OF INTERPHASES BETWEEN MODEL RUBBER COMPOUNDS AND PLASMA POLYMERISED ACETYLENE FILMS

Tsai Y M; Boerio F J; Kim D K

Cincinnati,University; Goodyear Tire & Rubber Co.

Results are presented of a study by reflection-absorption IR spectroscopy of the reactions occurring in the interphase between a plasma-polymerised acetylene primer and a model ‘natural rubber’ compound consisting of a mixture of squalene, zinc oxide, carbon black, sulphur, stearic acid, cobalt naphthenate, N,N-dicyclohexylbenzothiazole sulphenamide, and diaryl-p-diphenyleneamine. The results obtained, which are of importance for rubber-to-metal bonding, are shown to be consistent with the view that the accelerator breaks down to form a zinc perthiomercaptide which is the species responsible for crosslinking. 19 refs. (Adhesive & Sealant Council, Fall Convention, St.Louis, Missouri, USA, Oct.1993)

USA

Accession no.582554

Item 258

148th ACS Rubber Division Meeting. Fall 1995. Conference Preprints.

Cleveland, Oh., 17th-20th Oct.1995, Paper 66, pp.39. 012

OPTIMISATION OF AN ORGANOCOBALT CONTAINING WIRE COAT COMPOUND USING PRECIPITATED SILICA

Evans L R; Waddell W H

PPG Industries Inc.

(ACS,Rubber Div.)

Based on the proposed chemical mechanism of the enhancement of adhesion between brass coated steel tyre cords and NR by precipitated silica, statistically designed compounding experiments were undertaken to optimise the composite performance of an NR/polyisoprene wire coat compound containing silica and an organocobalt adhesion promoter. Compound cure and cured compound mechanical properties and adhesion were examined. Energy of adhesion values for original and heat, humidity and salt aged specimens were determined from tyre cord adhesion tests. Improvements in original and aged adhesive energy and rubber coverage values were obtained in the optimised system. An NR wire coat compound containing silica, organocobalt and a resorcinol-formaldehyde donor resin system was also studied. The results were compared with those for tyre manufacturers’ wire coat formulations using specialised ingredients to improve adhesion. 37 refs.

USA

Accession no.580249

Item 259

148th ACS Rubber Division Meeting. Fall 1995. Conference Preprints.

Cleveland, Oh., 17th-20th Oct.1995, Paper 65, pp.26. 012

MECHANISM BY WHICH PRECIPITATED SILICA IMPROVES BRASS COATED WIRE-TO-NATURAL RUBBER ADHESION

Waddell W H; Evans L R; Goralski E G; Snodgrass L J

PPG Industries Inc.

(ACS,Rubber Div.)

The effects of precipitated silica on adhesion between brass coated steel tyre cords and an NR/polyisoprene wire coat formulation were investigated by the quantitative determination of elements in the interfacial growth layer formed on cords treated in model systems consisting of squalene suspensions containing carbon black and curing ingredients, with and without silica and organocobalt. The surface characterisation techniques used included SEM with energy dispersive X-ray analysis, Auger electron spectroscopy, X-ray photoelectron spectroscopy and proton induced X-ray emission spectroscopy. The effects of using silica and cobalt neodecanoate in the suspensions were statistically analysed. The mechanism for adhesion improvement by silica was shown not to be a simple effect of improving the rubber physical properties. A chemical mechanism in which silica moderates the thickness and relative elemental composition of the interfacial growth layer was proposed. 44 refs.

USA

Accession no.580248

Item 260

148th ACS Rubber Division Meeting. Fall 1995. Conference Preprints.

Cleveland, Oh., 17th-20th Oct.1995, Paper 2, pp.24. 012

SELECTION AND TESTING OF ANTITACKS TO RETAIN COMPOUND PHYSICALS AND WIRE CORD ADHESION

O’Rourke S E

Hall C.P.,Co.

(ACS,Rubber Div.)

Results are presented of a study of the effects of four different antitack agents on the viscosity, curing characteristics, mechanical properties and wire cord adhesion of NR, EPDM and nitrile rubber compounds. 3 refs.

USA

Accession no.580191

Item 261
China Synthetic Rubber Industry
19, No.1, 1996, p.45-6
PREPARATION OF CHLOROSULHONATED POLYETHYLENE(CSM)-NR GRAFT POLYMER FOR ADHESIVE FOR METAL-TO-RUBBER BONDING IN VULCANISATION BY MECHANOCHEMICAL METHOD
Ma Xingfa; You Yusheng; Chongguang Wu; Wang Zhongping
Shandong,Non-Metallic Materials Institute

A graft copolymer of NR/CSM (mass ratio 10/90) for an adhesive for metal to NR bonding in vulcanisation was prepared by a mechanochemical method in an open mill. The 180 degree peeling strength was 23.6 to 24.6 kN/m when rubber sample was subjected to 100% failure. 6 refs.
JAPAN
Accession no.580075

Item 262
Rubber World
213, No.3, Dec.1995, p.56
ADHESION PROMOTER

It is briefly reported that Bonding Agent TZ from Uniroyal Chemical is a patented triazine-based adhesion promoter for use by the rubber industry. Bonding Agent TZ has been shown to provide superior adhesion to brass-coated steel wire used in tyres and excellent physical properties when combined with resorcinol and methylene donors. Additional applications being pursued include use with nylon or polyester fabric cord, and for steel reinforced conveyor belts and radiator hoses.
UNIROYAL CHEMICAL CO.INC.
USA
Accession no.579900

Item 263
European Rubber Journal
178, No.2, Feb.1996, p.22-3
DEVELOPMENTS IN CORD ADHESION
White L

Recently various suppliers have highlighted new materials for use in a niche area of rubber adhesion, promoting adhesion between rubber and steel tyre cords. The two major types of rubber adhesion promoter used with brass-coated steel tyre cord are RFS (resorcinol-formaldehyde-silica) systems or cobalt-based promoters. Cytek supplies Cyrez, a methylene donor in RFS systems, and has recently developed a new form of this material. Rhone Poulenc’s materials, Manobond, range from simple di-soaps of cobalt to more complex cobalt boro-acrylates. Environmental and handling problems associated with resorcinol are behind Hoechst’s introduction of a new form of resorcinol for use in cord/rubber adhesion promotion systems. Uniroyal Chemical recently announced commercialisation of a new, patented triazine based material, Bonding Agent TZ.
WORLD
Accession no.579791

Item 264
European Rubber Journal
178, No.2, Feb.1996, p.19-21
AQUEOUS SYSTEMS GROW STRONGER
White L

Water-based rubber-to-metal bonding systems are now in significant commercial use. The switch to water-based adhesives raises a number of issues. These include the need for costly requalification programmes, difficulty in persuading customers to change and new application equipment requirements. Lord’s new all-purpose aqueous covercoat, Chemlok 8282, is said to rival that of commercially available solvent-borne products. Morton’s latest offering is a general-purpose one-coat aqueous adhesive for rubber-to-metal bonding, Thixon 2500. At Aegis, one aspect of the EU CRAFT project is to improve laboratory bond tests. Most tests give failure within the rubber which provides no information about the bond.
WORLD
Accession no.579790

Item 265
Polymer Testing
15, No.1, 1996, p.13-34
STUDIES OF DYNAMIC ADHESION BETWEEN STEEL CORD AND RUBBER USING A NEW TESTING METHOD
Chandra A K; Mukhopadhyay R; Bhowmick A K
J.K.Industries Ltd.; Indian Institute of Technology

A new dynamic test for steel cord/rubber adhesion was developed. The Tyre Cord Adhesion Test (TCAT) specimen selected as the test piece is subjected to cyclic extension using a Monsanto Fatigue-to-Failure Tester. Cord pull-out tests were conducted before and after cyclic extension, or the number of cycles required to pull-out the cord from the TCAT specimen was utilised for evaluation of dynamic adhesion. The effect of various parameters, e.g. cord embedment length, number of extension cycles, degree of extension, aerobic ageing, thermal ageing, compound hardness, on adhesion was investigated using this dynamic adhesion testing technique. 20 refs.
INDIA
Accession no.575548

Item 266
Rubber World
213, No.1, Oct.1995, p.75
FLUOROPOLYMER ADHESIVE

It is briefly reported that Oakite Products has developed a water-based adhesive for bonding fluorocarbons to metal substrates for automotive seals and similar applications. Megum W3293 is a one-coat aqueous adhesive that will work with all different curing systems. It is said to provide the bond with an outstanding resistance to fuels, oil and other environmental influences.

OAKITE PRODUCTS
USA

Accession no.574501

Item 267
International Polymer Science and Technology
22, No.6, 1995, p.T/42-5
EFFECT OF ADHESION PROMOTERS ON THE FORMATION OF BONDED JOINTS IN RUBBERS
Potapov E E; Sakharova E V; Agatova I G; Salych G G; Gracheva N I
Moscow,Institute of Fine Chemical Technology

Rubber-cord systems, rubber-metal cord composites and rubber-adhesive systems are examined in detail. 6 refs. Translation of Kauchuk i Rezina, No.2, 1995, p.13. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

RUSSIA

Accession no.568096

Item 268
International Polymer Science and Technology
22, No.6, 1995, p.T/5-12
CLEANING AND PRETREATMENT OF METAL SURFACES AND RUBBER
Klein L; Lau H
Freudenberg Carl

Rubber-metal bondings are used for a wide variety of industrial applications. Thorough cleaning and pretreatment of the metal surfaces and the rubber is important to produce a strong rubber-to-metal bond. This article discusses several methods in some detail. Translation of Gummi Fasern Kunststoffe, No.5, 1995, p.298. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.568091

Item 269
Kautchuk und Gummi Kunststoffe
48, No.10, Oct.1995, p.729-34
German
WATER BASED RUBBER TO METAL BONDING AGENTS
Wefringhaus R; Gruber W
Henkel KGaA

A brief review is given of the use of a water-borne bonding agent for rubber-to-metal bonding. The necessary changes of parameters for surface pre-treatment and processing are described. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.567968

Item 270
Rubber World
212, No.6, Sept.1995, p.18/24
METALLIC COAGENTS FOR RUBBER-TO-METAL ADHESION
Costin R; Nagel W
Sartomer Co.

