Surface Preparation

Why Surface Preparation Is Important?

In adhesive bonding the epoxy is only one part of the equation. Each substrate that is being adhered to is often as important as the adhesive selection. Physical properties such as bond strength, conductivity, and bond reliability all hinge on the interface between substrate and adhesive. The adhesive-substrate interface is a sensitive equilibrium that can be upset by even the slightest contaminants. In preparing a surface for adhesive bonding users can increase reliability and productivity by optimizing the substrate’s ability to accept the adhesive.

Cohesive and Adhesive Failure

In an ideal adhesive substrate system, the adhesive will fail cohesively. A cohesive failure occurs when the adhesive is left evenly on both surfaces of the substrates. For a non-adhesive example of cohesive failure, consider an Oreo® cookie that is twisted open and has filling on both sides. Cohesive failures are ideal in terms of surface preparation because they indicate that the adhesive is the limiting variable in the equation. When this happens, it suggests that the adhesive had a stronger grip to the surface than itself which shows a high degree of surface adhesion. Alternately, an adhesive failure occurs when the entire adhesive is preferentially left on one substrate and can be indicative of poor surface preparation. For example, an Oreo® that is twisted open and all the filling is left on one side is an adhesive failure. Failure analysis and identification of adhesive or cohesive failure can be a good indication of the quality of surface preparation.

Mechanical and Chemical Bonding

It is a common misconception that the ability of an adhesive to bond hinges on how well it “sticks” to a surface. Bonding is far more complicated and can be broken down into two major types of bonding: mechanical and chemical bond. Chemical bonding is the formation of chemical bonds between the surface of the substrate and the surface of the adhesive. These are physical bonds created by a chemical reaction between the surface and the adhesive. Mechanical bonding, on the other hand, is the ability of the adhesive to grasp the nooks and crannies of a complex and irregular surface. Bonds are not formed, but the surface is held by the adhesive like molecular Velcro®. Both mechanical bonding and chemical bonding are critical to any substrate and adhesive interface.

Methods of Increasing Surface Adhesion

Optimal surface preparation is a two step process of solvent cleaning/abrasion, and chemical treatment.

1a. Solvent Cleaning: The most common type of surface preparation is a solvent wipe before bonding. This process removes surface contaminants and organic matter with an organic solvent. The most common and substrate independent solvents used are acetone and isopropyl alcohol (IPA). Both are relatively safe organic solvents that will remove a wide array of surface contamination. Surfaces should be wiped down with a clean cloth and allowed to fully dry.

1b. Abrasion: Another part of the cleaning process is abrasion. This further eliminates surface contaminates and oxide layers. Abrasion exposes a clean, uncontaminated surface and increases the roughness and irregularity of the surface. This allows for greater mechanical bonding due to the increase in surface area and creates a greater physical barrier to resist shear. Common intermediate cleaning processes include dry abrasion, wet abrasion, grit blasting, and detergent scrubs. This step should be followed by a solvent wipe as described in step 1a.
Methods of Increasing Surface Adhesion - (continued)

2. Chemical Treatment: A second step in surface preparation is chemical treatment with strong etching compounds. Once the surface has been fully cleaned and roughened, it is chemically altered to increase its ability to receive and hold adhesive. Chemical treatment is commonly a strong acid, or powerful solvent that has the ability to chemically react and change the surface chemistry of the substrate. Chemical treatments are substrate specific and should be performed only after ensuring proper chemical hygiene and reading all applicable MSDS.

### Surface Preparations of Common Substrates

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| Aluminum, aluminum alloys  | Cleaning - Vapor degrease with chlorinated solvent                              | 1 L DI water, 300g H₂SO₄, 60g Na₂Cr₂O₇· 2H₂O, 1.5g 2024 bare aluminum                               | • Etch in bath for 12-15 min at 150-160°F.  
  • Spray in tap water immediately for 5 min with a DI water rinse.  
  • Dry at 120-140°F and do not touch bonding surface.  
  • Prime or bond within 16 hours. |
| Copper, copper alloys      | Cleaning - Immerse, spray or wipe with chlorinated solvent                       | 15 pbw 42% aqueous FeCl₃, soin 30 pbw conc. HNO₃, 197 pbw DI water                                 | • Immerse for 1-2 min at room temp.  
  • Rinse in cold running DI water.  
  • Dry immediately with air at room temp. |
| Gold, Platinum or Silver   | Cleaning - Vapor degrease with chlorinated solvent                               | None                                                                                                     | • Follow abrasion with cleaning step. |
| Stainless Steel            | Cleaning - Vapor degrease with chlorinated solvent                               | 3.5 pbw Na₃Cr₂O₇· 2H₂O, 3.5 pbw DI water                                                                | • Immerse in bath at 140-160°F for 15 min.  
  • Scrub under cold water with a stiff bristle brush then rinse in DI water.  
  • Dry in oven at 200°F for 10-15 min. |
| ABS or methyl pentene      | Cleaning - Vapor degrease with acetone                                            | 26 pbw conc. H₂SO₄, 3 pbw K₂Cr₂O₇, 11 pbw DI water                                                   | • Etch at room temp. for 20 min.  
  • Rinse in tapwater then DI water.  
  • Dry in warm air. |
| Epoxy, phenolics           | Cleaning - Vapor degrease with chlorinated solvent                               | None                                                                                                     | • Follow abrasion with cleaning step. |
| Polycarbonate              | Cleaning - Vapor degrease with methyl alcohol                                   | None                                                                                                     | • Follow abrasion with cleaning step. |
| Fluorocarbons              | Cleaning - Vapor degrease with acetone or MEK                                    | 23g Na(s) 1293g Naphthalene 1 L THF  
  Add Napth. to THF carefully, adding cubes of Na slowly while stirring.  
  Let sit 16 hr at RT then stir 2 hrs. | • Immerse in the solution for 15 min at 77°F near exhaust ventilator.  
  • Wash in acetone or MEK then in cold, DI water and dry thoroughly. |
| Polyethylene, polypropylene| Cleaning - Vapor degrease with acetone or MEK                                   | 75 pbw K₂Cr₂O₇, 120 pbw DI water 1500 pbw H₂SO₄  
  Dissolve K₂Cr₂O₇ in water and stir in the H₂SO₄. | • Immerse in the solution for 60 min at 77°F.  
  • Rinse in cold, running DI water.  
  • Dry at room temperature. |
| Polyimide or polymethylmethacrylate | Cleaning - Vapor degrease with chlorinated solvent or methyl alcohol | None                                                                                                     | • Follow abrasion with cleaning step. |
| Polyurethane               | Cleaning - Vapor degrease with methyl alcohol                                   | None                                                                                                     | None   | None    |
| Glass quartz (non optical) | Cleaning - Vapor degrease with MEK                                              | 1 pbw CrO₃, 4 pbw DI water                                                                             | • Immerse 10-15 min at 77°F .  
  • Wash well in running water.  
  • Dry for 30 min at 210°F.  
  • Apply adhesive while still hot. |
| Optical grade glass        | Cleaning - Vapor degrease in an ultrasonically agitated detergent bath          | None                                                                                                     | • Rinse thoroughly.  
  • Dry <100°F. |
| Ceramics                   | Cleaning - Vapor degrease with MEK                                              | None                                                                                                     | • Follow abrasion with cleaning step.  
  • Evaporate the solvent. |

For other useful tips and surface preparation recommendations on alternate substrates, contact our Tech Service Group: techserv@epotek.com or www.epotek.com

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