Cork Tech TalkNews

Manufacturers of Waterbase, UV+EB Curable Coatings, Varnishes and Adhesives

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VARNISHING OR COATING PLASTICS?

Aqueous, UV and EB varnishes and coatings whose solids can be described as liquid plastics, become plastic films after they are dried, and/or cured.

When we varnish or coat plastic substrates, we can consider that we then have two plastic materials in intimate contact.

Adhesion, a performance property normally sought, is achieved through a dependence on surface tension and intimate contact. This is a result of aqueous, UV and EB varnishes and coatings being formulated without the use of low molecular weight, low energy solvents to physically bite into plastic substrates. The adhesion obtained is described as being like the mutually attractive forces that make it difficult for us to open a new plastic garbage bag with its two film sides in intimate contact.

In coating plastic substrates it is important that the surface energy of the surface well exceeds the surface tension of the varnish or coating being applied. We can think of the surface energy of a plastic substrate as the ability to attract a liquid, and the surface tension of a varnish or coating as the resistance to spreading. Surface tension is the property of liquids that makes the exposed surface area want to contract to the smallest possible area, as in the spheroidal forming of a drop due to the cohesive attraction between molecules.

Plastics are formed from non-polar, long chain molecules resulting in a surface that has little free energy and is, in a word, **inert.** It follows that these plastic surfaces lack bonding sites which are present when charged ions are distributed over the surface. Liquids cannot wet a surface without this molecular attraction. Additionally, the higher the surface energy of a surface, the greater the internal cohesive force and inter-molecular attraction, and the less adhesiveness there is to another material.

Adhesion failures are not the only problems encountered in coating plastics. Wettability problems also result in coated surface defects evidenced by pin-holes, craters and a lack of uniform coverage.

The solution to the wettability/adhesion problems inherent to plastics, is to alter the inert plastic surface chemically to increase it's polarity and surface energy so that bonding sites are created across the surface.

This is accomplished by several methods among which are: corona, flame and cold plasma treating. These techniques function by exciting air molecules to induce an ionized air stream, generating free radicals. The plastic substrates' surface is bombarded and **oxidized** creating reactive chemical sites forming carbonyl and hydroxyl groups.

Effective treatment improves wettability so that liquid plastic varnishes and coatings can flow out and completely cover the plastic substrate. Additionally, the free radical bonding sites allow a molecular bond to develop so that plastic varnishes or coatings can adhere effectively after drying and/or curing.

Virgin plastic substrates vary greatly in natural surface energy. Beyond this, they can exhibit lower surface energy levels due to contamination brought on by plastisizers, anti-stats, waxes, and other lubricants added to improve performance.

Suffice it to say that all non-porous plastic substrates should be considered a challenge for varnishing and coating with other plastic liquids. They are especially challenging for aqueous coatings since there is no absorption of the water component into the substrate. All of the volatile water component must be removed by evaporation during the drying process. Fast drying formulations are a must. 100% solid UV and EB formulations are different in that there are no volatiles to be driven off.

Surface energy values for common plastics:

Substrate	**Dynes/cm2**
Polyester (PET)	*43*
Polyethylene (PE)	*31*
Polypropylene (PP)	*31*
Polystyrene (PS)	*33-35*
Polyvinyl chloride (PVC)	*33-38*

In order to varnish and coat obtaining good flow out and lay to a plastic substrate with the prospect of good adhesion, the surface tension of the liquid varnish or coating must less than the surface energy of the plastic substrate and any inks printed on it.

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Cork Industries, Inc. 500 Kaiser Drive Folcroft, PA 19032 610.522.9550 F 610.522.9659
Elmer W. Griese, Jr. 440.353-0980 ewgriese.cork@att.net
Website http://www.corkindustries.com

Opinions differ as to how much lower the surface tension of a varnish or coating must be in relation to the surface energy of a substrate. Some say a practical range of difference between 7 and 10 dynes is necessary to achieve acceptable performance.

Typically, UV/EB and aqueous varnishes/ coatings have dyne levels of 30-38. Therefore, treatment levels would have to be in the 37- 48 range for plastic substrates. This treatment level is the treatment level seen at the varnishing/coating station not as treated earlier. The treatment level provided by plastic film and sheet manufacturers will vary and the treatment level also deteriorates over time.

Obviously, the chart above indicates that most virgin plastic substrates will require treatment in-order to effectively print, varnish or coat them. Some converters decide to in-line-treat all plastic substrates processed, removing the concern of whether to treat or not. A benefit of this approach is that in-line treatment effectively eliminates or removes potential contamination from various sources or from additives that can migrate to the plastic surface over time.

There are a number of methods to measure the surface energy, or treatment level of non-porous substrates. One, is to use surface tension (dyne level) test fluids. This method is widely used to test, and measure the wetting of non-porous plastic and other substrates to predict adhesiveness. In the test, if a selected dyne solution wets the tested surface, then it's dyne level is lower than the substrates. If, on the other hand, it quickly forms beads, its dyne level is greater than that of the substrate. The test procedure is outlined in ASTM D 2578. An alternative test utilizes dyne test marker pens. Unfortunately, most of these are flawed by the fact that they become contaminated easily and quickly in use, skewing the dyne readings thereafter. There is one pen design, the **ACCU-DYNE-TEST** marker pen, that eliminates wicking of contaminants from the substrate allowing continuous reliability.

Both aqueous and UV/EB formulations can benefit from the formulators expertise when it comes to coating difficult substrates. Choosing proper raw materials, including additives to lower the surface tension of the finished formulation, is critical to achieving defect free coating flow-out and substrate wetting. Proper formulation can produce coatings that dry and/or cure with minimum shrinkage, good flexibility and even some bite to produce a stress free intimate bond. Shrinkage of coatings after drying and/or curing is a key issue in that shrinkage produces stress which will act destructively on fragile plastic to plastic adhesiveness.

Be aware too that some difficult to coat plastic substrates will be primer coated. This plastic primer surface, must be considered for its own unique surface energy level as must be any inks to be over coated/varnished.

Whenever you consider coating, consider ***CORK!*** ....for leading expertise in formulating.

LOOK TO CORK!....... for all of your coating and varnish needs, for both aqueous & UV/EB coatings and varnishes.