The manufacture of conventional metal-reinforced rubber products requires both an adhesive to bond the metal to the rubber and a separate curing system to increase the mechanical properties of the rubber. Elastomers that are peroxide-cured with metallic coagents yield stronger rubber-to-metal bonds without the use of external adhesives or a separate curing step, and demonstrate improved performance properties. During curing, metallic coagents develop adhesive bonds at the metal-rubber interface, while simultaneously producing strong crosslinks in the rubber. This article provides excerpts from a study conducted by Sartomer which demonstrate the superior adhesion and performance properties achieved by metallic coagents when used with a variety of rubbers. 2 refs.

USA

Accession no.567508

Item 271
Journal of Adhesion
53, No.3-4, 1995, p.183-99
MECHANICS OF RUBBER-TO-METAL BOND FAILURE
Ansarifar M A; Lake G J
Malaysian Rubber Producers' Research Assn.

In many applications rubber is bonded to metal for fixing purposes or in order to alter the stiffness, and the integrity of the bond is often vital for maintenance of the required stiffness characteristics and to ensure adequate life. The mechanics of bond failure were studied for various types of deformation. Provided that the tests were carried out under suitable loading conditions, time-dependent failure with a similar locus was observed in peeling at 90 or 180 degrees, pure shear and various combinations of simple shear and compression. There were indications that an energetics approach could enable results from different geometries to be quantitatively interrelated. Cavitation-like processes observed in the rubber in the bond region were thought to result from the constraint imposed by the metal and could be the cause of the time-dependent failure. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.566630

Item 272
Rubber World
212, No.4, July 1995, p.115
RUBBER-TO-METAL ADHESIVES

It is briefly reported that Oakite Products, a supplier of rubber-to-metal adhesives, has introduced two lead-free cover coats. Megum 121 is free of lead and chlorinated solvents. It can be used as a one-coat adhesive with a primer which will add superior resistance under environmental influences such as corrosion and humidity. It bonds NR, SBR, NBR, CR, etc. under vulcanisation conditions to metals or other substrates. Megum 530, said to a more reactive cover-coat, can be used to bond low hardness NR, SBR, IR, BR, EPDM, IIR, NBR, CR, etc.

OAKITE PRODUCTS
USA

Accession no.560784

Item 273
China Rubber Industry
42, No.7, 1995, p.413-6
Chinese
EFFECT OF COBALT AND NICKEL P-HYDROXY BENZOATES ON ADHESION BETWEEN NR AND BRASS
Liu Jun; Jiang Wanlan; Chen Bingquan; Bai Naibin
South China,University of Technology

Results of studies of the above showed that the addition of an appropriate amount of cobalt or nickel p-hydroxy benzoate to the NR compound increased the adhesion between NR and brass and doubled the static adhesion strength. The nickel p-hydroxybenzoate was more effective in giving the compound higher static and dynamic adhesion strength, as well as good moisture and thermal ageing resistances. 1 ref.

CHINA

Accession no.559094

Item 274
International Polymer Science and Technology
22, No.3, 1995, p.T/44-5
METHOD FOR BREAKING DOWN THE ADHESION BETWEEN RUBBER AND METAL
Matyukhin S A

An electrochemical method was developed for removing rubber from metal, based on breakdown of the interphase layer through the growth of zinc hydroxides in the high-sulphide zone of the main components of the brass. The advantages of the method are described. The electrochemical method, with the necessary equipment, can be used, in particular, to extract the bead rings from spent tyres. Bead rings are currently cut out and dumped as industrial waste, since they make it difficult to process the tyres. 5 refs. Translation of Kauch.i Rezina, No.5, 1994, p.28

RUSSIA

Accession no.558224

Item 275
International Polymer Science and Technology
22, No.2, 1995, p.T/15-22
BONDING OF RUBBER SURFACE-PROTECTING MATERIALS TO METALS
Busse G; Meyer K P

Topics discussed include criteria for rubber-metal bonding, selection of coupling agent and adhesive, composition of the adhesive, nature and quality of the preparation of the surfaces to be bonded, pretreatment of metal surfaces, pretreatment of rubber surfaces, production of the adhesive joint, strength behaviour, and design principles. 5 refs. (VDI Plastics Technology Association, 12th Annual Conference on Plastics Processing, Braunschweig, Germany, Feb.1994) (Full translation of Gummi Fas. Kunst., No.12, 1994, p.797)

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.557941

Item 276
Adhesives Age
38, No.7, June 1995, p.24/30
PRETREATMENT PROCESSES FOR RUBBER-TO-METAL BONDING
Eby M A; Decker M C
Morton Automotive Adhesives; Nova Max Technologies Inc.

A review is presented of techniques used to produce higher bond value in rubber-to-metal bonding applications, by the pretreatment of metal surfaces. Techniques for pretreatment include solvent washing, grit blasting and chemical treatments.

USA

Accession no.554378

Item 277
147th Meeting, Spring 1995, Conference Preprints. Philadelphia, Pa., 2nd-5th May 1995, Paper 3, pp.22. 012
USE OF SILICONE RUBBER ON DISCARDING SABOT PROJECTILES
Walker F J
Alliant Techsystems Inc.
(ACS,Rubber Div.)

The application of liquid, high consistency and pumpable silicone rubbers in gas seals for discarding sabot projectile assemblies is discussed. An examination is made of the properties required of such seals, processes used in their manufacture, and methods for bonding silicone rubber to steel, aluminium and plastics inserts used in this application. 7 refs.

USA

Accession no.552346

Item 278
International Journal of Polymeric Materials
29, Nos.1-2, 1995, p.97-118
POLY(1,1,2-TRICHLOROBUTADIENE-1,3) AND ITS COMPOSITIONS: II. ADHESIVES AND ADHESIVE COMPOSITIONS FOR RUBBER TO METAL BONDING
Vointseva I I; Klimentova N V; Niazashvili G A
Russian Academy of Sciences

The adhesive characteristics of polymers and copolymers of 1,1,2-trichlorobutadiene-1,3 are reviewed in detail. 66 refs.
RUSSIA
Accession no.551582

Item 279
Rubber and Plastics News
24, No.20, 24th April 1995, p.30
REAL-LIFE TEST RESULTS IN BRIDGESTONE CONTRACT
Whitford M

The real life testing of Bridgestone's rubber-to-metal seismic bearings on the Los Angeles County Emergency Operations Center during a recent earthquake has led to the company being awarded a 3.5 million US dollar contract to supply the 27 floor Los Angeles City Hall with 564 isolation bearings. Brief details are given of the use of the bearings.
BRIDGESTONE ENGINEERED PRODUCTS CO.
USA
Accession no.551169

Item 280
Patent Number: US 5364921 A 19941115
SILICONE RUBBER WITH SELF-ADHESION TO GLASS AND METAL
Gray T E; Kunselman M E; Palmer R A
Dow Corning Corp.

A composition curable to a silicone rubber exhibits adhesion to metal and glass substrates under both dry and wet conditions where the composition contains an alkenyl-containing polydiorganosiloxane, an organohydrogensiloxane, a hydrosilation catalyst containing platinum, an (epoxy-functional organo)trialkoxysilane, an alkoxy-silicon compound, and a titanium compound having Ti-O-CH bonds. The molar amount of alkoxy-silicon compound exceeds the molar amount of (epoxy-functional organo)trialkoxysilane.
USA
Accession no.551063

Item 281
Adhesives Age
38, No.4, April 1995, p.34/40
METALLIC COAGENTS INCREASE ADHESION OF RUBBER TO METAL
Costin R; Nagel W
Sartomer Co.

The advantages are discussed of the use of metallic coagents such as Saret 633 and Saret 634 in the manufacture of metal-reinforced rubber products. It is demonstrated that elastomers which are peroxide cured with metallic coagents demonstrate improved performance properties and yield stronger rubber-to-metal bonds without the use of external adhesives or a separate curing step. The metallic coagents function as adhesion promoters as well as crosslinking agents.
USA
Accession no.549906

Item 282
Patent Number: US 5354805 A 19941011
ADHESIVE COMPOSITION FOR BONDING NITRILE RUBBER TO METAL
Treat C J; Mowrey D H
Lord Corp.

An aqueous adhesive composition for bonding nitrile rubber is disclosed, containing a chlorosulphonated polyethylene latex, a polyhydroxy phenolic resin copolymer, and a high molecular weight aldehyde polymer. The adhesive composition exhibits an unusual affinity for nitrile rubber and excellent adhesive performance as a single-coat formulation, withstands high temperature bonding conditions and minimises the use of volatile organic solvents.
USA
Accession no.549234

Item 283
International Polymer Science and Technology
21, No.9, 1994, p.T/14-23
RUBBER/METAL COMPOSITES IN CONVEYOR BELTS
Tegtmeier P
Contitech Transportbandsysteme GmbH

The use of conveyor belts in large scale installations throughout the world is described, and the belts are classified. Adhesion with steel cord conveyor belts, and the connecting of conveyor belts, are examined in detail. 16 refs. Translation of Gummi Asbest Kunststoffe, No.5, 1994, p.309
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.541102

Item 284
Patent Number: US 5321070 A 19940614
ADHESION PROMOTERS FOR RUBBER AND SYNTHETIC MIXTURES
Meier K; Goerl U; Wolff S
Degussa AG

The invention relates to mixtures including resorcinol and silica which are used as adhesion promoters for improving the adhesion between textile or metal strength carriers and rubber or plastics. The mixtures exhibit a sharply limited sublimation behaviour with regard to the resorcinol.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.539534

Item 285

146th Meeting, Fall 1994, Conference Proceedings. Pittsburgh, Pa., 11th-14th Oct.1994, Paper 92, pp.31.
012

NEW WATER-BORNE RUBBER-TO-METAL BONDING ADHESIVES

Plasczynski T; Bond K M
Lord Corp.
(ACS,Rubber Div.)

An aqueous adhesive, Chemlok 8200 (Lord Corp.), was used in combination with various Chemlok primers for the bonding of NR, SBR, polychloroprene, nitrile rubber and butyl rubber to metal substrates. Adhesion was assessed after a 5 minute pre-bake at 137 or 171C and after exposure to aggressive environments. 2 refs.

