LORD® IMB™ Liquid Silicone Rubber Primers

Application Guide

LORD® In-Mold Bonding (IMB™) liquid silicone rubber (LSR) primers are non-tacky polymer-based coatings that when applied to a substrate provide a structural bond to a rigid or elastomeric polymer, which is formed under heat and pressure. LORD IMB 3000 series primers are designed for bonding platinum-cured silicone rubber to a variety of thermoplastic and metal substrates during the injection molding process.

Although a premium primer is the basis of a quality bond, it's only the beginning; proper application is essential for maximum results. Whether you're dipping or spraying, you'll learn how to maximize efficiency and optimize results. This guide also shows how to troubleshoot common bond problems. We hope this resource will become an indispensable part of your operation and a convenient, one-source solution to many of your bonding questions.

Substrate Surface Preparation:

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, 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.

Types of Surface Preparation:

There are several ways to prepare substrates for primer application; however, the methods can be broadly divided into mechanical and chemical. Regardless of which method you choose, the essentials of good surface preparations include:

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

Mechanical preparation involves physically removing surface contamination and increasing surface area and substrate profile. This method includes:

- Blasting – Abrasive particles (sand, grit or metal oxides) are projected against the surface with a stream of air. Blasting is especially effective for removing inorganic contamination and other corrosion compounds found on metal. 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.

Chemical processes, on the other hand, utilize organic and inorganic chemicals to dissolve, suspend or eliminate soils and surface contaminants. Preparation methods include:

- Alkaline cleaning
- Acid passivation

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:

Maintaining optimum surface cleanliness is essential until primer application is complete. To accomplish this:

- Apply the primer immediately after the surface is prepared.
- 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.

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 primer application.

Stainless Steel (Chemical Preparation)

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

- Alkaline Wash
  1. Hot water rinse (70°C)
  2. Wash in sodium tripolyphosphate solution
  3. Hot water rinse (70°C)
  4. Hot air dry
- Acid Passivation
  Washing step that uses mild acid solution such as citric or oxalic acid

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

Plastics

LSR can be bonded to many rigid plastics. To prepare plastic surfaces:

1. Solvent wipe. Hydrophobic solvents such as n-heptane and Isopar™ can remove waxes and mold release. Alcohol such as ethanol or isopropanol can remove polar contaminants.
2. Surface oxidation by plasma, flame, or corona treatment.

Preparing the Primer:

Temperature – Temperature affects the viscosity of LORD IMB primers. Recommended storage temperature is 21-27°C (70-80°F) in original, unopened container. Cold storage is not recommended.

Dilution – Regardless of dilution amounts, it is important in all cases that the appropriate diluent be added to the primer while stirring. Mixing guidelines are listed in the respective technical data sheets for each LORD IMB product.

Applying the Primer:

LORD IMB primers may be applied by brush or spray methods. General recommendation for dry film thickness is 2.0 to 5.0 micron (0.05 to 0.2 mil).

Hand Brushing – LORD IMB solvent-based primers are suitable for hand brushing straight from the container. When using this method, wear the proper personal protective equipment, and work in a clean environment. Also make sure there are no dirty or greasy objects within reach.

Spray Application – Spray application of primers is particularly applicable when coating one side or certain areas of a part. When spraying, however, it is important that the primer reach the substrate wet. If drying occurs before reaching the metal, adhesion will be poor.

Hand-held guns may be used for small runs, while conveyorized or automated units are effective for large production operations. And for small, intricate parts, an air brush may be used. Regardless of size, properly adjusted equipment ensures delivery of uniform films – without sags and tears.

During hand-spray operations, parts are often assembled on racks that incorporate masks wherever needed. If the application requires overall coating, parts can be rotated in front of the spray gun.

Precision Spray / Jetting – This technique follows the same principles as typical spray techniques outlined above but utilizes very precise application equipment to apply primer to small areas with minimal overspray. LORD IMB primers are compatible with this process.

Drying Processes:

All LORD IMB LSR primers can be dried at room temperature (21°C/ 70°F) in 30 minutes or less. During the drying process, no reaction is taking place – only solvent is evaporating. Thus, methods to speed up solvent evaporation are effective, such as increasing air flow or using hot air. Heating to 65°C (149°F) in a convection oven for 5 minutes is usually sufficient. Avoid drying temperatures of greater than 65°C (149°F). Avoid IR-based heating because this creates a high level of heat directly at the primer surface, potentially destroying the bonding ability.

Handling Coated Parts:

Both clean and coated parts should be kept free of contamination. Because fingerprints can adversely affect adhesion, gloves are highly recommended. Thin, white, cotton gloves are satisfactory, as they show soil easily, are economical enough to be discarded when necessary, and are thin and porous enough to be comfortable.

Coated Parts Layover Stability:

Mold as soon as possible, but store all coated parts properly to ensure maximum layover. Typically, this entails sealing primer-treated substrates in a clean plastic container and storing the package in a cardboard box. These precautions ensure parts are protected from airborne contaminates. Refer to the applicable technical data sheet for recommended layover durations.

Molding Considerations:

One of the most important steps in the manufacturing process is molding. During this phase, the primer-coated substrate and elastomer are placed in the mold cavity, and under proper conditions of time, temperature and pressure the bonded assembly is formed.

