

How to Properly Maintain Your UV Production System

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Key Goals: Eliminating Variability in Your UV System

You have installed a UV coating system. Now the question is, “how do you intend to maintain your UV system to insure your production throughput is optimized?”

The goal of this article is to provide you with an overview of the industry’s best recommendations to

properly insure that your UV coating system is capable for the long-term. This feedback is based on reviewing more than 200 successful UV applications in a variety of markets and customers, along with consulting industry experts in the UV technology field. This article also provides

best practices for effectively maintaining your UV production system.

Overview of a UV System

Let’s start with a brief review of the basic parts of a UV coating system.

■ Fluid Delivery System:

- Spray system (for this example)
- Fluid monitoring system
- Coating heater
- Coating agitation
- Coating re-circulating
- Line purging and cleaning

■ Lighting System:

- UV bulbs
- UV reflectors
- UV power supplies
- UV filters/materials
- UV blowers

■ UV Coating

Fluid Delivery System

Spray Equipment

Calibrating your spray equipment (Figures 1 and 2) is an important maintenance item and should be done on a daily basis. First, you should run a fluid flow check to determine if your spray equipment is operating within specification. The proper fluid flow rate provides the right film build on your parts. If the flow rate is too low, then the film will be too low, thus creating other problems such as poor corrosion resistance, poor hiding power with

FIGURE 1

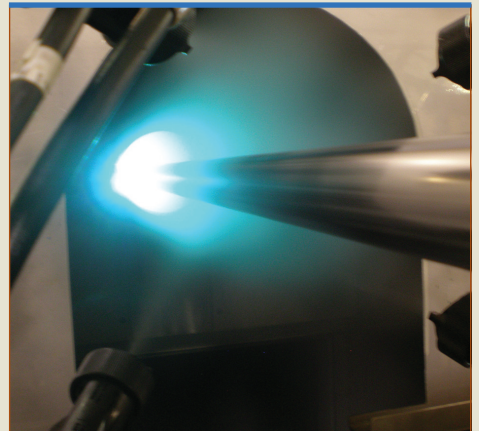
Rotary atomizer



Courtesy of Finishing Technology Solutions

FIGURE 2

HVLP guns spraying steel tube



Courtesy of Finishing Technology Solutions

pigmented coatings and less protection than required. Too much film build simply wastes coating and costs dollars. It can also affect the cure of the coating which can cause other possible rejects.

Fluid Monitoring System

One simple way to know your fluid delivery rate is to monitor or use closed-loop flow rate control (Figure 4) using a gear meter with a sensor and readout. The open-loop flow monitoring system (Figure 3) is designed to be installed in the fluid stream that provides the coating to the spray device. As the fluid flows through the gear meter, a specific amount passes through the teeth of the gears. A sensor measures the rate of gear movement and sends a signal to an electronic unit that converts the electrical pulses to a fluid flow rate. In

turn, the electrical unit displays the flow rate on a readout unit.

For totally automatic control, you can install a flow computer to control a transducer that provides an air signal to the fluid control regulator. Once a flow rate is set, if the monitoring system detects a different flow rate than the set point, then it sends a signal to the transducer to automatically raise or lower the air pilot pressure on the fluid regulator to keep the flow rate within the set point range. It is important to note that some UV materials are not compatible with a gear meter unit. The small fluid passages between the teeth of the gears create premature polymerization of the coating. It is important to check your coating for compatibility before using this type of unit.

Other items to consider for a daily checklist:

- Check spray device for work distance. It should always remain consistent.
- Check spray pattern size to ensure it is the same each day.
- If you are using electrostatic spray equipment, perform an electrostatic check to insure high-electrostatic efficiency.
- Check to be sure the parts and work holders are properly grounded.
- Perform an airflow check of the spray booth to be sure it is consistent from day to day.
- Monitor temperature and humidity on a periodic basis throughout the day and record.

All of these items will help ensure a consistent running system. This will, in turn, help provide a consistent finish on the product day in and day out.

Coating Heater

It is critical to eliminate variability in the process, so heating the coating to a specific temperature is very important. There are a variety of different methods to heat the coating (See Figure 5).

• Hot water heating

This method typically involves heating the coating lines with a blanket of hot water (specifically dialed into a specific temperature). This type of heating uses special lines that jacket around the coating fluid lines and spray equipment. It uses a remote heating system that heats the water and circulates it through the special lines, transferring the heat to the coating fluid lines.