USA

Accession no.535566

Item 286

146th Meeting, Fall 1994, Conference Proceedings. Pittsburgh, Pa., 11th-14th Oct.1994, Paper 62, pp.52.
012

NEW DEVELOPMENTS IN RUBBER-TO-METAL ADHESION TESTING

Rearick B A
Lord Corp.
(ACS,Rubber Div.)

A new test method for rubber-to-metal adhesion is described which uses a buffer-like test specimen consisting of a rubber section vulcanised between two metal parts which have a convex shape to the surface where adhesive has been applied. Adhesion testing shows that this method provides better discrimination between the performance of different adhesives than standard ASTM D429 test methods. Finite element analysis demonstrates that the buffer method induces a shear force near the outer edge of the part which causes the failure of the specimen. The interaction of the adhesive and the elastomer is seen in the presence of this shear force. Results are presented of tests on NR specimens bonded to metals with solvent-based and aqueous adhesives. 6 refs.

USA

Accession no.535536

Item 287

146th Meeting, Fall 1994, Conference Proceedings. Pittsburgh, Pa., 11th-14th Oct.1994, Paper 16, pp.23.
012

METALLIC COAGENTS FOR RUBBER-TO-METAL ADHESION

Costin R; Nagel W
Sartomer Co.
(ACS,Rubber Div.)

The influence of Sartomer's Saret 633 zinc diacrylate and Saret 634 zinc dimethacrylate co-curing agents on rubber-to-metal adhesion was investigated for a number of peroxide vulcanised elastomers. These additives were shown to function as both co-curing agents and adhesion promoters, enhancing both the adhesive and mechanical properties of the vulcanisates. 2 refs.

USA

Accession no.535495

Item 288

International Polymer Science and Technology

21, No.8, 1994, p.T/42-9

ADHESION OF NATURAL RUBBER TO METAL IN A CORROSIVE ENVIRONMENT

Yokoi H; Okumoto T; Takeuchi K; Imai H

An investigation was made of the adhesive delamination of NR-steel bonded laminates in a corrosive environment. The test specimens comprised steel-NR-steel laminates in which the interlayer was given a 10% extension to impart strain at the bonding surface prior to corrosion testing. The tests investigated delamination due to corrosion of the bonding surface between the rubber and the steel in hot water immersion, salt water immersion and salt water spray conditions, and the effect on corrosive delamination of differences in surface treatment (grit blasting and phosphating) of the steel substrate. The mechanism of delamination due to corrosion from the bond end-face in NR-steel laminates was investigated. 15 refs. Translation of Nippon Gomu Kyokaishi, No.3, 1994, p.198.

JAPAN

Accession no.535268

Item 289

Rubber and Plastics News

24, No.7, 24th Oct.1994, p.17-8

WETTING IN RUBBER-TO-METAL BONDING AGENTS

Moore M J
Morton International Inc.

Manufacturers of rubber-to-metal bonded goods are currently faced with the need to reduce or eliminate their use of adhesives containing volatile organic compounds. In addition, they are required to discontinue the traditional practice of vapour degreasing with ozone depleting chlorinated solvents. With the development of aqueous adhesives, the role of wetting is seen as critical, with

the performance of rubber-to-metal bonded components using such adhesives, dependent on the design of the adhesive, and the end-user's metal preparation and adhesive preparation. A review of the thermodynamics of wetting and measurement methods is presented, and a method is described which has been adapted from the printing industry, to determine the wetting of waterborne adhesives on metals.
USA
Accession no.534664

Item 290
Rubber World
210, No.6, Sept.1994, p.19-22
MECHANISM OF BRASS ADHESION
Hewitt N L
PPG Industries Inc.

This article describes a compounding approach to explore the mechanism by which precipitated silica enhances the adhesion of natural rubber to brass. Brass adhesion evaluation was generally conducted in the dynamic mode by the disc fatigue procedure. Replicate assemblies of rubber and wire coated with 63% copper brass were flexed in the cord compression fatigue test apparatus for six hours at 16% strain, compressed and extended. It was concluded that bond fatigue life of brass coated wire to rubber adhesion assemblies is greatly improved at reduced concentrations of zinc oxide. Further improvement occurs when carbon black is partially replaced by precipitated, fine particle silica. The mechanism of brass adhesion enhancement by silica involves a reduction of interfacial zinc oxide when soluble zinc is removed from the system by attachment to silica surface silanols. 5 refs.
USA
Accession no.532325

Item 291
Journal of Adhesion
47, No.1-3, 1994, p.51-64
INTERFACIAL CHEMISTRY OF AN ALUMINIUM-TO-EPDM BONDING SYSTEM
Hemminger C S
Aerospace Corp.

During recent examinations of ageing in aluminium-to-rubber bonds on stored solid rocket motors, corrosion and minor insulator debonds were observed. A test was conducted to study the progressive effect of exposure to high humidity of the bondline, elevated temp. being used to accelerate the ageing. In a parallel test, samples were held at elevated temp. in a dry atmosphere. The test results were compared with the analyses of corroded and non-corroded hardware samples. The predominant corrosion product detected at the bondlines was aluminium oxide/hydroxide. In general, there was a very good correlation between the Cl:Al atomic percent ratio calculated from X-ray photoelectron spectroscopy analysis of the ruptured bondline surfaces and the visual characterisation of the extent of corrosion. The Cl:Al ratio, which represented the ratio of primer to corrosion product at the locus of failure, varied from 0.4 to 47. The implications for metal-to-rubber bond fabrication and storage are discussed. 3 refs. (Adhesion Society Inc., 16th Annual Meeting, Williamsburg, Virginia, USA, Feb.1993)
USA
Accession no.532160

Item 292
Journal of Adhesion
46, Nos.1-4, 1994, p.15-38
MOLECULAR BONDING AND ADHESION AT POLYMER-METAL INTERPHASES
Lieng-Huang Lee
Xerox Corp.

This review demonstrates that there are well established molecular bonding and strong interactions between monomers or polymers and metals. Both theoretical and experimental work related to adsorption and adhesion at polymer-metal interphases are discussed. The fractal nature of polymer-metal interphases and the effect of chemisorption on fractal dimension are described. Several theoretical studies related to the models and the conformation of polymer segments to metal surfaces are mentioned. Experimental work is cited on XPS, surface-enhanced Raman scattering spectroscopy, Mossbauer emission spectroscopy, on chemisorption, molecular bonding, redox interaction, restructuring of polar groups, and contact oxidation of polymers on metal surfaces. Among them, SERS and XPS are capable of describing chemical composition and conformation right at the interfaces. 67 refs.
USA
Accession no.531568

Item 293
Rubber Products Manufacturing Technology.
New York, Marcel Dekker, 1994, p.449-72. 8
RUBBER-TO-METAL BONDING
Sexsmith F H
Lord Corp.
Edited by: Bhowmick A K; Hall M M; Benarey H A
(Indian Institute of Technology; Industrial Engineering Corp.)

The motor vehicle industry is by far the biggest user of bonded elastomer components. Typical applications such as engine mounts, suspension bushings, transmission and axle seals, couplings and body mounts are largely engineered to each vehicle's requirements. Manufacture usually involves moulding of the elastomer to shape, vulcanisation and bonding, all in a single stage operation. Aspects covered include rubber-to-metal assemblies, materials, manufacturing methods, adhesives and testing. 38 refs.
USA
Accession no.524806

Item 294
Natural Rubber: Current Developments in Product Manufacture and Applications. Conference Proceedings.
Kuala Lumpur, 14th-16th June 1993, p.347-57. 41C1
MECHANICAL AND SPECTROSCOPIC CHARACTERISATION OF RUBBER-METAL ASSEMBLIES
Prakash N S; Roche A; Charbonnier M; Romand M
Lyon,Universite Claude Bernard; Vibrachoc/GEC Alstrom
Edited by: Kadir A A S A
(Rubber Research Institute of Malaysia)

The practical adhesion of rubber-stainless steel assemblies is studied by the three-point flexure test and the opposing metal and polymer faces of the systems which are delaminated during this test are examined by X-ray photoelectron spectroscopy (XPS) and ion scattering spectrometry. It is shown that both these surface spectroscopies are ideally suited to characterising the failure zone in such assemblies. Differences in initial substrate surface treatment are shown to influence assembly performance and anodising is confirmed to be an effective means of improving on the latter. Poor assembly adhesion appears to be linked to the enrichment of carbonyl and carboxyl bonds as well as of silicone, in the fracture region. It is also found that fracture always occurs in a modified interphasial zone between substrate and polymer, and leaves a very thin residual polymer layer on the metal face of the assembly. Finally, it is determined that ageing of the assembly shifts the focus of failure towards the polymer. 14 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.524780

Item 295
Euradh ‘92. Conference Proceedings.
Karlsruhe, 21st-24th Sept.1992, p.602-5. 6A1
EFFECT OF MOLECULAR WEIGHT OF SOME ELASTOMERS ON THE RUBBER-TO-METAL ADHESIVE JOINTS SELECTION
Pritykin L M; Emelyanov Y V; Vakula V L
(Dechema Institut; Adhecom; Deutsche Verband fur Schweisstechnik)

The effect of the molec.wt. of chlorinated NR and polychloroprene on the rubber-to-metal adhesive joint strengths was investigated. The role of surface energies in these dependences was examined. This parameter was calculated by a refractometric method proposed earlier. All the relationships showed a linear character (in the case of small values of shelf time) and could be described in the analytical form with a correlation coefficient of 0.90-0.96. The corresponding coefficients for the proposed relation were calculated. This approach provided some guidance for prediction and control of the adhesion properties of Cl-substituted elastomers and plastics when used as adhesives. 6 refs.

