Chemlok®

Preparation of Substrates for Bonding

Surface preparation is one of the most important factors influencing adhesion in the bonding process. This bulletin will review surface preparation practices, particularly the preparation of metallic substrates for rubber-to-metal bonding.

Metal Surface Preparation Overview

Metal surface preparation consists of two categories:

- Mechanical methods - include blasting with sand, grit or metal oxides; abrading with wire brush, steel wool or backed abrasives; machining or scoring with cutting tools. Chemical or solvent cleaning is sometimes necessary with methods that are classified as mechanical.

- Chemical methods - use inorganic or organic chemicals to achieve two reactions;

  1) Dissolve, suspend or otherwise eliminate soils and surface contaminants by chemical action, and
  2) Convert metal surfaces from the essentially free metallic state into metallic compounds.

The following factors will dictate which surface preparation method is the best choice:

Economy - Chemical treatments are generally less costly than mechanical methods.

Versatility - The same mechanical methods may be applicable to many metal surfaces, while each chemical treatment may be specific to a certain metal.

Adaptability to Existing Equipment - The type of pre-existing facilities will influence surface preparation choice.

Adhesion Requirements - Because the degree of adhesion required in manufacture can vary, surface preparation methods need to be adapted accordingly.

Environmental Resistance - Chemical conversion often provides enhanced environmental resistance compared to mechanical methods.

Government Regulations - Waste disposal regulations may not allow the use of chemical treatments for surface preparation.

Maintaining Surface Conditions

Both mechanical and chemical surface preparation methods will provide clean surfaces, increased surface area, chemically activated or modified surfaces, or some combination of these conditions.

It is important to maintain the optimum surface condition until the bonding process is complete. Protect surfaces from dust, moisture, chemical fumes, mold release agents, and other contaminants. Keep solvents and cleaning solutions free from contamination and replace them when necessary. In order to produce clean surfaces, use clean grit and abrasives. Check rinse water and air quality frequently.

A water-break test can be used to check for oil and grease removal. A surface that supports an unbroken film of deionized or distilled water for 20 or more seconds is considered free from grease or oil.

Applying the adhesive immediately after surface preparation is one of the best ways to preserve optimum surface properties.

Surface oxidation can cause adhesion problems. A good precaution is to protect the metal surface from oxidation with an adhesive coating.

Surface Preparation by Substrate

Steel (Mechanical Preparation)

Blasting with grit (steel or aluminum oxide) is a widely used method of preparing steel surfaces. It is especially useful for metals covered with rust, scale, oxide layers and similar corrosion compounds.

Listed below is a typical sequence of steps:

I. Degrease - The initial vapor degreasing or alkaline cleaning is used to remove soils such as greases and oils. This is done to prevent grit contamination during the subsequent blasting step. Scale or corrosion will not be removed.

product information

II. Grit Blast - 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. Use air blast that is free of oil and water.

III. Degrease/Alkaline Cleaning - The second vapor degreasing or alkaline cleaning step will ensure that abrasive dust and any contaminants that may be present in the blasting media are removed.

Consult the manufacturers of blasting equipment, abrasive media and degreasing units for specific information concerning equipment for this process. The names of representative qualified suppliers will be furnished on request.

Grinding and abrading with wire brush, steel wool or abrasive cloth produces a satisfactory bonding surface. Care must be taken to prevent contamination of the abrasive material and to remove abrasive dust and particles of steel wool or wire.

Freshly milled or machined surfaces are also excellent for bonding, provided that cutting oils have been completely removed from the surface. Poor adhesion may result from a film of oil left on a metal surface by evaporation of a contaminated solvent.

Steel (Chemical Preparation)
A typical chemical treatment, zinc phosphatizing, is used to prepare steel surfaces. The proper zinc phosphatizing process produces a surface with excellent adhesion properties. This treatment consists of the following:

1. Hot caustic clean
2. Water rinse
3. Phosphoric acid pickle
4. Water rinse
5. Zinc phosphatize
6. Water rinse
7. Rust inhibitive rinse
8. Dry

For rubber-to-metal bonding applications, a calcium-modified, microcrystalline zinc phosphate is suggested. The film weight should be 125 - 450 mg/ft^2 for optimum adhesion.

In addition to phosphatizing, steel parts can also be chemically treated with an autodepositable coating such as MetalJacket™, manufactured by Lord Corporation. This aqueous based coating provides whole part protection and eliminates the need for a traditional rubber-to-metal primer. The excellent flexibility of the MetalJacket system allows the parts to be swaged without fracturing, which sometimes occurs with phosphate coatings. The process for preparing metals with MetalJacket coating is as follows:

1. Hot caustic clean
2. Water rinse
3. Phosphoric acid pickle
4. Water rinse
5. Application of MetalJacket metal treatment
6. Hot air dry
7. Application of MetalJacket coating
8. Hot air dry
9. B-stage

Parts are now ready to be coated with a Chemlok® rubber-to-metal adhesive.

Stainless Steel (Mechanical Preparation)
Mechanical methods used to prepare stainless steel include blasting with sand or aluminum oxide. Do not use steel grit as it leaves ferrous deposits which can result in accelerated corrosion under the bond. For optimum bond results, do not exceed a 1 hour layover period between blasting and adhesive application.

Stainless Steel (Chemical Preparation)
Chemical methods used to prepare stainless steel consist of the following steps:

1. Vapor degrease and/or alkaline clean
2. Immerse for 15 - 20 minutes at 49°C - 57°C (120°F - 135°F) in this solution:
   Nitric acid 20 - 25%, by weight
   Sodium dichromate 2 - 4%, by weight
   D.I. Water 71 - 78%, by weight
3. Water rinse
4. Dry and apply adhesive within 1 hour.

