LOCTITE®

Hard to Bond Plastics?

Designer Tip – Surface Treatment!

Have you ever selected a pliable, chemical resistant, low cost plastic that seemed to meet all of your medical device needs only to discover it won't adhere to anything when scaling up to large performance and qualification builds? As a contract manufacturer, have you ever wondered how certain materials were selected on drawings, but more importantly, how you will ever bond them? If you've answered yes to one of these questions, you're not alone.

These scenarios are commonplace in the ever-changing world of plastics but fortunately there are ways to combat the challenges of bonding certain plastics, even in the 9th inning when it seems too late to turn things around. The solution lies in Surface Treatment!

There are four main types of surface treatment that rely on a layer of ionized gas at the polymer surface. They are: **Corona, Flame, Plasma in Vacuum and Plasma in Air.**

Corona Treatment

MOST COMMON USE: POLYOLEFINS

In a corona discharge process, the plastic is exposed to an electrical discharge, usually in the presence of air and at atmospheric pressure which creates a plasma "field." This process roughens the surface, which provides sites for mechanical interlocking, and introduces reactive sites on the plastic's surface, consequently increasing the wettability and reactivity of the surface.

Corona treatment systems form a layer of ionized gas by applying a high voltage differential between two opposing electrodes. The plastic film being treated is typically placed between the electrodes which produces streamer like discharges that ionize the atmosphere at the substrate surface. The reactive functionalities which are theorized to be introduced to the surface may include, but are not proven to be, carbonyl, hydroxyl, hydroperoxide, aldehyde, ether, ester, and carboxylic acid groups, as well as unsaturated bonds.

This method also offers the advantage of in-line utility at atmospheric pressure plus achieves an electron density greater than that achieved with flame treatment. Despite these advantages, this treatment does not have the ability to uniformly treat surfaces or reach into deeper surface features. In addition, substrates thicker than 0.125" do not generally work well with corona discharge. Corona treaters must be used with caution due to the high voltages they employ.

Flame Treatment

MOST COMMON USE: POLYOLEFINS, POLYACETALS, POLYETHYLENE TEREPHTHALATE

A combustion flame results from the burning of propane or butane which is aimed at the polymer surface. Care must be taken to adjust the flame, so it is an oxidizing flame (blue tint). The resulting ionized gas is generally lower in electron density than is achieved by other means and the flame temperature can degrade most polymer surfaces. If the surface reaches too high of a temperature, it will cause charring and effectively reduce bonding performance. To prevent this, exposure time and flame distance must be dialed in for maximum performance. This method offers the processing advantage of in-line use at atmospheric pressure. In addition, equipment required to employ flame treatment is a low capital investment. It should be noted open flames can be a concern in manufacturing plants where volatile organic chemicals may be in use.

Plasma Treatment in a Vacuum (or Low Pressure)

MOST COMMON USE: POLYOLEFINS, POLYESTERS, AND MANY MORE

In this method, parts are placed in a chamber, a vacuum is pulled, and a small amount of gas is fed back into the chamber. A gas plasma is formed using high frequency RF energy. By placing low concentrations of various types of gases in the chamber (e.g., Oxygen, Argon, Helium) it is possible to control the types of new reactive groups formed on the substrate surface. The ionized gas plasma produced in this method is much more uniform than that generated by corona discharge. Since it is uniform it can be used effectively to treat 3-dimensional parts. The need for a vacuum however makes it necessary to batch process parts treated with this process. Some polymers such as fluoropolymers do not respond well to corona treatment but can be processed using plasma treatment.

Plasma Treatment at Atmospheric Pressure

MOST COMMON USE: POLYOLEFINS, POLYESTERS, MANY MORE

This method offers the advantage of a uniform plasma discharge without requiring the use of vacuum equipment. This is a newer technology and several techniques are being used. One approach involves injecting noble gases into the discharge gap, which eliminates the streamers that confound corona's efforts to uniformly treat a surface. This method also uses lower voltages than corona so unwanted treatment of a plastic film's backside is avoided.

Other Surface Treatments

Primers – Commonly used with Acetals, Fluoropolymers, Polybutylene, Terephthalate, Polyolefins, Polyurethanes, Silicones

Primers typically consist of a reactive chemical species dispersed in a solvent. To use the primer, the solution is brushed or sprayed onto the substrate surface. The carrier solvent is then allowed to flash off, leaving the active species behind. Depending on the type of primer, the surface may be ready to bond immediately, as in the case of polyolefin primers for cyanoacrylates. In other cases, the surface may require time to react with atmospheric moisture before the application of the adhesive. Primers that must react with atmospheric moisture include silane and isocyanate-based primers which are typically used for silicone and polyurethane-based adhesives respectively. Surface primers generally improve substrate bondability by acting as a chemical bridge between the substrate and the adhesive. Typically, the reactive species in a primer will be multifunctional, with one set of reactive groups that will preferentially react with the substrate surface, and additional groups that will have a high affinity for the adhesive.

Surface Roughening – effective on many plastics

Surface roughening is a simple, low-cost method of increasing the bondability of many plastics by dramatically increasing the number of mechanical interlocking sites. To determine if it will be effective on a specific plastic material, refer to the Loctite® Design Guide for Bonding Plastics.