CIS; COMMONWEALTH OF INDEPENDENT STATES; RUSSIA

Accession no.522525

Item 296
Euradh ‘92. Conference Proceedings.
Karlsruhe, Germany, 21th-24th Sept.1992, p.322-8. 6A1
AQUEOUS ADHESIVES FOR RUBBER AND METAL AS AN ALTERNATIVE TO SOLVENT-CONTAINING SYSTEMS
Wefringhaus R; Beiersdorf W D; Scheer H
Henkel KGAA
(Dechema Institut; Adhecom; Deutsche Verband fur Schweisstechnik)

The development by Henkel of waterborne rubber-to-metal bonding agents for manufacture of seals and gaskets based on polychloroprene, nitrile rubber, EPDM and NR is described. Results of technical tests on the products are discussed and their processing is considered.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.522345

Item 297
Rubber World
210, No.3, June 1994, p.58
BONDING SYSTEM

ProTech International has introduced Ultra-Bond RF cold bonding system cement which is said to be ideal for bonding rubber to rubber and rubber to metal. It is claimed to particularly suitable for applying rubber linings to steel and other substrates, and for splicing rubber to rubber or rubber to fabric, such as fabric ply belting. The product is also applicable for repairing rubber-lined vessels, rubber components and items made of PVC and urethane. It is designed to achieve an optimum cure in 30 days and gains sufficient bond strength to subject most applications to service within a short time, according to the company. This abstract includes all the information contained in the original article.

PROTECH INTERNATIONAL
USA

Accession no.522180

Item 298
Patent Number: WO 9407968 A1 19940414
ONE-COAT RUBBER-TO-METAL BONDING ADHESIVE
Mowrey D H
Lord Corp.

The adhesive composition, which exhibits strong rubber-to-metal bonds with excellent environmental resistance without the need for priming the metal surface, comprises a halogen-containing polyolefin, an aromatic nitroso compound, a polymaleimide and a metal oxide, such as zinc oxide or magnesium oxide. It may also contain a vulcanising agent, such as sulphur or selenium, a phenolic epoxy resin or carbon black.

USA

Accession no.519660

Item 299
International Polymer Science and Technology
21, No.2, 1994, p.T/42
NEW PROMOTER OF ADHESION TO METAL CORD, BASED ON POLYMERISED RESIN
Zakharova T V; Radbil' B A; Frolikova V G; Soinova E P

A new promoter of adhesion to metal cord and a process for making it have been developed; the promoter is a cobalt salt of of polymerised rosin.The effect of the degree of rosin polymerisation and of the mass fraction of metal on the adhesion promoter's properties were studied. The properties of the rubber mixes, rubber and rubber cord vulcanisates, obtained with the proposed adhesion promoter, are tabulated. Translation of Kauch.i Rezina, No.6, 1993, p.37
RUSSIA

Accession no.517142

Item 300
Nippon Gomu Kyokaishi
67, No.3, 1994, p.198-206
Japanese
ADHESION OF NATURAL RUBBER TO METAL IN A CORROSIVE ENVIRONMENT
Yokoi H; Okumoto T; Takeuchi K; Imai H
Toyoda Gosei Co.Ltd.

A rubber vibration insulator is composed of rubber and steel fittings, which are prepared by rubber to metal bonding during vulcanisation. To evaluate the performance of the adherends in a corrosive environment, the adherends were stretched by inserting a spacer in the gap between the steel plates before corrosion testing. The corrosion tests, such as a hot water dip test, salt solution dip test and salt spray test, were carried out and bonding degradation factors in the corrosive environment were studied in order to find differences in degradation between these tests. 15 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.
JAPAN

Accession no.515779

Item 301
145th Meeting, Spring 1994. Conference Proceedings. Chicago, Il., 19th-22nd April 1994, Paper 50, pp.19. 012
SURFACE ENERGY MEASUREMENTS AND THEIR APPLICATION TO RUBBER-TO-METAL BONDING
Moore M J
Morton International Inc.
(ACS,Rubber Div.)

The thermodynamics of wetting and surface tension are reviewed, and details are given of a method for determining the level of metal cleanliness applicable to rubber-to-metal bonding operations with water-borne adhesives. This technique uses a series of solutions of formamide, ethylene glycol, monomethyl ether and a blue dye of gradually increasing surface tension, which are applied to the metal until a solution is found which no longer wets the metal. The surface tension of the last solution to wet the metal is recorded as the surface energy of the sample. 7 refs.
DIVERSIFIED ENTERPRISES
USA

Accession no.511456

Item 302
145th Meeting, Spring 1994. Conference Proceedings. Chicago, Il., 19th-22nd April 1994, Paper 43, pp.14. 012
AQUEOUS ADHESIVES FOR THE DYNAMIC SEAL INDUSTRY
Moore M J
Morton International Inc.
(ACS,Rubber Div.)

Morton International's Thixon 7000 range of water-borne adhesives is evaluated for the bonding of nitrile rubber and acrylic elastomers to phosphated steel in the manufacture of dynamic seals. Curing characteristics, hot oil, hot water and corrosion resistance, ease of application and appearance are examined in comparison with Thixon 753 adhesive. 1 ref.
USA

Accession no.511449

Item 303
145th Meeting, Spring 1994. Conference Proceedings. Chicago, Il., 19th-22nd April 1994, Paper 38, pp.30. 012
MECHANISM OF BRASS ADHESION
Hewitt N L
PPG Industries Inc.
(ACS,Rubber Div.)

A compounding approach was used to investigate the mechanism by which precipitated silica enhances the adhesion of NR to brass coated wires in radial tyre belt compounds. The adhesion evaluations were generally conducted in a dynamic mode by means of the disc fatigue procedure, thus producing bare wire separations during flexing, the number of which was an indicator of tyre belt performance. Screening experiments of the relative effects of silica, accelerator and soluble zinc oxide revealed that low concentrations of zinc oxide produced the most fatigue resistant bonds. It thus appeared that the positive effect of silica on bond fatigue life related to its well known ability to react with soluble zinc and thus restrain the formation of bond degrading zinc sulphide at the brass-rubber interface. 5 refs.
USA

Accession no.511444

Item 304
International Polymer Science and Technology
20, No.12, 1993, p.T/98-102
ADHESIVE PROPERTIES OF STEEL AND ARAMID CORD IN VULCANISATE
Kovacevic M; Raffaelli D; Cop D

Bonding of NR and synthetic polyisoprene vulcanisates to steel cord and aramid cords (Kevlar and Twaron) was examined. The steel cord was brass plated and the aramid fibres were treated with both an epoxy resin and a resorcinol-formaldehyde latex. The strengths of adhesion, T-tests, were examined at room temp. and at 80, 120 and 160C. Ageing time was 6h. Bond strength reduced as ageing temperature increased. However, resting for 24 h restored the bond strength. 12 refs. (Transl. from Polimeri, No.1, 1992, p.13).

EASTERN EUROPE; YUGOSLAVIA

Accession no.510367

Item 305
IRC '93/144th Meeting, Fall 1993. Conference Proceedings.
Orlando, Fl., 26th-29th Oct.1993, Paper 157, pp.47. 012
NITROALCOHOL BASED ADHESION PROMOTER FOR BONDING STEEL AND FABRIC REINFORCEMENTS
Brutto P E; Wong W K; Mou Y H; Zhang J Y
Angus Chemical Co.; Polymer Technologies Inc.
(ACS,Rubber Div.)

The performance of 2-nitro-2-methyl-1-propanol (NMP) as an adhesion promoter was evaluated and compared with that of hexamethoxymethylmelamine (HMMM) and hexamethylene tetramine (HMT) in steel-reinforced tyre breaker belt and nylon-reinforced tyre carcass compounds. The vulcanised laminates were tested fresh and after various ageing treatments. Rubber-reinforcement adhesion was tested by measuring pull-out force, peel force and percent coverage. Cure response and static and dynamic mechanical properties were also determined. NMP was found to give improved adhesion of steel to rubber relative to HMMM and HMT, in the presence or absence of cobalt naphthenate. It also provided improved nylon-rubber adhesion when the fabric itself was aged to simulate unfavourable storage conditions. 3 refs.

USA

Accession no.505721

Item 306
IRC '93/144th Meeting, Fall 1993. Conference Proceedings.
Orlando, Fl., 26th-29th Oct.1993, Paper 122, pp.19. 012
CURE STUDIES OF RUBBER-TO-METAL BONDING AGENTS
Moore M J
Morton International Inc.
(ACS,Rubber Div.)

A moving-die rheometer was used to study the contribution of adhesive and primer cure to bond formation in rubber-to-metal bonding. The results provided information on the impact of crosslinking, interdiffusion and crossbridging in bond formation. 4 refs.

MONSANTO INSTRUMENTS
USA

Accession no.505693

Item 307
IRC '93/144th Meeting, Fall 1993. Conference Proceedings.
Orlando, Fl., 26th-29th Oct.1993, Paper 52, pp.55. 012
REVIEW OF BONDING AGENTS AS ADHESION PROMOTERS IN RUBBER TO METAL AND RUBBER TO TEXTILE APPLICATIONS
Seibert R F
Uniroyal Chemical Co.Inc.
(ACS,Rubber Div.)

The role of bonding agents in promoting adhesion between rubber and metal and textile reinforcements is discussed. For rubber-to-metal adhesion, cobalt salt, tetrachlorobenzoquinone and resin systems are reviewed, together with the mechanisms involved in the resulting enhanced adhesion. The effects of compounding ingredients on adhesion are also examined. For rubber-to-textile adhesion, the various fabrics used and the treatments necessary to obtain adhesion are reviewed, with particular reference to rayon, polyamide and polyester adhesion. 30 refs.

USA

Accession no.505643

Item 308
Rubber Chemistry and Technology
66, No.5, Nov/Dec.1993, p.837-48
INFLUENCE OF DIFFERENT BRASS PRETREATMENTS ON RUBBER-METAL BONDING: INVESTIGATED BY ANALYTICAL ELECTRON MICROSCOPY
Kretzschmar T; Hummel K; Hofer F
Graz,Technische Universitat

Brass samples (thin foils or plates) were pretreated either by etching with aqueous hydrochloric acid or by rubbing with emery cloth. A mixture of cis-1,4-polybutadiene with sulphur and N,N-dicyclohexyl-2-benzothiazylsulphenamide was vulcanised in contact with the brass surfaces. The bonding layers were investigated by analytical electron microscopy(AEM). Two preparation techniques for AEM were used, i.e. cryo-ultramicrotomy to obtain cross-sections (applied to foils) or separation of ultrathin surface layers with an aqueous hydrochloric acid/ferric chloride solution (applied to plates). Across the bonding layers, various crystallographic structures and chemical compositions were found, depending on the pretreatment of the brass. 16 refs.

