

Preparation of Metal Substrates for Bonding with LORD® Adhesives

One of the most important factors influencing adhesion in the bonding process is surface preparation. To ensure optimum bond performance and long-term environmental resistance, metal substrates must be free of organic and inorganic contaminants. Organic materials include grease, dirt and oils which can be removed by solvent or alkaline cleaning. Common inorganic contaminants are rust, scale and oxide layers. These can be cleaned by either mechanical or chemical processes, or a combination of both.

Regardless of which method you choose, the essentials of all good surface preparations include:

- Removal of all surface contaminants and decomposable products.
- Prevention of recontamination.
- Careful handling through all processing steps.

In most cases, LORD® adhesives can be used without unique mechanical or chemical treatments.

Types of Surface Preparation

Mechanical preparation involves physically removing surface contamination and increasing surface area and substrate profile. Solvent cleaning is necessary with methods that are classified as mechanical. These methods include:

- **Blasting** – Abrasive particles (sand, grit or metal oxides) are projected against the surface with a stream of air. The character or quality of the treatment is affected by duration of the blast; shape and size of the blasting media; particle velocity; and the hardness, porosity and other substrate properties. Substrates with high surface areas from mechanical blasting will generally bond better than those with low surface area.

- **Abrading** – A wire brush or abrasive paper is used to grind the surface. Care must be taken to prevent contamination of the abrasive material and to remove dust and particles after use.
- **Machining** – If cutting oils are completely removed, machining provides an acceptable bonding surface. However, any oil/grease left on the metal surface will reduce adhesion.

Chemical processes, on the other hand, utilize organic and inorganic chemicals to achieve two reactions:

- Dissolve, suspend or eliminate soils and surface contaminants.
- Convert metal surfaces from the essentially free metallic state into metallic compounds.

Selecting a Preparation Method

To determine which preparation method best suits your needs, consider:

- **Economy** – In large volumes, chemical treatments are generally less expensive than mechanical methods.
- **Versatility** – Mechanical preparation methods may be applicable to numerous metals, while chemical treatments may be metal-specific.
- **Adaptability to Existing Equipment** – Existing facilities may favor either mechanical or chemical processing.
- **Adhesion Requirements** – Adhesion requirements vary from product to product, and bond quality is affected by the particular application. Therefore, surface preparation will vary accordingly.
- **Environmental Resistance** – Chemical conversion often provides enhanced environmental resistance compared to mechanical methods.
- **Government Regulations** – Waste disposal regulations may prohibit the use of chemical treatments in certain areas.

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.

Maintaining optimum surface condition is essential until adhesive application is complete. To accomplish this:

- Apply the adhesive immediately after the surface is prepared, preventing surface oxidation.
- Avoid exposure to dust, moisture, chemical fumes, mold release agents and other possible contaminants.
- Keep solvents and cleaning solutions free from contamination, and replace when necessary.
- Ensure grits and abrasives remain clean and free of contaminants.
- Check the purity of rinse water and “drying” air frequently, ensuring minimal contamination.

The water break test can be used to check for oil and grease removal. If a surface can support an unbroken film of deionized water for 60 seconds or more, it is considered essentially free from grease or oil.

Surface Preparation for Various Substrates

Although the general principles are the same for preparing all substrates, some materials require special attention. Outlined below are guidelines for surface preparation of specific substrates:

Steel (Mechanical Preparation)

Grit blasting (with steel or aluminum oxide) is widely used for preparing steel surfaces. It is especially effective for metals covered with rust, scale, oxide layers and similar corrosion compounds.

Steel preparation usually involves:

1. Degrease – The initial 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.

2. Grit Blast – Blasting consists of impinging abrasive particles against the metal surface with an air stream that is free of oil and water. Grit size most commonly used is G-40. Use of grit is preferred over the use of shot since grit produces a rough, open surface, while shot peens the surface and sometimes causes occlusion with loose particles.
3. Alkaline Cleaning – The second 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 alkaline cleaning 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 can produce 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. However, poor adhesion may result from a film of oil left on a metal surface by evaporation of a contaminated solvent.

