Radiation Curable Coatings — a New Coatings Process to Consider

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Radiation curable coatings identifies a method used to cure coatings. These coatings are formulated specifically to cure or cross-link with ultraviolet light being directed onto the UV coating at various UV light energy levels.

Many UV light sources are available from many manufacturers, each one differs somewhat which may have qualities more desirable for the user than others. Various dosages are also available but keep in mind that these dosages must be compatible with a specific need and use.

Radiation curing processes are used for many different applications but because this is the Society of Vacuum Coaters, the emphasis will keep in step with the vacuum deposition of aluminum onto many different substrates. At Red Spot, our affiliation has been to supply basecoats and topcoats to the industry which heretofore were either thermo cured or air dry types. While thermo cured coatings were more popular for basecoats by necessity, thermo cured topcoats were also used on applications where more stringent coating performance specifications were needed.

As you know, the majority of parts being vacuum metallized were and are plastics. Plastics come in many different types, each with its own characteristics of sensitivity to solvents, resins, temperature for the coating manufacturer to consider.

Thus, coating manufacturers had no choice but to use solvents that did not attack the plastic and resins that allowed the coatings to cure and have adhesion to the substrate. The next thing that occurred was the race to cure the coatings - putting one coating manufacturer against the other in order to shorten the curing process - which after all means money to the processor.

Here at the processing point was where costs began to soar! Costs of the coating was not the real problem that processing was. While energy costs soared, so did tooling. UV curable coatings processes promised to reduce these costs dramatically, at the same time, plastics appeared, which were lower cost materials but difficult to get the proper build with thermo cured systems. Better results were found with UV curable coatings and advantages were discovered that had not been predicted.

In short - Radiation Curable Coatings were quickly accepted to lower the cost of processing and yet yield a far superior product.

How did the cost of production lower -

A. 1. A three (3) minute cure of the basecoat compared to one (1) to two (2) hours.
   2. A three (3) minute cure of the topcoat compared to one (1) to two (2) hours.
   3. Tooling cost cut by as much as 10-1 via less tools needed for racks and fixtures used to hold parts during cure, for production requirements.
   4. Space needed for production.

B. 1. Less rejects - better flow - more cleanliness.
   2. More chemical resistance.
   3. Better scratch resistance to handling, packing, assembly, etc...

C. 1. Better utilization of coating use. (Better stability - non oxidation type coatings.)

WHAT'S DIFFERENT ABOUT UV RADIATION TECHNOLOGY

UV curable coatings are highly-unsaturated. They attempt to cure to satisfy their need but cure results only from UV exposure to a certain dosage of UV energy. They may be "satisfied" with strong alkaline solutions but this only renders them practically harmless to skin contact.

UV curable coatings may be formulated in many versions. For instance VOC's are easier to control for local, state or federal regulations. Some misunderstanding exists relative to solids but is easily explained. For instance, some formulators use the term- 100% solids to identify their products when in effect the coating may be far less non-volatile but merely is a 100% convertible coating at cure.

A new term used more often than the word "cure" is "cross link density". High cross link density measures the degree of cure relative to cure hardness, chemical resistance, brittleness of scribed coating. Much harder and more chemical resistant are UV curable coatings.

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UV curable coatings may be sprayed, flowcoated - dipped - rolled or just about any method used on thermo-cured coatings. Manual spray is not recommended due to possible skin contact but automation should be used in all applications.

UV light dosages are very similar to the way vacuum metallized aluminum travels to the part. UV dose travels in a straight line- same as vacuum metallized films. Thus, if a three dimensional part is to be cured, it must rotate in order that all surfaces (All areas to be vacuum metallized must see the aluminum source.) see the proper dose of UV energy. Proper dosages to cure the coated part may be adjusted by controlling the time exposure, angle of exposure, distance from UV source - rotational speeds and power output of the bulb.(bulbs) Most current applications utilize clear or flattened clears for satin effects. Tinted gold, brass, copper or transparencies are not in use at this time due to the fading of tints during high dosage levels of UV energy.

Opaque coatings also are not available due to a lack of cure propagation throughout the coating film which the pigmented opaque materials shield the transmission of the UV energy through the coating film.