AUSTRIA; WESTERN EUROPE

Accession no.503638

Item 309
Adhesion '93. Conference Proceedings.
York, 6th-8th Sept.1993, p.153-8. 9(12)4
FAILURE OF RUBBER TO METAL BONDED UNITS
Ansarifar M A; Lake G J
Malaysian Rubber Producers' Research Assn.
(Institute of Materials)

In many applications rubber is bonded to metal for fixing or other purposes. Integrity of the bond may be vital to maintain the required stiffness characteristics and ensure adequate life. The mechanics of bond failure was studied and it appears that similar behaviour may occur in compression, shear or peeling. Cavitation-like failure observed in the rubber in the bond region may be associated with the constraint imposed by the metal on the deformation of the rubber. 8 refs.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE

Accession no.499041

Item 310
International Polymer Science and Technology
20, No.9, 1993, p.T/13-21
FACTORS AFFECTING BOND STRENGTH OF RUBBER TO METAL PARTS
Setiawan L; Schonherr D; Weihe J

Some of the factors that influence the manufacture of rubber to metal parts, as seen from a rubber processor's point of view, are discussed. 15 refs. Translation from Gummi Fasern Kunst., No.7, 1993, p.357. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

Accession no.498654

Item 311
Kautchuk und Gummi Kunststoffe
46, No.9, Sept.1993, p.710-7
RUBBER-METAL BONDING: INVESTIGATION OF RUPTURE BEHAVIOUR OF THE BONDING LAYER BY MEANS OF TRANSMISSION ELECTRON MICROSCOPY AND BONDING STRENGTH MEASUREMENTS
Kretzschmar T; Hofer F; Hummel K; Sommer F
Graz,Universitat; Semperit Technische Produkte GmbH

Rupture behaviour of the rubber-brass bonding layer was investigated by TEM and bond strength measurements by shearing. Rubber-brass composites were prepared by either embedding thin brass foils in, or by connecting two brass plates with different cure systems (sandwich). The foil samples were cut by cryo-ultramicrotomy for TEM investigations and the sandwich samples were inserted in the stress equipment of a Zwick universal testing machine and sheared. The strength values measured and the rubber coverage of the brass plate surface observed after shearing were compared with the appearance of the bonding layer in the foil samples made visible in TEM. Correlations between the results of both investigation methods are discussed. 39 refs.

AUSTRIA; WESTERN EUROPE

Accession no.494058

Item 312
Automotive Engineering
101, No.8, Aug.1993, p.45-7
WATERBORNE RUBBER-TO-METAL ADHESIVES
Bond K M; Mowrey D H
Lord Corp.

Following the passage of the US Clean Air Act Amendments, requiring that emissions of volatile organic compounds be reduced, choices have been limited for rubber-to-metal adhesive users in the vehicle industry, and also for formulators. This article reports in detail on the performance of a new aqueous one-coat adhesive and primer, which is proving superior to that of solvent-based adhesive products. Experiments are described for testing levels of adhesion and environmental resistance, and results are given.

USA

Accession no.491840

Item 313
Kautchuk und Gummi Kunststoffe
45, No.12, Dec.1992, p.1038-43
RUBBER-METAL-BONDING. DIRECT OBSERVATION OF THE INTERFACE LAYERS BY MEANS OF ANALYTICAL ELECTRON MICROSCOPY (AEM)
Kretzschmar T; Hofer F; Hummel K
Graz,Technische Universitat

The bonding layers of rubber-brass systems were observed directly by transmission electron microscopy coupled with energy dispersive X-ray spectroscopy. The techniques used are described. In each case, a rubber-metal bonding layer, divided into one or more sublayers and showing good fusion with the rubber, was observed. The thickness of the bonding layer system correlated well with the sulphur content in the cure system. With increasing sulphur content, a thicker layer with more sublayers was obtained. It became more brittle with increasing thickness. Thus, vulcanisation led to a tear off of rubber directly from the brass surface at some spots, after which the molten rubber filled the developing cavities. The sublayers consisted mainly of copper sulphide which had grown into the rubber compound. A very thin zinc oxide layer adjacent to the brass surface was found. Copper sulphides were responsible for the formation of the rubber-metal bonding. 49 refs.

AUSTRIA; WESTERN EUROPE

Accession no.487379

Item 314
143rd Meeting, Spring 1993. Conference Proceedings.
Denver, Co., 18th-21st May 1993, Paper 62, pp.24. 012
NEW AQUEOUS ADHESIVES FOR BONDING ACRYLONITRILE-BUTADIENE RUBBER TO METAL
Treat C J
Lord Corp.
(ACS,Rubber Div.)

Applications of two water-based adhesives developed by Lord Corp., Chemlok 8102 and 8110, in the bonding of nitrile rubber to steel are described. Results are presented which show that the performance of these adhesives is comparable and sometimes better in primary adhesion, boiling water and hot oil testing when compared to their solvent-based counterparts, TyPly BN and Chemlok 205. They can be sprayed or dipped to give coatings 0.3-0.5 mil in thickness, or diluted to very low solids for an extremely thin and practically invisible coating less than 0.05 mil in thickness. 1 ref.
USA
Accession no.480209

Item 315
143rd Meeting, Spring 1993. Conference Proceedings.
Denver, Co., 18th-21st May 1993, Paper 23, pp.21. 012
NOVEL ADHESION PROMOTERS BASED ON VINYL TERMINATED CARBAMYLMETHYLATED MELAMINES
Singh B; Sedlak J A
American Cyanamid Co.
(ACS,Rubber Div.)

Details are given of a new resorcinol-free experimental adhesion promoter, RAP-393, for the bonding of vulcanised rubber to brass plated steel cords in tyres. The material is part of a broader series of vinyl terminated carbamylmethylated melamine resins which are capable of crosslinking through vinyl polymerisation, mercapto addition and conventional condensation mechanisms. RAP-393 may be used in conjunction with Cyrez 963 hexamethoxymethylmelamine (HMMM) adhesion promoter. Oscillating disc rheometer, stress-strain and 21-day adhesion results on NR compounds are presented to show equivalence to the commercial HMMM/resorcinol adhesion promoter system. 6 refs.
USA
Accession no.480178

Item 316
Kautchuk und Gummi Kunststoffe
46, No.3, March 1993, p.233-5
German
STRUCTURE OF BRASS PLATED STEEL CORD WIRES AND ITS INFLUENCE ON RUBBER-METAL ADHESION
Krone R
Wolf G.,Seil- & Drahtwerke GmbH & Co.

Brass layers of different structure were galvanised onto the wires of steel cords to optimise rubber to metal adhesion. The structures of the brass layers were analysed and the properties of steel cord-rubber composites were examined under different test conditions. 7 refs.
EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE
Accession no.477960

Item 317
Kautchuk und Gummi Kunststoffe
46, No.2, Feb.1993, p.139-45
German
BONDING SYSTEMS FOR TEXTILE AND STEEL WIRE BONDING, TODAY AND TOMORROW
Magg H
Bayer AG

Bonding systems and mechanisms for the bonding of rubber to textiles and steel cords are discussed. Textile bonding systems examined include resorcinol-formaldehyde (RF) latices, RF/silica systems and isocyanates. The proposed mechanism for RF systems involves a reaction product of resorcinol and formaldehyde acting as a link between rubber and textile fibres to form covalent bonds by means of addition and condensation processes. The bonding mechanism of bonding agents for brass or zinc plated steel cords (sulphur, RF/silica systems and lead or cobalt adhesion promoters) is explained by the formation of non-stoichiometric phases characterised by an excess amount of sulphur. 12 refs.
EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE
Accession no.477948

Item 318
Kautchuk und Gummi Kunststoffe
46, No.2, Feb.1993, p.112-5
INFLUENCE OF BORIC ACID ESTER ON THE STRUCTURE AND COMPOSITION OF THE RUBBER/BRASS INTERFACE OF COBALT-CONTAINING BONDING COMPOUNDS
Pieroth M; Holtkamp D; Elschner A
Bayer AG

A study was made of the role of KA 9128 boric acid ester in improving the post-ageing adhesion of cobalt-containing bonding compounds to brass plated steel cords. Transmission electron microscopy and secondary ion mass spectrometry were used to investigate the influence of steam ageing on the structure and composition of the brass/rubber interface using high sulphur NR bonding compounds without additives, with cobalt naphthenate (CN) and with CN plus boric acid ester. The effect before ageing was not pronounced, but a considerable difference between the compounds was observed after steam ageing. The boric ester acted with cobalt salts as a corrosion inhibitor, preventing the growth of a thick intermediate layer. 5 refs.
EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE
Accession no.477944

Item 319
China Rubber Industry
40, No.3, 1993, p.141/63
Chinese
STUDY ON FORMULATION OF BONDING MATERIAL FOR RETREADING STEEL RADIAL TYRES
Huang P
Beijing,Research & Design Institute of Rubber Industry

Details are given of a rubber formulation for bonding steel cords in radial tyres. The composition consists of NR, BR, cobalt salt, silica, auxiliary bonding agent, thiazole accelerator and insoluble sulphur. 4 refs.
CHINA

Accession no.476485

Item 320
Kautchuk und Gummi Kunststoffe
44,No.7,July 1991,p.674-8
German
WATERBORNE RUBBER-METAL BONDING AGENTS AS ALTERNATIVE TO SOLVENT-BASED SYSTEMS
Beiersdorf D; Scheer H
Henkel KGaA

Waterborne rubber-metal bonding agents which have equivalent processing, adhesion and corrosion and chemical resistance properties to solvent-based bonding agents are studied. Tests for the performance of these water-based rubber-metal bonding agents are described and the results are discussed. 4 refs.
EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

Accession no.472452

Item 321
International Polymer Science and Technology
19,No.11,1993,p.T/89-97
DIRECT ADHESION BETWEEN RUBBER AND METAL PLATING
Ishikawa Y

