Coated Vs. Uncoated UV Inkjet Film

The 'how' and 'why' of coated material; a guide to understanding if the investment will be worth it.

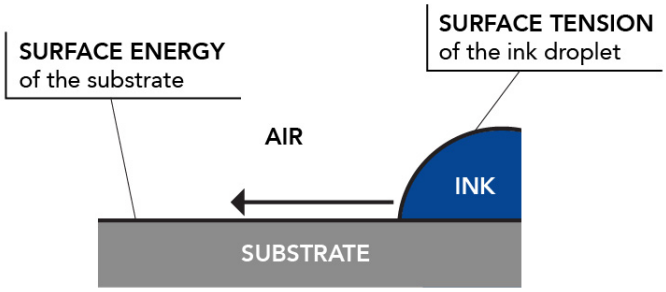
When you decide to print with a UV Inkjet platform, you've probably chosen that method for a number of reasons; durability, color gamut, reduced post-cure time. At the same time, one of the main benefits of UV inkjet printing is the inks ability to adhere to almost anything. You can print on everything from board stock to golf balls, without sacrificing vibrant colors and tight, detailed imagery. But sometimes, there are applications that may require 'above and beyond' ink adhesion. With the advancements in UV inks and media, it's hard to know when a specialty coating is worth the upfront cost to save you time and money downstream.

The dyne level, chemical compatibility of the ink and the material surface are the deciding factors in how great your adhesion levels will be. Each inkjet ink set has variables in its chemical makeup that will require testing before production. However, there are a few known guidelines to give you the best starting point.

Dyne Levels

Dyne is a unit of measurement for the surface tension of the material. Surface tension is an indicator of how well a liquid will wet out across a plastic film. The elastic tendency (surface tension) is what determines how much surface area a liquid acquires when placed on the substrate, which causes the initial bond and ink droplet placement (See figure 1). A good 'rule of thumb' is to make sure dyne levels of the material's surface are 10 dynes greater than the inks surface energy. This dyne level increase generally will provide an adequate surface for adhesion and desired print quality.

Figure 1



Compatibility

In addition to dyne levels, the material needs to be compatible with the ink-set. With plastic substrates, the surface's make-up can vary during processing due to temperatures, surface migration, and surface roughness, which can have an effect on the bond. Ultimately, proper dyne levels or not, the ink and the substrate need to adhere to one another.

Mechanical Interlocking

With UV ink, the ink intends to sit on the surface, and will cure and stick with minimal post-process handling. However, for situations that require more complex post-processing, the desired adhesion required is created with a level of bond that needs to take place: mechanical interlocking. Mechanical interlocking theory is defined by how the substrate surface engages with the ink. This engagement allows the ink to 'lock' in place, once cured. The ink fills into the hills and valleys of the material surface and traps them together. With certain polymers, the chemicals in the ink have an effect on the surface of the substrate. As a result, valleys are created and the surface roughens, which allows for a mechanical bond. See figure 2.

Figure 2.

Chemical Bonding

Chemical bonding occurs when the ink's chemical make-up and the surface it is adhering to have been formulated to combine on a molecular level in such a way that a bond is formed. This bond is greater than the force being applied against it, creating the most desirable ink adhesion for UV printing.

Which Materials Work Best

Here's a quick guide to understanding plastic substrates so you can better predict the right film for your application.

Rigid Vinyl and Polystyrene

Polyvinyl Chloride (PVC) and High Impact Styrene (HIPS) tend to maintain higher dyne levels than polyesters or polycarbonate, making them an easy go-to for UV inkjet printing. In combination with the optimal surface tension, the make-up of these substrates plays an active role in the bond. The chemical within the ink, no matter how slight, roughen up the surface of PVC and HIPS just enough to allow for mechanical interlocking. These films are most likely to be used for signage, point-of-purchase and promotional items that are less likely to need long-term durability or post-processing that includes adhesive being applied directly to the ink. Primer is generally not required.

Polyester

Polyester (PET) film is often one of the desired options when UV inkjet printing due to its optical brilliance and durability. This substrate inherently matches the vibrancy and durability of UV inkjet inks. It can be a great choice for POP signage, backlit signs and promotional materials that need a higher-end look. However, PET does not inherently hold dyne levels that are optimal for long-term adhesion. Therefore, this material works best with UV inkjet inks if the material is offered with a print-treatment. This allows for enough surface tension for proper wetting and a chemical compatibility to allow chemical bonding. Print treatment is usually recommended.

Polycarbonate

Polycarbonate (PC) does not naturally maintain a high dyne level, leaving the raw substrate at a disadvantage for UV inkjet ink anchorage. PC also tends to be less naturally porous with fewer voids or crevasses. This creates an aesthetically pleasing choice for a high-end and durable substrate, but it does not allow for the material to have much for the ink to adhere to. When polycarbonate is textured, the topography imposed on the surface does not create voids fitting for a mechanical bond, as these are typically too large. The amount of ink required to fill the void does not allow for proper curing to take place for secure bond to take place.

Due to the smooth surface of the material, polycarbonate will accept ink. However, the ink is not likely to withstand any aggressive post-processing or heavy use in the field. In these situations, a proper print-treat coating on the material will be the best solution to ensure adequate adhesion. The coating allows the ink form a chemical bond, as the coating has been specially formulated to bond to the specific substrate.

Polycarbonate is typically used for applications with UV inks that require a higher-end visual or higher-stress end use application, due to its durable nature. For instance, backlit signage reverse sign graphics, which generally require adhesive to be applied to the ink directly before mounting. When a chemical bond between the ink and the coating have been formed, you have an increased probability that the force of the adhesive being applied in the post-process will be less than the bond itself, allowing for optimal ink adhesion. Primer is recommended.

Testing/Conclusion

When choosing the best material for your application, the end use and post-processes the printed material will go through are the most important factors. If there will be adhesive applied to the ink after printing, it is recommended that you test the material with an ASTM D3359 cross-hatch tape test for ink adhesion. (See Figure 3). If the material can pass this test, you should feel comfortable using it for production. If the printed material does not pass this testing, you need to evaluate the handling the material will have, if enhanced ink anchorage is desired, and if the delta between the costs of coated films vs. uncoated films is justified in the value of the optimally-performing material. Keep in mind that 24-72 hours of post-cure time is typically recommended, even if the inks feel dry to the touch. Inks will continue to out gas any excessive chemicals, which can affect your desired outcome during the post processing or cause field failures. Refer to your ink manufacturer's recommendation for post-cure time.

Figure 3