HOW TO CONSIDER UV TECHNOLOGY

The automotive lighting industry currently utilizes UV technology for all the previously mentioned reasons. Mostly, the substrates are glass filled substrates of the thermoset type. UV coating allows one basecoat to be used which is not only a high solids coating, but also a coating that cures at a very low temperature exposure. This prevents the glass wicking that occurs with a thermo temperature cure. Actually, the coating surface cures very quickly upon exposure to UV energy and this also prevents wicking of the glass filler.

Some custom shops exist which can advise whether UV is for your application. Of course, we have a complete UV applications laboratory which also can assist you in your decision.

THE MOST COMMON PROBLEMS OF UV COATINGS

UV coatings differ vastly from thermo cure coatings due to their chemistry. UV coatings are referred to as “unsaturated”. This basically means they are constantly trying to satisfy the need to cure by coming into contact with everything from the container they are shipped in to the final application to the substrate. Spray guns, hoses, flowcoaters, pumps, and even people’s skin if contacted becomes to the coating a possible means of cure of “satisfaction” of its unsaturated nature.

By understanding this one characteristic, you can quickly see and understand that these coatings are very different in nature.

It then becomes an educational process for identification of problems caused by the nature of the coating on a particular substrate.

While it is not our intent to teach you how to formulate UV coatings, it is our intent to educate you to the fact that this is new technology and a complete new set of terminologies come with this system. We all know about such things as attack, stress relieving, iridescence, drop-thru, brittleness, adhesion, soak-in, but with UV coating use, we define the problems as they actually occur. This means changing some of the terms which define the problem or problems more completely and exact. For instance, cure and the degree of cure may be called cross-link density. With UV, there’s either cure or no cure. Once the coating is exposed to the proper UV dosage, it cures — period. If you have areas on the part that is not cured, then its not receiving the proper dosage of UV energy.

Proper dosage must occur to accomplish cure and this must be as close to perpendicular to the surface as possible. UV energy hitting the surface which is at a very low angle may reflect away from the coating surface and not cure. After being exposed to low UV energy (low dosage) it is often “kicked out” and leaves a dull or semi-wrinkled uncured area. So, it is very important to maintain the proper UV dosage in the proper exposure angle to achieve cure. Experience has shown UV systems to be sensitive to many substrates. Specialized formulations and processes are common but universal UV coating systems are available as the use of UV coatings increases. For instance, these individual systems are being used on BMC, Nylon, Polycarbonate, ABS, Acrylic at the present time. By using a universal systems, the use of one UV system can be used on more than just one or two substrates any many specific coating needs.

Another common problem is the belief that any coating may be used in any system or to put it another way, some try to use UV coatings in conventional thermo cure coating systems. Generally, this doesn’t work! To be successful with UV coating use and realize the full potential of its capabilities while not compromising the safety of operators we have and do recommend equipment manufactured for the specific need and use and for maximum utilization of the technology. These are the successful systems.

Specialty equipment manufacturers do exist and more and more are showing interest but only one or two understand UV technology at this point which we consider being very important to the successful use of this new technology. Another common problem is fixtures for the UV coating process.

In very few cases are the fixtures for thermo cure coatings suitable for UV cure coatings. There are lots of reasons for this but the most common reason is “load density” of the thermo cure system. Because UV requires full exposure to UV

light, the fixture load density will be less due to the need to space parts farther apart. Most all parts are three dimensional and keep in mind the UV energy must "see" the areas to be cured.

Smaller fixtures for mounting the parts must be used in order to keep from "shadowing" and preventing UV energy from getting to areas to be cured. Rotation often is absolutely necessary as well as movement of reels while exposed to UV energy in order to expose areas that would otherwise mask the areas to be cured.

Avoid "masking" areas to be cured with large spring clips which shadow the UV from penetrating and cure. Remember - if areas are not cured, the raw coating - when touched - is the same as it's right from the container and may cause skin burns.

HOW TO GO ABOUT CONSIDERING UV FOR YOUR USE

First, you must consider your needs whether they may be more temperature resistance, more chemical resistance, more mar resistance, humidity resistance, salt spray or maybe process related.