Immersion times, solution concentrations, and operating temperatures can be varied in order to suit conditions and alloys.

Aluminum
Blasting aluminum provides an excellent bond surface when precautions are taken to prevent surface oxidation between the blasting and processing operations. For best results, apply the adhesive within 30 minutes of blasting the aluminum substrate. Use sand or aluminum oxide when blasting, as steel grit blasting leaves a ferrous deposit on the aluminum. This ferrous deposit can cause galvanic corrosion and result in poor long term bond quality.

Excellent bonds are also obtainable when aluminum surfaces are treated with chromate (alodizing). The steps include:

1. Vapor degrease and/or aqueous aluminum clean
2. Water rinse
3. Deoxidize
4. Water rinse
5. Chromate conversion treat
6. Water rinse
7. Warm air dry

The manufacturers of the proprietary materials used in these processes may be consulted for further information.

Anodizing aluminum will produce a bondable surface. Although both sulfuric acid anodizing and chromic acid anodizing can be used to prepare aluminum, do not use the latter when bonding silicone rubbers. Sulfuric acid anodized surface must be unsealed and the adhesive applied within 1 hour.

Magnesium
The amount of environmental resistance required will determine whether mechanical or chemical surface preparation method is the best choice. While blasting with sand or aluminum oxide will provide a good surface for bonding to magnesium, the bond will not provide outstanding environmental resistance. Maximum environmental resistance is obtained by using a chemical method, such as chrome pickling or anodizing. The chrome-pickle process consists of:

1. Vapor degrease and/or alkaline clean
2. Cold water rinse
3. Chrome-pickle
4. Cold water rinse
5. Hot water rinse

Further details concerning this process are available on request.

Brass and Copper
Mechanical preparation methods, including blasting with sand and aluminum, are appropriate for brass and copper.

The following two methods will produce surfaces with enhanced bonding properties:

- ***Ammonium persulfate method***

1. Vapor degrease and/or alkaline clean
2. Immerse for 1 to 3 minutes at room temperature in the following solution:
   Ammonium persulfate 25%, by weight
   Water 25%, by weight
3. Water rinse at room temperature
4. Dry and apply adhesive as soon as possible.

- ***Acid-ferric chloride method***

1. Vapor degrease and/or alkaline clean
2. Immerse for 1 to 2 minutes at room temperature in the following solution:
   Concentrated hydrochloric acid 50%, by weight
   Ferric chloride 20%, by weight
3. Water rinse at room temperature.
4. Dry and apply adhesive as soon as possible.

Immersion times, solution concentrations and operating temperatures may be varied to suit conditions.

Lead
Mechanical methods are used almost exclusively with lead and are usually satisfactory. If the lead surface is freshly abraded and an oxide film has not had time to form, surface preparation may not be required.

Zinc
Zinc surfaces are almost always prepared mechanically. Carefully evaluate each situation when bonding directly to zinc surfaces such as zinc plated, galvanized, or electrogalvanized surfaces.

Plated Metals
Two unique problems are encountered in surface preparation and bonding of plated metals:

1. Vigorous mechanical treatment may penetrate and destroy the plating.
2. The adhesion of the plating to the base metal may be inadequate.

In many cases, the freshly plated surface will not require additional preparation because the plating process produces a clean, bondable surface. The conditions under which the plating process is conducted will affect the surface condition of the plated metal. Plating conditions determine the adhesion, porosity and surface stress of the metal deposit. Current density, composition of plating bath (including brightener content) and the temperature of the bath all have an affect on the bondability of the plated surface.

When using mechanical treatments, abrade the surface lightly. Fine grades of sand, abrasive paper or steel wool will have minimum penetrating effect. The amount or type of metal deposited in the plating process will determine which chemical treatment to use.

If the plating does not adhere tightly to the base metal, the plating process should be investigated.

Plastics
Rubber can be adhesive bonded to many rigid plastics. Prepare plastic surfaces by aqueous alkaline, solvent cleaning, or surface roughening. If using the later process, consider the softness of the material and the need for retention of dimensional tolerances. A rough surface can be molded into the plastic by using a mold that has been textured.

Further details concerning the proper treatments of many engineered plastics are available on request.

Miscellaneous Substrates
The general principles outlined in the bulletin can be adapted to the surface preparation of practically any rigid material for bonding.

Values stated in this bulletin represent typical values as not all tests are run on each lot of material produced. For formalized product specifications for specific product end uses, contact the Customer Service Department.

Information provided herein is based upon tests believed to be reliable. Inasmuch as Lord Corporation has no control over the manner in which others may use this information, it does not guarantee the results to be obtained. In addition, Lord Corporation does not guarantee the performance of the product or the results obtained from the use of the product or this information where the product has been repackaged by any third party including but not limited to any product end user. Nor does the company make any express or implied warranty of merchantability, or fitness for a particular purpose concerning the effects or results of such use.

Good surface preparation includes the removal of all surface contaminants and decomposition products, prevention of recontamination, and careful handling through all processes. Substrates with high surface areas from mechanical blasting will generally bond better than those with low surface areas.

Note
Many of the chemical processes described involve chemical solutions that must be handled by employees properly trained in the safe handling and disposal methods for hazardous chemicals.

Cautionary Information

Before using this or any other Lord product refer to the Material Safety Data Sheet (MSDS) and label for safe use and handling.

For additional information, contact Lord Corporation at: 814/868-3611 extension 3211, FAX: 814/864-3452 or write: **Lord Corporation, Chemical Products, 2000 West Grandview Blvd., P.O. Box 10038, Erie, PA 16514-0038**

LORD Chemical Products