Controlling each step in the molding process is critical to bond success. Major variations in any step will cause bond failures. Minor alterations, though not detrimental individually, can collectively result in poor or marginal adhesion and above-average scrap rates.

Considerations include:

- **Primer Dry Film Thickness (DFT)** – One of the most important factors in environmental performance. Low and high DFT films can result in poor performance. Refer to the applicable technical data sheet for recommended DFT.
- **Molding Pressure** – Optimum adhesion requires adequate pressure and intimate contact of elastomer and primer during vulcanization and cure. Molds that are either too tight or are too loose will hinder bond quality.
- **Temperature** – Dramatic temperature variations from cavity to cavity may cause bond failure, lack of cure, or overcure conditions. Mold temperature should be checked periodically, particularly within the individual cavities. Tempilsticks®, or selective melting-point wax pencils, are excellent for spot-checking mold cavities. Thermocouples can also be used, but they must be calibrated regularly.
- **Mold Design** – When designing the mold, provisions should be made to facilitate substrate loading as well as removal of the cured part.

Post Treatment:

Following part bonding, post-bake may be required to achieve maximum bonding performance. A typical post-bake condition for silicone parts is 150°C to 200°C (302°F to 392°F) for 2 to 4 hours.

Troubleshooting:

ASTM International provides a set of detailed symptom descriptions for bond failures. These descriptions allow complete and accurate problem assessment as well as quick solutions. (In this document, the terms “elastomer” and “primer” should be interpreted as “rubber” and “cement”, respectively.)

Three basic ASTM designations are:

- **RC** – failure at the rubber-cement interface.
- **CM** – failure at the cover cement-metal interface; or at the primer-metal interface.
- **R** – failure in the rubber.

Rubber-Cement (RC) Failures

Separation between rubber and cement is usually characterized by a hard, glossy surface on the metal with little or no visible rubber.

The following list includes common causes of RC failures, as well as potential solutions:

- Substrate not hot enough upon LSR injection.
  - Preheat the substrate inside of the mold by using an injection delay or preheat the substrate in a batch oven to minimize cycle time.
  - Increase mold temperature.
- Silicone rubber contains low concentration of functional groups.
  - Increase amount of B component in two-part primers.
  - If using single-component primer (LORD IMB 3050, for example), mix with side B catalyst (LORD IMB 3040B, for example). Details are provided in the respective technical data sheets.
- Color concentrate contains incompatible components.
  - Reduce or change color concentrate.
- Primer is sweeping, or being removed by flowing silicone.
  - Reduce filling speed.
  - Change gate location.
- Silicone is not compatible with primer.
  - Change to a different grade of silicone.

Cement-Metal and Primer-Metal (CM) Failures

A clean separation between the primer and metal or other substrate indicates that no adhesion has occurred.

The following list includes common causes of CM failure as well as potential solutions:

- Substrate is not clean.
  - Clean substrate; often, oil, dirt, dust or other contaminants inhibit bonding.
- Primer is not sufficiently dried.
  - Reduce dry film thickness (apply thinner).
  - Increase drying time and/or temperature.
- Substrate is not compatible with primer.
  - Mechanically roughen the substrate with abrasive.
  - Chemically activate the substrate with plasma, flame, or corona treatment.
  - Change to a different substrate.

Rubber (R) Failures

Rubber failures are separated into the following categories:

SR (Spotty Rubber) – Often caused by pre-bond surface contaminants, this failure appears like splattered rubber on the substrate surface.

TR (Thin Rubber) – Thin rubber failures are marked by even, but very light rubber residue on the substrate surface. These imperfections usually occur with butyl or rubber stocks that are highly oil-extended. When oils migrate to the RC interface, they create a bond layer that is part primer, part oil and part rubber. This weak layer easily fails when the part is stressed.

HR (Heavy Rubber) – A thick or heavy layer of rubber remaining on the substrate surface indicates an excellent bond. The stock fails because it is stressed beyond its cohesive strength. This is the ideal failure mode.

SB (Stock Break) – With stock breaks, the elastomer appears as if it was folded back on itself, then broken off. The break is jagged and at a sharp angle to the substrate surface.

Although there are three primary bond failures, keep in mind that rubber-cement, cement-metal/substrate and rubber failures are often found in combination.

Things to Avoid:

- Certain chemicals are incompatible with LORD IMB primers and can cause failure. These include amines, sulfur, latex, or chemical compounds containing nitrogen, phosphorous or tin.
- Certain silicone components commonly used in other primers. Make sure to avoid cross-contamination with silane/silicone-based primers.
- Silicone-based mold release is not compatible with LORD IMB primers. Use PTFE-based release agents, such as McLube™ 1711L.

Safe Handling:

Proper handling of LORD IMB primers is essential for safe and effective application. We recommend these procedures be followed when using any LORD IMB LSR product:

- Read labels, SDS and technical data sheets before use.
- Ventilate application and storage areas.
- Wear proper personal protective equipment.
- Clean application and processing equipment regularly.
- Dispose of waste according to federal, state and local regulations.

Parker LORD Applications Laboratory:

As an extension of our product development efforts, Parker LORD has injection molding machines in Erie, PA. By simulating customers' applications, we can provide detailed technical support and more thoroughly evaluate optimum application characteristics of new products.

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