Steel (Chemical Preparation)

Chemical treatments for steel typically include iron phosphate or zinc phosphate conversion coatings.

- Zinc Phosphate – The proper zinc phosphating process produces a surface with excellent adhesion properties. Zinc phosphate treatment consists of:
 1. Hot caustic clean
 2. Water rinse
 3. Phosphoric acid pickle
 4. Water rinse
 5. Zinc phosphate
 6. Cold water rinse
 7. Hot water rinse
 8. Hot air dry

This type of surface treatment provides on-the-shelf corrosion protection of the uncoated part as well as improved under-bond corrosion protection.

Stainless Steel (Mechanical Preparation)

Preparing stainless steel with mechanical methods includes:

1. Blasting with sand or aluminum oxide. Steel grit should not be used because it leaves ferrous deposits that can cause galvanic corrosion.
2. One-hour layover maximum between blasting and adhesive application.

Stainless Steel (Chemical Preparation)

Chemical treatment for the passivation of stainless steel involves the following:

1. Vapor degrease and/or alkaline clean
2. Immersion for 15 to 20 minutes at 120-135°F (49-57°C) in a solution of nitric acid (20-25% by weight), sodium dichromate (2-4% by weight) and deionized water (71-78% by weight).
3. Cold water rinse
4. Dry and apply adhesive within one hour.

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

Aluminum

The preferred mechanical method for preparing aluminum is blasting. This includes:

1. Blasting with sand or aluminum oxide. Steel grit should not be used because it leaves ferrous deposits that can cause galvanic corrosion.
2. Thirty-minute layover maximum between blasting and adhesive application.

Chromate alodizing of aluminum also produces excellent bonds. This involves:

1. Solvent degrease or aqueous clean
2. Water rinse
3. Deoxidizer
4. Water rinse
5. Chromate conversion treatment
6. Water rinse
7. Warm air dry

Consult the manufacturers of the proprietary materials used in these processes for more information.

Aluminum surfaces may also be prepared by anodizing (electrolytic deposition of aluminum oxide).

Magnesium

Depending upon the required environmental resistance, preparation of magnesium surfaces varies. Blasting with sand or aluminum oxide provides a good bonding surface, but the bond will not provide outstanding environmental resistance. For best results, use chemical methods such as chromic 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

Brass and Copper

In addition to blasting with sand or aluminum oxide, brass and copper surfaces may be treated with chemical methods including ammonium persulfate etching. This method involves:

1. Solvent degrease and/or alkaline clean
2. Immersion for 1 to 3 minutes at room temperature in a solution of ammonium persulfate (25% by weight) and water (75% by weight).
3. Water rinse at room temperature
4. Dry and apply adhesive as soon as possible.

In addition to ammonium persulfate etching, there are a number of commercially available etchants. Consult the manufacturers of these specific products for product selection and processing information.

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 can be prepared mechanically. Carefully evaluate each situation when bonding directly to zinc-plated, galvanized or electrogalvanized surfaces.

When bonding galvanized metals with LORD 200 or 400 series adhesives, solvent cleaning is recommended, not mechanical preparation.

Plated Metals

Two unique problems are often encountered when preparing and bonding plated metals:

- Vigorous mechanical treatment may penetrate and destroy the plating.
- Adhesion of the plating to the base metal may be inadequate.

Since the plating process produces a clean, bondable surface, freshly plated surfaces often do not require additional preparation. Keep in mind, however, that plating changes surface properties such as adhesion, porosity and surface stress of the metal deposit. Current density, composition of the plating bath (including brightener content) and temperature of the bath also affect the bondability of the plated surface.

When mechanical pretreatment is used, abrade the surface lightly. Fine grades of sand or abrasive paper will minimize penetration. The correct chemical treatment depends upon the type of metal which is deposited during the plating process.

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