Adhesion between steel cord and rubber is an important factor determining product performance in tyres, conveyor belts, hoses and other rubber products using steel cord as a rubber reinforcement. In particular steel radial tyres have focussed attention on adhesion between rubber and brass plating on the steel cord surface as a fundamental technology guaranteeing tyre endurance. This article examines the trends in research and its significance, referring mainly to the adhesion of rubber to brass plating on steel cord. Adhesion between rubber and zinc plating is also touched upon. 44 refs.Translation of Nippon Gomu Kyokaishi,No.2,1992,p.86
JAPAN

Accession no.472398

Item 322
Rubbercon 92 - A Vision for Europe.Conference Proceedings.
Brighton,15th-19th June 1992,p.419-26. 012
TRENDS IN ADHESIVES FOR BONDING RUBBER-TO-METAL
Polaski E L
Lord Corp.
(PRI)

Speciality elastomers have been developed to meet the ever-increasing stringent environmental resistance of today’s rubber-to-metal bonded components. These new polymers have prompted the adhesive manufacturers to develop complementary adhesives that must not only provide primary adhesion, but also must survive the same environments as the rubber. Today’s modern adhesives can do this but proper selection and application of the correct adhesive remains dependent upon such things as the polymer type, the cure system, the moulding process, and the vulcanisation process, as well as the operating environment. Emerging technologies include adhesives for thermoplastic elastomers and more environmentally friendly products.
USA

Accession no.471658

Item 323
Adhasion Kleben und Dichten
No.10,1992,p.22/7
German
ADHESIVE SUBSTANCES AND THEIR APPLICATION
Endlich W
Ing.& Beratungsbuero fuer Kleb- & Dichttechnik

A comprehensive review of the subject covers surface treatment, types of application, tackiness, solvent and aqueous adhesives, contact adhesives, gelling adhesives, hot melt adhesives, moisture-curing adhesives, anaerobic adhesives, radiation-curing adhesives, heat-hardening adhesives and two-component adhesives.
EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

Accession no.466392

Item 324
Chemical Engineering
99,No.9,Sept.1992,p.167/70
SELECT THE RIGHT GASKET
Kulesus G; Samdani G
Tranter Inc.

This article examines in some detail the selection of elastomeric gaskets for plate heat exchangers. Information is presented on the performance of several elastomers used for this application under varying temperature limits and in several fluid environments. Materials studied include NBR, EPDM, butyl rubber, Viton fluoroelastomers, Neoprene, and Hypalon

chlorosulphonated PE. Selection of gasketing techniques - glued, glueless or spot-glued - is also discussed. 3 refs.
USA
Accession no.465924

Item 325
Rubber World
207,No.2,Nov.1992,p.18
CHLOROPYRIMIDINES AND CHLOROTRIAZINES AS RUBBER-TO-METAL ADHESION PROMOTERS
Seibert R F; Wheeler E L; Barrows F H; True W R
Uniroyal Chemical Co.

US patent 5,126,385 has been assigned to Uniroyal Chemical Co. concerning a reinforced elastomeric composition produced by curing a blend comprising vulcanisable rubber, brass coated metal reinforcement, sulphur or sulphur donor and a compound containing chloropyrimidines and chlorotriazines as rubber-to-metal adhesion promoters.
USA
Accession no.465249

Item 326
Rubber and Plastics News
21,No.27,6th July 1991,p.15-8
ADHESION IMPORTANCE IN REINFORCED PRODUCTS
Gozdiff M
Goodyear Tire & Rubber Co.

The basics of direct rubber bonding to brass plated and zinc coated steel reinforcement are examined, and selected reactions and conditions that contribute towards destroying those bonds, once formed, are discussed. Discussion is restricted to moisture, acidic gases and water soluble salts that occur as vulcanisation byproducts are brought in by compounding ingredients. 11 refs.
USA
Accession no.463858

Item 327
London, 1992, pp.ii,5. 12ins. 19/6/92. 95171T
BS 903:PART A14:1992. PHYSICAL TESTING OF RUBBER. PART A14. METHOD FOR DETERMINATION OF MODULUS IN SHEAR OR ADHESION TO RIGID PLATES - QUADRUPLE SHEAR METHOD
British Standards Inst.
BS 903:Part A14:1992

This part of BS 903 describes methods to determine the modulus in shear or the strength of bonds of rubber to metal or other rigid plates, using rubber bonded between four parallel plates. This edition supersedes BS 903: Part A14:1970 which has been withdrawn. It makes provision for the testing of thermoplastic rubbers and for mechanical conditioning, when required and includes two test methods. Photocopies and loans of this document are not available from Rapra. It may be purchased from BSI. Contact Rapra for further details.
EUROPEAN COMMUNITY; UK; WESTERN EUROPE
Accession no.463026

Item 328
Kautchuk und Gummi Kunststoffe
44,No.6,June 1991,p.560-5
German
EFFECT OF VARIOUS SURFACE TREATMENTS ON THE BONDING PROPERTIES OF EPDM VULCANISATES
Dorn L;Wahono W
BERLIN,TECHNICAL UNIVERSITY

A study was made of the effectiveness of various treatments, i.e. etching, low pressure plasma, thermocorona as well as use of methylcyanoacrylate adhesion promoters, for improving the adhesion of EPDM to steel surfaces using epoxies, PU and methylcyanoacrylates as bonding agents. Results obtained with the different pretreatments and bonding agents are discussed and evaluated. 21 refs.
GERMANY
Accession no.457617

Item 329
141st Meeting,Spring 1992,Conference Proceedings. Louisville,Ky.,19th-22nd May 1992,Paper 67,pp.24. 012
NEW DEVELOPMENTS IN WATERBORNE ADHESIVE TECHNOLOGY
Bond K M;Mowrey D H
LORD CORP.,ELASTOMER PRODUCTS DIV.
(ACS,Rubber Div.)

The use of Chemlok 855, a water-borne one-coat adhesive developed by Lord Corp., in rubber-to-metal vulcanisation bonding is examined. Test results are presented which show that this adhesive is equal in performance to commercially available solvent-based one-coat systems, giving excellent primary adhesion to a wide variety of elastomers. 3 refs.
USA
Accession no.453340

Item 330
Adhasion
36,No.4,April 1992,p.28-34
German
CURRENT ASPECTS OF ADHESION TECHNOLOGY: ADHESIVES IN MANUFACTURING PROCESSES
Hennemann O-D;Gross A
FRAUNHOFER-INSTITUT FUER ANG. MATERIALFORSCHUNG

The paper is divided into five sections: adhesion of sheet steel, bonding of machine components, adhesion to glass

in precision manufacture, adhesion to stainless steel, and a flexible integrated system for the adhesion of structural parts. Improvements desirable in adhesive technology are: the ability to calculate the strength of a joint, estimation of the stability of an adhesive, and further efforts at intergrating it into the manufacturing process. 1 ref.
GERMANY

Accession no.451487

Item 331
Adhesives Age
35,No.6,31st May 1992,p.17
POLYCHLOROPRENE-BASED SYSTEM
Mowrey D H;Pontare N M
LORD CORP.

US patent 5,093,203 has been assigned to Lord Corp. concerning an adhesively bonded rubber-metal assembly prepared by applying a primer component and an overcoat component between a metal surface and a rubber substrate. The primer component comprises a polychloroprene compound, a phenolic resin and a metal oxide.
USA

Accession no.451486

Item 332
Journal of Adhesion
37,No.1-3,1992,p.63-72
SURFACE PREPARATION OF TANTALUM FOR ENCAPSULATION AND ADHESIVE BONDING
Allen K W;Tiow Lin Tan
CITY UNIVERSITY,LONDON

A number of methods of surface preparation of tantalum for encapsulation in silicone rubber and for structural adhesive bonding were explored. The only ones which could be generally useful were boiling for 24h in distilled water (28% improvement) or boiling for 4h in sodium hydroxide solution followed by boiling for 2h in dilute hydrochloric acid (34% improvement). An alternative, which could sometimes be used, was heating in air for at least 2h at 100C.
EUROPEAN COMMUNITY; UK; WESTERN EUROPE

Accession no.447488

Item 333
Polymer Plastics Technology and Engineering
31,Nos.1-2,Jan/Feb.1992,p.135-56
INVESTIGATION OF RUBBER-TO-METAL BONDING ON SOLID RUBBER TYRES
Ercin M;Berber R
ANKARA,UNIVERSITY

The results are reported of a study carried out to determine the factors contributing to the ability to produce strong and permanent rubber-to-metal bonds in solid tyres made from a blend of NR and cis-polybutadiene. The effect of surface cleaning on adhesion was examined and the optimum cure time determined using a Monsanto Rheometer. Percent elongation, bond strength and tensile strength measurements were carried out on samples cured at 140, 150, 160 and 170C. The use of a cushion gum (NR/SBR blend) to achieve a good rubber-to-metal bond was also evaluated as was the influence of compression on rubber-to-metal bonding during curing. 19 refs.
TURKEY

Accession no.442346

Item 334
139th Meeting,Spring 1991.Conference Proceedings. Toronto,Ont.,21st-24th May 1991,Paper 91. 012
OPTIMISATION OF A NATURAL RUBBER BREAKER COMPOUND CONTAINING SPECIFIC CHLOROTRIAZINES AS WIRE TO RUBBER ADHESION PROMOTERS
Seibert R F
UNIROYAL CHEMICAL CO.INC.
(ACS,Rubber Div.)

Two experimental adhesion promoters are discussed, i.e. 2-chloro-4, 6-bis(N-phenyl-p-phenylenediamino)-1,3,5-triazine and 2, 4-dichloro-6-(N-phenyl-p-phenylenediamino)-1,3,5-triazine. Further work on optimisation of compounds containing these additives is presented on the adhesion of brass coated steel to NR breaker compounds in the aged and unaged state. Physical and dynamic properties are shown. An optimised compound for zinc coated galvanised steel cable to NR and NR/BR compounds is formulated for conveyor belt applications. 2 refs.
USA

Accession no.441950

Item 335
Rubber World
205,No.3,Dec.1991,p.30-3
DYNAMIC ASPECTS OF BRASS ADHESION
Hewsitt N L
PPG INDUSTRIES INC.