Red Spot has made a commitment by providing a UV applications laboratory. UV equipment suppliers for curing equipment also have equipment available for trial use. In fact most equipment manufacturers for UV cure devices advise the customer on how many lamps needed and guarantee the proper cure.

Next, consult with your coating supplier on what is needed equipment wise and have some parts finished and tested to your specifications. Red Spot also has a list of all equipment manufacturers which is available. Determine if your best entry is via custom shop prior to your final commitment.

Evaluate your company and determine if you can meet the challenge UV technology offers. Include all areas of the process, and the results you expect and hold meetings with all proposed suppliers to confirm or deny the expected results. Include all safety issues relative to handling and disposal of refuse.

Check the issues of non-pollution and other environmental requirements.

THERMOCURE VS UV CURE

Thermocure and airdry type coatings have been used on plastics since the beginning of painting plastics began. Most of the early coatings were the air dry or evaporative types. Cure was achieved through evaporation of solvents as well as oxidation of the resin systems.

Eventually, the use of decorative plastics grew to the point that necessitated such improvements to the coating as mar resistance, hardness, adhesion, humidity, salt spray, thermocycling, weatherometer, fadeometer and many other areas of testing that the part would possibly encounter.

With every new plastic came new molding specifications for molding—also new coating specifications, and new process methods.

With each new process came a new set performance specification.

This kept the whole industry busy all the time to basically improve each phase of the process from the substrate to actual use of the part all the time.

Our problems were well known to molders and decorators as related to each phase of the process. Both molders and decorators exchanged one another's problems and solutions as the SVC, SPE, SPI and other professional groups.

Somewhere in the background were designers who no doubt had great "visions" of "nothing's impossible" and moved the use of plastics applications forward at a great speed.

The designer was assisted by plastic resin manufacturers who also saw the need for much more strength and durability which would enhance the use of plastics.

This opened the door of opportunity to the coating systems that met the expectations set for performance —and in most cases exceeded the minimums set as guidelines.

Coating manufacturers never had the opportunity to really revolutionize the industry other than meet or exceed minimums. A few times in past history, developments of coatings and process technology improved a lot of processes, but not as significantly as the UV curable coating process.

WHAT HAD TO BE DONE

Lighten the weight of an automobile
Allow design flexibility
Improve durability
Improve "light redundancy"
Improve "light availability in minor road hazards"
Compete with glass
Improve light distribution
Reduce costs
Be high production feasible

The list could go on and on but each of these goals were achieved—with UV being a great contributing factor.

The first UV application for three-dimensional use was a 1984 Corvette reflector molded of 20% glass filled polyester. The part was being finished with two coats of basecoat, each coating was thermo cured for two hours, vacuum metallized and topcoated with one coat of an exterior quality air dry topcoat (which was force dried one hour at 150°F for processing speed).

With UV, one coat of basecoat was applied, allowed to "flash" for ten minutes and UV cured for three minutes, vacuum metallized and topcoated with and air dry topcoat and the process was complete in about 45 minutes total versus five hours plus for thermo-cure.

COMMON APPLICATION QUESTIONS (1)

For vacuum metallizing, may an air dry or thermocure topcoat be used?

Can pigmented overlays be applied over UV cured coatings?

May UV coatings be applied over air dry or thermocured coatings?

Can UV coatings be hot-stamped?

May they be tampo printed (golf balls, etc.)?

How chemical resistant and what chemicals (MEK, n-Butyl Acetate, gasoline, tar remover, waxes) effect:

WX testing
Xenon testing
Florida weathering tests
EMMA testing
EMMA "AMAQUA" testing
QUV
Scratch steel-wool tests
Cosmetics

COMMON APPLICATION QUESTIONS (2)

Can UV coatings be masked when sprayed?

Who teaches the proper use and handling UV coatings and equipment?

How do we pick an equipment supplier?

Should we spray or flowcoat?

Are custom houses available?

How hot does the part being cured get?

How can we "cool" the part during "cure"?

Can the part be overcured?
Warp—yes, Overcure—no