RELTEK

Adhesives and Coatings for Harsh Environments

Thermo Plastic Injection Molding Procedures for Cohesive Bonds

There are several issues to address in injection molding with thermoplastics when a bond is desired to another substrate. The following discussion applies for applications where the bond is not occurring as cohesive bond, or as strong as desired with usual molding procedures. The issues discussed here typically occur for larger molds and particularly with convoluted geometries.

A rather small molded part with simple and symmetrical geometry is usually not a problem and will not require any of the following. Simply prime the substrate with BONDiT™ A-3, A-43, C-52 or other RELTEK product and mold per normal procedures, adjusting the time-temperature-pressure variables to get the optimum results.

Description of the technical issues:

1. One issue is that when molding thermoplastic materials of any significant volume, the melt flow will not whet the substrate because the leading interface of the melt is "cold" and contacting a "cold" substrate. The sense of it is like recoiling from touching something cold when expecting it to be warm.

Sometimes, preheating the substrate, slowing down the flow and holding the pressure longer under higher heat can work. Be careful not to scorch the polymer.

2. A second factor is the pressure distribution of the larger melt volume can be very non-uniform over the entire part surface due to the geometry of the part and gating arrangement of the mold. The pressure can be balanced by providing multiple gates in the mold.

The combination of factors 1 and 2 may be revealed in noticing the polymer is bonded immediately under the gate where the melt is hottest and pressure the highest for the longest time. But, not bonded elsewhere or the bonding is spotty where there are high pressure and hot spots.

3. The third factor is that under higher temperatures and pressures--say above 175°C to 200°C, the primer adhesion strength to the substrate may weaken sufficiently for the primer to be abraded off the substrate due to the high abrasive forces of the polymer flow.

The Solution

The solution is to mold a "thin" layer of the thermoplastic on the primed substrate and then mold the large volume over that thin layer and allow inter-melt. That works very well, is repeatable, produces consistent results and is reliable in the long term. "Thin" is relative to the size and geometry of the part being overmolded, and the mold volume.

Any method to create the thin layer is acceptable. One method is to make a film of the polymer, and lay it over the substrate. Then melt the film to the substrate with any convenient heat source -- hot air gun, oven, hot plate, heated band around the part -- are all ideas that have been successfully used. The film will whet the primer and bond very well. You can easily confirm the quality of the bond before overmolding.

For faster work when doing large quantities of parts, you can mold a thin layer on using a mold for that purpose. Customers have successfully done this for polyethylene on metal connectors made of titanium, stainless steel, and Monel.

Another fast approach is wrapping a heated metal band around a part being overmolded, like a connector backshell, to melt and whet the thin film of TPU or PE or other thermoplastic to the adhesion promoter. The turn-around time on this is fast and convenient.

In a particularly difficult case involving a very large connector molded with PE, RELTEK molded a thin layer using a modified blend developed by RELTEK of PE so it has high adhesion properties itself; then overmolded with standard PE resin. That system was qualified for twenty-year life on the Sea Wolf submarine.

Conclusion

All the solutions offered here can produce a cohesive bond to the metal substrate that is stronger than the polymer. They have been used by RELTEK, our customers and have been qualified under contract with the U.S. Navy for application of PE and TPU to electrical connectors of many substrates for harsh environments.

Materials

BONDiT A-3 and A-43 are adhesion promoters particularly useful for bonding TPU to metals, glass and ceramic. The A-3 provides exceptionally high chemical resistance. The A-43 is higher concentration and more reactive than A-3. Hence, A-43 tends to be less process sensitive.

BONDiT C-52 is an excellent adhesion promoter for polyethylene for metals, glass and ceramic. Bonds are stronger than the PE. Materials tested are HDPE and MDPE and various polyethylene blends. It is also suitable for flouropolymers, acrylics, and polycarbonates.

Nylons are responsive to BONDiT A-3, A-43 and C-6.

Thermoset materials are responsive to A-3, A-43 and A-53.

RELTEK has numerous other adhesion promoters and will custom formulate materials on request.

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