Using disc fatigue for the dynamic evaluation of brass adhesion is reported to provide an opportunity to measure the fatigue life of rubber-to-metal bonds unencumbered by cohesive failure. As a result of disc fatigue studies two brass skim compounds are recommended. 5 refs.
USA

Accession no.441604

Item 336
Journal of Adhesion Science and Technology
5,No.10,1991,p.927-44
CONTROLLING FACTORS IN CHEMICAL COUPLING OF POLYMERS TO METALS
Bell J P;Schmidt R G;Malofsky A;Mancini D
CONNECTICUT,UNIVERSITY; DOW CORNING CORP.

An overview is presented on the effects of variables on the mechanical behaviour and durability of the polymer-metal interfacial region when a polymeric coupling agent is used to enhance bonding. Variables include locus of failure, effect of coupling agent thickness, effect of surface wetting, surface preparation, coupling agent functionality, durability in water, and corrosion versus adhesion failure mechanisms. 19 refs.
USA

Accession no.437474

Item 337
Kautchuk und Gummi Kunststoffe
44,No.1,Jan.1991,p.69-73
German
BONDING AGENT PRODUCER AS A PARTNER OF THE RUBBER INDUSTRY
Heine E
CHEMETALL GMBH

Developments in materials for bonding of rubbers to metals are discussed with special reference to the activities of Chemetall GmbH in this field. Information is given on bonding agent formulation, analysis of bonding defects and activities in reducing solvent emission. Particular attention is paid to the use of rubber/metal bonding agents in car manufacture.
GERMANY

Accession no.437473

Item 338
138th Meeting Fall 1990.Preprints.
Washington,DC,9th-12th Oct.1990,Paper 30. 012
COMBINING COBALT AND RESORCINOLIC BONDING AGENTS IN BRASS-RUBBER ADHESION
Hamed G R;Huang J
AKRON,UNIVERSITY
(ACS,Rubber Div.)

The bonding of NR compositions to brass plated steel cord in steel belted radial tyres is investigated. The merits of both cobalt naphthenate and HR additives to promote bonding and to enhance durability are studied. Secant modulus, tear resistance, squalene model experiments, atomic absorption, energy-dispersive X-ray analysis, and FTIR-ATR, was conducted. Ageing experiments were also carried out.
USA

Accession no.436395

Item 339
138th Meeting Fall 1990.Preprints.
Washington,DC,9th-12th Oct.1990,Paper 31. 012
ADHESIVES FOR BONDING CATHODICALLY PROTECTED RUBBER TO METAL DEVICES
Warren P A;Mowrey D H;Gervase N J
LORD CORP.
(ACS,Rubber Div.)

The resistance of various Chemlok adhesives to cathodic disbonding was evaluated. Salt spray tests were conducted to determine if a relationship existed between the failure mechanisms involved. Several adhesives which previously were found to possess little cathodic disbonding resistance were also tested. 9 refs. (Appears in German in Kaut. u.Gummi Kunst.,44,No.5,May 1991,p.456-8.)
USA

Accession no.436380

Item 340
Plaste und Kautschuk
38,No.3,March 1991,p.91-5
German
ALGORITHM FOR THE DETERMINATION OF ADHESIVE JOINT STRENGTH OF POLYMER/ NON-POLYMER SYSTEMS
Pritykin L M;Zilberman A B;Zilberman I I;Vakula V L
DNEPROPETROVSK CHEMICOTECHNOLOGICAL INSTITUTE

A concept for calculating the adhesive joint strength of polymer/non-polymer systems, especially metals, is described in detail. 29 refs.
EASTERN EUROPE; USSR

Accession no.434977

Item 341
Stuttgart, c.1991, pp.4. 8x6ins. 24/9/91. 42D14-6A1
FAMOUS ADHESIVES
CHEMISCHE FABRIK ASPERG KG

Descriptions are given of three well-known adhesives from Asperg. They are Adhesive SK700, Adhesive R9 and Adhesive AK60. The first is a neoprene-based contact adhesive for bonding leather to leather, rubber foam, cork, felt and fabrics. The second is also neoprene-based, but is used for bonding plastic laminates, and veneering. Adhesive AK60, also neoprene-based, is designed for bonding metal to rubber, foam, felt, leather, wood, glass, cork and stone, and has been developed for bodywork applications in the automotive industry. Brief performance properties are described for each.
GERMANY

Accession no.434709

Item 342
Rubber World
204,No.5,Aug.1991,p.74
COMPOSITE BONDING

K & K Technologies has recently introduced an advanced process for rubber/plastic composite bonded parts. The process uses a thermoplastic material, Vestoran, engineered to obtain one step rubber to plastic bonding without the use of adhesives, clamps, adhesion promoters and secondary connectors. Structural integrity is said to be maintained and a durable lasting bond ensured. Vestoran can take the place of metal in conventional rubber to metal bonded parts.

K & K TECHNOLOGIES INC.
USA

Accession no.433769

Item 343
137th Meeting Spring 1990.Conference Preprints.
Las Vegas,Nv.,29th May-1st June 1990,Paper 77. 012
SELECTED CHLOROPYRIMIDINES AND CHLOROTRIAZINES AS WIRE ADHESION PROMOTERS
Seibert R F
UNIROYAL CHEMICAL CO.INC.
(ACS,Rubber Div.)

The adhesion characteristics of several adhesion promoters are demonstrated and compared to existing systems. The adhesion promoters are chloropyrimidines and chlorotriazines. Their effectiveness is shown in both unaged conditions and several different ageing environments. Formulations are based on 80:20 NR and polybutadiene and 100% NR. 3 refs.

USA

Accession no.430739

Item 344
Adhesion.Principles and Practice for Coatings and Polymer Scientists.Conference Proceedings.
Kent,Oh.,20th-24th May 1991,Paper 10. 9(12)4
COUPLING AGENTS AS ADHESION PROMOTERS IN ADHESIVE BONDING
Boerio F J;Dillingham R G;Ondrus D J
CINCINNATI,UNIVERSITY
Edited by: Krauss C J
(Kent State University)

The characteristics of silane primer films applied to metals and the use of silane primers to enhance the hydrothermal stability of adhesive bonds to metal are presented. Emphasis is given to iron/epoxy adhesive joints, titanium/epoxy adhesive joints, aluminium/epoxy adhesive bonds, rubber to metal bonding, adhesion of PE to sapphire. 38 refs.

USA

Accession no.430273

Item 345
Nippon Gomu Kyokaishi
64,No.6,1991,p.372-7
Japanese
ADHESION OF RUBBER TO METAL AND ITS ALLOY. II. CURE-ADHESION OF RUBBERS TO ELECTROLESS PD-P ALLOY DEPOSIT. EFFECT OF SULPHUR AND WATER RESISTANCE
Ikeda Y;Nawafune H;Mizumoto S;Yamaguchi K;Kadota K;Haga M
ISHIHARA CHEMICAL CO.LTD.;
KONAN,UNIVERSITY

The effect of sulphur dosage on peel strengths before and after ageing in hot water was investigated for SBR and NR adhesion-cured onto an electroless Pd-P alloy deposit. 6 refs.

JAPAN

Accession no.429870

Item 346
Rubber World
204,No.4,July 1991,p.13
RUBBER-TO-METAL BINDERS FROM CHLORINATED RUBBER AND BROMINATED POLYDICHLOROBUTADIENE
Scheer H
HENKEL AG

US patent 4,994,519 has been assigned to Henkel concerning a heat-stable binder for use in the vulcanisation of natural or synthetic rubber mixtures onto metallic or other substrates, comprising a mixture of chlorinated rubber, after-brominated polydichlorobutadiene, quinone dioxine, carbon black and ground sulphur.

GERMANY

Accession no.429689

Item 347
Rubber India
63,No.4,April 1991,p.19/42
MOULDING IN RUBBER INDUSTRY
Dighe K D
SWASTIK RUBBER PRODUCTS LTD.

This comprehensive article examines the various moulding methods for rubber including compression, transfer and injection moulding. The advantages and disadvantages, mould design, equipment, curing and problem prevention are described in some detail. In addition the bonding of rubber to metal is discussed, including surface preparation, choice of method and bond failures. 8 refs.

INDIA

Accession no.428703

Item 348
Hule Mexicano y Plasticos
45,No.522,Jan.1990,p.12/20
Spanish
DEVELOPMENTS IN RUBBER-METAL FABRICATIONS
German Torres A

Following a short synopsis of the history of rubber-to-metal bonding, the article devotes itself to the technology involved. The aspects briefly covered include adhesion theory, surface preparation, adhesive applications, process control and moulding equipment. Dynamic properties of rubber metal components and the factors influencing them are dealt with at greater length.

EUROPEAN COMMUNITY; SPAIN; WESTERN EUROPE

Accession no.426891

Item 349

Adhasion

35,No.3,March 1991,p.36-40

German

SURFACE TREATMENT OF EPDM COMPOUNDS BEFORE BONDING

Dorn L;Wahono W
BERLIN,TECHNICAL UNIVERSITY

Seven low pressure plasma treatments and three corona treatments were compared in the adhesion of EPDM to steel. Gases used in the plasma treatments were oxygen, air, argon, nitrogen and 70:30 and 30:70 mixtures of oxygen and tetrafluoromethane. Two epoxy resins and two polyurethane adhesives were used in the investigation. 18 refs.

GERMANY

Accession no.421611

Item 350

Adhasion

35,No.3,March 1991,p.10/6

German

PRESENT STATE OF BONDING TECHNOLOGY IN THE MASS PRODUCTION OF CARS

Altmann O
BMW AG

The use of adhesives in automobile manufacture is reviewed and an attempt is made to rationalise the use of adhesives in bonding the many different types of polymers encountered, with particular reference to BMW cars. 12 refs.

GERMANY

Accession no.421462

Item 351

Fourteenth Annual Meeting of the Adhesion Society. Meeting Proceedings.

