Bonding Considerations

Section 5

Fundamental Practices for Achieving Good Adhesion of PSAs

Adhesion is a very complex science based on chemical and physical interactions at the surface of the adhesive and the substrate. One of the most important factors in achieving a good bond is selecting the correct adhesive or adhesive construction to permit maximum adhesion. At times, adjustments will be necessary to obtain the best overall performance in a specific application.

Selecting the Best Adhesive for the Job

Generally, rubber adhesives provide the highest adhesion to a wide variety of substrates. Because of their aggressive nature, excellent bonds are relatively easy to achieve. However, because of their limited temperature effectiveness, chemical and UV exposure resistance, these adhesives cannot always be used.

Most high-performance acrylic adhesives are relatively firm – they are typically not as aggressive or high in adhesion as their rubber counterparts. Acrylic adhesives have more difficulty bonding to low energy surfaces such as polyethylene and polypropylene. However, excellent UV, chemical and temperature resistance, along with superior durability, often dictate their selection.

Surface Preparation

For an adhesive to fully contact the substrate surface, the substrate must be dry and free of any surface contaminants. Dust and other loose particles can be wiped off with a clean cloth, blown off with an air-jet, or removed with a tack cloth. Sometimes it may be necessary to remove loosely bonded coatings (i.e., paint) by scraping or with an abrasive such as sandpaper or steel wool.

For contaminants such as oils, waxes, silicones and similar lubricating or processing materials, cleaning with a mild solvent such as isopropyl alcohol may be adequate. At times, a more aggressive solvent, such as heptane, hexane, toluene or a chlorinated solvent may be necessary. Remember: always exercise caution as these solvents are highly flammable and potentially toxic; and frequently replace cloths to effectively remove the contaminant from the surface.

Surface Contact

The elementary concept of adhesion involves getting the adhesive in contact with the substrate. The more complete the contact, the better the bond. Once surface contaminants have been removed (see above) and the correct adhesive / adhesive construction has been selected, the actual bonding process can begin.

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Coping with Surface Concerns

Because no two surfaces are alike, each may require a different approach to achieving optimal adhesion. The following are examples of approaches to several frequently encountered surfaces:

Rough or Irregular Surfaces

- The proper adhesive product construction must be selected to maximize the potential contact of the adhesive and the surface. Using enough adhesive (correct thickness) to permit the adhesive to flow into the valleys or crevices is very important.

- Sufficient pressure must be used during bonding to force adhesive into surface valleys. The amount of pressure required varies with the firmness of the adhesive and the depth of the valleys. Often this must be determined through trial and error.

- Applying heat during bonding softens the adhesive and allows it to flow into the valleys or crevices more readily. The actual temperature needed will be dependent on the selected adhesive as well as other processing conditions. Firm pressure should be used along with heat.

Mismatched or Non-Parallel Surfaces

- Often a thicker adhesive product is required to bond mismatched or non-parallel surfaces. As an example, foam tapes of varying thickness can fill the gap and compensate for the mismatched surfaces.

- Use thick transfer tapes for a relatively small mismatch.

- Very firm pressure is required to reform the adhesive product to match the unevenness of these surfaces, thus permitting more complete contact.

- It's imperative to achieve intimate adhesive contact during bonding. This will allow the adhesive to resist any tendency of the surfaces to separate after pressure is removed.

Smooth Uniform Surfaces

- A clean, smooth uniform surface is much easier to bond. The wet-out or contact of the adhesive on the substrate surface is usually more complete without having to resort to excessive pressure or heat.

- Although the surface appears to be perfectly smooth, there is always a degree of roughness that may not be visible to the naked eye. The use of good, firm pressure will help insure maximum initial contact with the surface and the maximum initial adhesion. However, with the passage of time, the adhesive will flow (cold-flow) on its own into these tiny surface irregularities. The adhesive will approach 100 percent contact, thus insuring the maximum potential bond. Typically, 24 to 48 hours of dwell time will allow the adhesive to obtain 95+ percent of its potential. Some very firm adhesives may require up to 72 hours or longer.

- One of the greatest concerns with PSAs is that complete contact is not achieved because of entrapped air during the bonding process. To prevent this, use a lamination process, featuring a laminating roll, to chase out the air as the bond is made.

- Typically, pressures of 15 to 25 lbs. per inch width of bond line are used. Higher pressures are beneficial, provided the pressure will not damage the substrate.

Guideline to Surface Energies

Adhesion is the molecular force of attraction between unlike materials, similar to a magnetic force. The strength of attraction is determined by the surface energy of the material. Therefore, the higher the surface energy, the greater the molecular attraction; the lower the surface energy, the weaker the attractive forces. Greater molecular attraction results in increased interfacial contact between an adhesive and a substrate. In other words, on a high surface energy material the adhesive can flow or wet-out to assure a stronger bond.

The following is a listing of surface energies for a variety of materials. Keep in mind that different finishes or surface treatments can affect the adhesion. Likewise, different formulations of a material can substantially alter surface energies. As a result, the numbers below are presented as a guideline.

		Surface Energy Surface Dynes/cm
Metals	Copper	1103
	Aluminum	840
	Zinc	753
	Tin	526
	Lead	458
	Stainless Steel	700 – 1100
High Surface Energy Plastics	Kapton®	50
	Phenolic	47
	Nylon	46
	Alkyd Enamel	45
	Polyester	43
	Epoxy Paint	43
	Polyurethane Paint	43
	ABS	42
	Polycarbonate	42
	PVC	39
	Noryl®	38
	Acrylic	38
Low Surface Energy Plastics	PVA	37
	Polystyrene	36
	Acetal	36
	EVA	33
	Polyethylene	31
	Polypropylene	29
	Tedlar®	28
	Teflon®	18

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