Kalcor University

UV Curable Coatings

Or…curing at the speed of light.

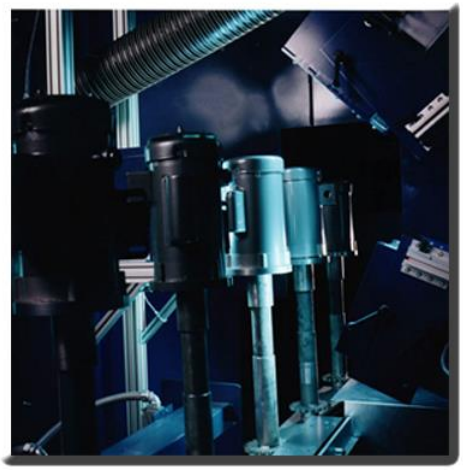
From eyeglass lenses to hardwood flooring; from magazine covers to your car headlight -- UV coatings are ubiquitous. You find manufacturers in increasing numbers turning to UV beause of some key advantages:

High Speed

Compared to most thermally cured paints UV coatings cure extremely fast; almost instantly. This makes them an obvious choice for high speed production such as printing, fiber optic cable, CD and DVD production and other high speed processes. But time also translates into other advantages.

Low Contamination

If a coating cures rapidly, the reduction in "open time" presents less opportunity for plant and other airborne contaminants to get into the finish and cause defects. Unlike typical convection ovens, UV curing generally has much less moving air to stir up dirt. For cosmetic parts this means less scrap and rework due to dirt.



Small Space Requirements

UV lines can be compact in size since the need for long convection ovens is frequently eliminated. This savings allows for leaner manufacturing, and just-in-time production to reduce WIP and production scheduling hassles. Plastic parts for example can be placed from the mold directly onto the finishing line.

Coating Performance

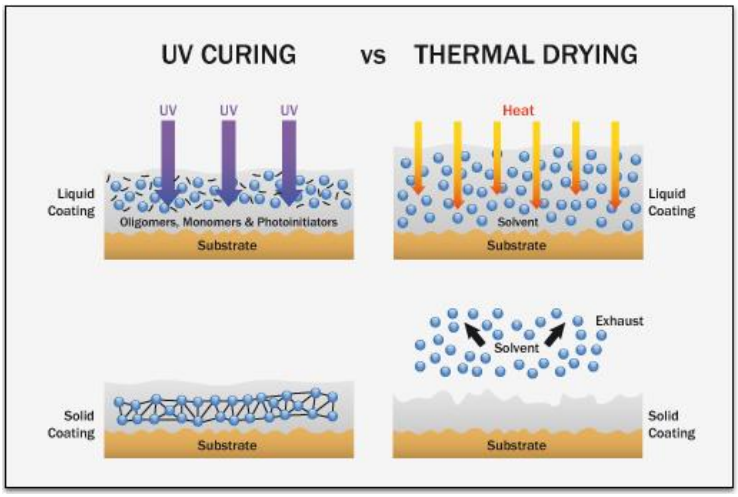
UV coatings are by nature, highly cross-linked materials with lots of bonds among the resins. This typically results in properties such as harder surfaces with high scratch and mar resistance. Though this does not mean that all UV cured materials are brittle and inflexible – in fact formulations for flexible and soft touch are commercially available.

Environmentally Friendly

Many UV coatings are formulated with few if any solvents. 100% solids UV material eliminates Hazardous Air Pollutants (HAPS) and volitile organic compaounds (VOCs). One reason is that many UV coatings use shorter chain length monomers and oligimers as reactive dliuents in place of traditional

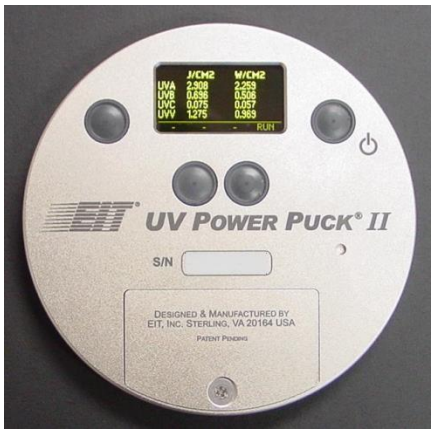
solvents. This makes UV materials an excellent “green” technology. So, if that all sounds good you might ask: How does UV curing work?