Clearwater,Fl.,17th-20th Feb.1991,p.27-9. 9(12)4

MIXED MODE FRACTURE UNDER CATHODIC DELAMINATION

Liechti K M;Adamjee W
TEXAS,UNIVERSITY

Edited by: Clearfield H M
(Adhesion Society Inc.)

A characterisation of the mutli axial stress strain behaviour of Neoprene 5109S was carried out. A fracture analysis of the scarf specimens of rubber to metal bonds was then conducted to determine the energy release rates and crack opening angles associated with various loads and scarf angles. Cathodic delamination experiments were conducted and crack growth rates were correlated with energy release rates and crack opening levels. 11 refs.

USA

Accession no.420640

Item 352

Fourteenth Annual Meeting of the Adhesion Society. Meeting Proceedings.

Clearwater,Fl.,17th-20th Feb.1991,p.30-2. 9(12)4

DURABILITY CHARACTERISATION AND LIFE PREDICTIONS OF CATHODICALLY PROTECTED ELASTOMER TO METAL ADHESIVE BONDS IN MARINE ENVIRONMENTS

Hamade R F;Dillard D A
VIRGINIA,POLYTECHNIC INSTITUTE & STATE UNIVERSITY

Edited by: Clearfield H M
(Adhesion Society Inc.)

An interdisciplinary study involving the durability of adhesively bonded elastomer to metal joints in marine environments is reported. A methodology was developed to identify and model adhesion loss in service. Surface analysis techniques were utilised to determine the locus and mechanism of disbonding. Easily used test specimens were developed and the design and implementation of test matrices were created. Two schemes for model degradation were also produced.

USA

Accession no.420138

Item 353

Adhesive Bonding.

New York,Plenum Press,1991,p.175-202. 9(12)4

SURFACE CHARACTERISATION IN POLYMER/ METAL ADHESION

Filbey J A;Wightman J P
HOECHST CELANESE CORP.;
VIRGINIA,POLYTECHNIC INSTITUTE & STATE UNIVERSITY

Edited by: Lee L H
(Xerox Webster Research Center)

Techniques for surface characterisation in polymer/metal adhesion are reviewed, including SEM, scanning TEM, surface reflectance IR spectroscopy, inelastic electron tunnelling spectroscopy, auger electron spectroscopy, ion scattering spectroscopy, secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. Examples are given of surface characterisation of pretreated adherends, adhesive/ adherend interaction, failure surface analysis and correlation of these results with bond performance. 39 refs.

USA

Accession no.419597

Item 354
International Polymer Science and Technology
17,No.4,1990,p.T/82-3
IMPROVING THE TECHNOLOGY FOR MAKING SPECIMENS FOR TESTING BOND STRENGTH OF RUBBER TO METAL BY DIRECT PULL
Salitan E M;Kulakova G V;Mashina I A
USSR,SCIENTIFIC RES.INST.OF THE RUBBER INDUSTRY

Full translation of Prom.Sint.Kauch. Shin i Rez-tekhn.Iz., No.11, 1989, p.38.
EASTERN EUROPE; USSR

Accession no.419592

Item 355
Fundamentals of Adhesion.
New York,Plenum Press,1991,p.383-406. 9(12)4
CHEMISTRY, MICROSTRUCTURE AND ADHESION OF METAL-POLYMER INTERFACES
Ho P S;Haight R;White R C;Silverman B D;Faupel F
IBM T.J.WATSON RESEARCH CENTER
Edited by: Lee L-H
(Xerox Webster Research Center)

A detailed review is given of the results of recent studies on the chemistry, microstructure, and adhesion of the metal-polyimide interface. A stretch deformation method was developed for quantitative study of adhesion and deformation of metal/polymer layered structures. This method provides a direct measurement of interfacial adhesion energy without resorting to complex stress analysis to extract the energy, as in other tests.
USA

Accession no.418510

Item 356
Fundamentals of Adhesion.
New York,Plenum Press,1991,p.325-48. 9(12)4
ADHESION AT METAL INTERFACES
Banerjea A;Ferrante J;Smith J R
GENERAL MOTORS CORP.,RESEARCH LABS.; US,NASA,LEWIS RESEARCH CENTER
Edited by: Lee L-H
(Xerox Webster Research Center)

A review is given, by way of background, of what has been accomplished in understanding the theory of those properties which influence metallic adhesion. 39 refs.
USA

Accession no.418506

Item 357
Fundamentals of Adhesion.
New York,Plenum Press,1991,p.349-62. 9(12)4
HARD-SOFT ACID-BASE (HSAB) PRINCIPLE FOR SOLID ADHESION AND SURFACE INTERACTIONS
Lee L-H
XEROX WEBSTER RESEARCH CENTER
Edited by: Lee L-H
(Xerox Webster Research Center)

An attempt is made to apply the hard-soft acid-base (HSAB) principle to solid interactions with the aid of the frontier orbital method. The HSAB principle is described as it has been evolved in recent years, then the band structures of solids are described. After the compatibility between the HSAB principle and the band structures in the solid state are described, several examples of adhesion and surface interactions between metals and polymers are described in an attempt to further understand the dynamics and energetics of surface interactions at molecular level. 46 refs.
USA

Accession no.418505

Item 358
Adhesives Age
34,No.4,April 1991,p.38/43
EVALUATING SURFACE TREATMENTS FOR BONDING REINFORCED METALS
Bergquist P R;Petrie S P;Wentworth S E
US,ARMY MATERIALS TECHNOLOGY LABORATORY

The results are reported of a study of the effectiveness of state-of-the-art surface treatments for the adhesive bonding of aluminium alloys reinforced with particulate silicon carbide. Surface treatment methods evaluated included grit blasting, polishing, degreasing, Forest Products Laboratory etching, chromic acid anodisation and phosphoric acid anodisation. The adhesive employed was a commercial rubber-toughened epoxy film adhesive, Scotch-Weld AF163-2U. Test results for bonded thick lap shear specimens at 25C and 60% R.H. are tabulated. (22nd International SAMPE Technical Conference, 6-8 Nov.1990,Boston). 11 refs.
USA

Accession no.418130

Item 359
Kautchuk und Gummi Kunststoffe
43,No.5,May 1990,p.385-7
ESTERS OF BORIC ACID OFFERING A GREATER FLEXIBILITY FOR COBALT BONDING SYSTEMS
Pieroth M;Schubart R
BAYER AG

A study was made of the influence of boron compounds, especially esters of boric acid, on cobalt compound-based bonding agents used for bonding of NR to brass plated steel cord. Adhesion results obtained with different boron compounds are discussed, special mention being made of findings for KA 9128. 1 ref.

EUROPEAN COMMUNITY; WEST GERMANY; WESTERN EUROPE

Accession no.417146

Item 360

Revue Generale des Caoutchoucs et Plastiques

67,No.696,May 1990,p.221-2

EFFECT OF SURFACE ROUGHNESS AND MECHANICAL INTERLOCKING ON ADHESION

Gent A N;Lin C W

AKRON,UNIVERSITY

Two models of adhesion have been considered: one when the substrate was a rigid plate containing a regular array of cylindrical holes and one when the substrate was a woven cloth of stainless steel wire. In the second case the adhesive could not be removed from the holes without breaking the strands. Experimental measurements were compared with the theoretical predictions, using NR and SBR; reasonable agreement was obtained. It was found that in either case the apparent work of detachment could exceed the work of rupture of the adhesive layer without the material actually breaking.

USA

Accession no.410357

Item 361

Automotive Engineering

98,No.7,July 1990,p.35-7

RUBBER TO METAL ADHESIVES IMPROVE QUALITY OF HYDRAULIC MOUNTS

Mowrey D

LORD CORP.

The development of a new rubber-to-metal bonding system for hydraulic mounts, that meets the most demanding specifications of automakers for resistance to high temps, boiling water, salt spray and a wide variety of aggressive automotive fluids, is highlighted. The new system, called Chemlok EP5665-28A and EP5772-52, was extensively field tested for bonding a wide variety of NR compounds to grit blasted and zinc-phosphatised steel and aluminium.

USA

Accession no.410356

Item 362

Swiss Bonding 90-Bonding in Metalwork and Construction.Conference proceedings.

Rapperswil,28th-30th May 1990,p.353-72. 6A1

German

PRETREATMENT OF SUBSTRATES BASED ON EPDM RUBBER COMPOUNDS

Dorn L;Wahono W

BERLIN,TECHNICAL UNIVERSITY

Edited by: Schindel-Bidinelli E

A study was made of various electrical surface pretreatment methods for EPDM and their effectiveness in improving the adhesion properties of this rubber. Particular emphasis is placed on a thermocorona technique which was developed at Berlin University. Results obtained with these techniques for EPDM/metal bonds, using epoxy and PU as adhesives, are discussed and evaluated. 18 refs.

EUROPEAN COMMUNITY; WEST GERMANY; WESTERN EUROPE

Accession no.408999

Item 363

Swiss Bonding 90-Bonding in Metalwork and Construction.Conference proceedings.

Rapperswil,28th-30th May 1990,p.233-58. 6A1

German

INFLUENCES OF MANUFACTURING CONDITIONS ON QUALITY OF ADHESIVE METAL JOINTS WITH VERY DIFFERENT MATERIAL PARAMETERS

Marwinsky-Moniatis B

SCHINDLING AG

Edited by: Schindel-Bidinelli E

Using the bonding of a chrome-nickel-steel to a hard ferrite as an example, the influence of metal pretreatment, application of adhesive curing behaviour and type of adhesive on quality of bonded joint was investigated. Adhesives employed were two anaerobic systems, a silicon rubber and a modified epoxy resin. Results obtained are reported and evaluated. 5 refs.

SWITZERLAND; WESTERN EUROPE

Accession no.408997

Item 364

European Rubber Journal

172,No.9,Oct.1990,p.38-40

LOOKING FOR A BINDING SOLUTION

White L

The pressure is on in the rubber-to-metal bonding industry as solvent-based adhesives are under increasing environmental pressure. Many industry experts are sceptical that water-based systems will be able to provide an acceptable alternative. The major bonding agents are examined including Chemlok, the agreed market leader. Bonded parts used in the automotive industry and quality control measures are discussed.

WORLD

Accession no.408020

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