UV coatings, like other coatings, are a mixture of several ingredients. Many of these materials serve the same purpose in a UV coating that they do in a conventionally cured coatings. Resins, pigments, and additives for properties such as gloss reduction, adhesion promootion and other functions are common to both technologies.



In addition, UV coatings contain photo-reactive agents called photoinitiators. When these photoinitiators are exposed to high intensity “light” in the Ultraviolet region of the spectrum (usually around 250-400 nanometers) the energetic UV rays cause some atomic bonds on the photoinitator molecules to break - quickly.

As atoms are rapidly cleaved off of the photoinitiator a highly-reactive molecule called a free radical results. These free radicals bond rapidly through a propagation process with atoms on the monomers and oligimers to form long polymer chains. The process finally temrinates and the resulting polymer is a durable film or coating.

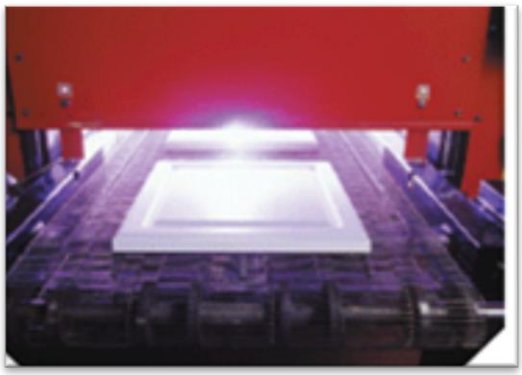


To completely cure, the UV coating needs to see enough high energy UV wavelength for a long enough time to complete the free-radical polymerization. So the specification for UV formulations should have three important features:

1. The ***wavelength*** of the UV source (in nanometers) needed for full cure. This is determined by the chemistry of the coating. Some coatings require a blend of photoinitiators to achieve the costmetic and appearancequalities desired.

2. The energy level of the UV source, called ***irradiance*** and typically measured in Watts/square centimeter. Irradiance is determined by the intensity of the light source but also the distance from the lamp to your parts.

3. The total exposure to UV, (called ***energy density***, or sometimes "***dose***")which is the product of the irradiance over a length of time and typically expressed in Joules/square centimeter. This is similar to thermal coatings "time at temperature". And just like cooking a cake – there is an interplay between irradiance and dose. If a cake recipe calls 30 minutes in a 350 degree oven, you won't get very good results if you try to cheat on either of these variables. (You couldn't just turn the oven up to 1200 degrees and try to cook a cake for 5 minutes for instance.)



Proper formulation of UV curable coatings requires some special expertise that Kalcor has developed. As with any coating, proper selection of the materials constituants along with an understanding of how they interact is necessary. But with UV there are the added complexities of the UV curing photochemistry mechanism and how these additives will perform over time. With improper selection or the wrong amounts of photinitiator both cost and performance are comprimised. Yellowing over time can take place and propertiese can change as the material continues to absorb UV afterintial cure.

One fundamental difference between thermal curing and UV curing however is that UV curing required geometries such as flat parts, bottles, gas cyclinders and any part that is free from hard-to-see shadow areas.

UV coatings can be formulated with a wide range of properties inclding clear or pigmented coatings, hard or soft touch, rigid or flexible coatings, indoor or exterior UV weatherable formulas. Kalcor has developed UV formulations for perfume and other cosmetic containers, interior parts for automobiles, and exterior grade coatings for building products like home siding.

While UV coatings require UV lamps, these are readilly available from a number of commercial suppliers and come in a wide range of lamp sizes and output levels to meet most industrial applications.

UV curing can be a safe – even safer process than conventional curing or drying. Since there are frequently less HAPS and VOCs, the coatings themselves may present fewer application related dangers.

The skin irritability and odor problemsthat plaugued early UV cure chemistry have been largely outmoded.

On the equipment side, UV light sources must be properly installed and operated to avoid direct worker exposure to high intensity UV light. UV light, especially at the shorter wavelengths common to coatings can the damage skin and eyes. Proper light sheilding and safety interlocks to protect operators for exposure to UV will permit UV curing to be used without danger. Arc and mercury lamps also contain small amounts of mercury and so lamps should be handled and dsiposed of according to safety procedures and local regulations.