• In-Line Coating Heater

This type of heater is thermostatically controlled and uses an electric heating element to heat a metal fluid housing that typically has a spiral shape in which the coating enters at the bottom of the spiral and exits from the top of the

FIGURE 3

Open-loop flow monitoring

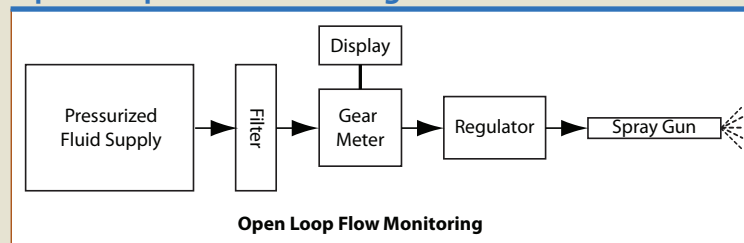


FIGURE 4

Closed-loop flow monitoring

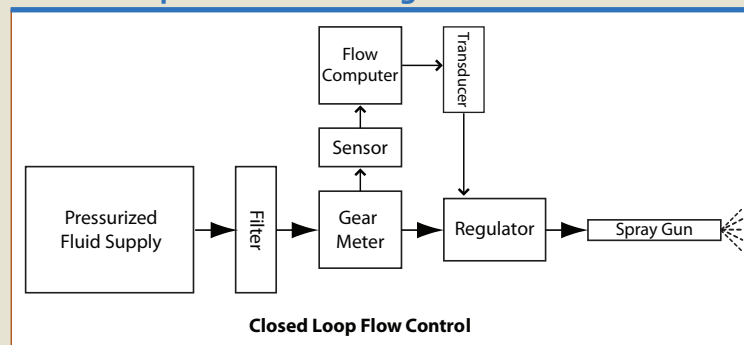
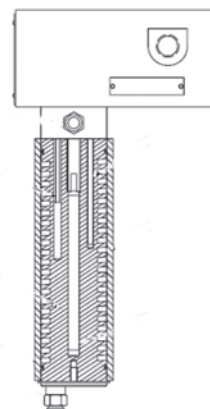


FIGURE 5

Examples of coating heating systems



Courtesy of Finishing Technology Solutions

spiral. As the coating passes through the spiral, the heat is transferred to the coating from the heating element. A temperature readout indicates to the operator the coating temperature as it exits the heater.

In either case, the advantage of heating most coatings is to reduce the viscosity without having to use solvents or monomers. A reduced viscosity allows the coating applicator to work more efficiently. The other advantage of heat is to provide a consistent temperature throughout the course of a day and/or from seasonal temperature changes. The more consistent the coating viscosity, the easier it is to control the fluid delivery rate of the coating through the spray device.

Coating Agitation

This should be a standard practice for any UV coating installation. Agitation of the coating eliminates variability in your process and is a best practice recommended by UV-formulation suppliers.

The best way to agitate the coating is to use an agitation blade, set for an estimated 30-40 revolutions a minute. Depending on the coating

supply size (since most UV materials are relatively high viscosity), a back-gear, air-motor driven agitator is usually recommended. These are more expensive than a simple air motor agitator but are more consistent and reliable. Figure 6 shows a back-gear agitator system with an air-operated elevator assembly for use with 55-gallon, open-top drums.

Coating Overspray Collection and Reuse

100% solids UV coatings offer the benefit of reclaiming any overspray, filtering this material and re-introducing it back into the original supply. This is a critical part of driving toward maximum system efficiency and offers a great return on investment payback. There are many methods

FIGURE 6

Drum agitation systems



Coating agitator and coating drum heater.

Courtesy of Finishing Technology Solutions

FIGURE 7

Reclaim system



Courtesy of Finishing Technology Solutions

for achieving this. Most systems use a reclaim baffle system that captures a high percentage of the oversprayed coating (See Figure 7).

It collects on the baffles and then drains into a holding reservoir, where it can be pumped through a bag filter and back to the original fluid supply for reuse. For multiple color systems, one reclaim module is required for each color. Many manufacturers use individual reclaim modules for high-volume coatings and then have a single module that may be used for many colors that are small-volume users. In this case, the coating may not be reused, but by capturing it in the baffle system, it keeps it from going into the booth filters, thus extending the filter life before changing them is required.

Line Purging and Cleaning

When you have a coating system with more than one coating (color or clear), it is important to fully purge and clean the UV coating lines. One simple procedure is to mount a manifold block as close to the actual spray guns and run separate UV lines from each fluid supply to the manifold block. You would then have a separate fluid supply that would contain a cleaning solvent, such as alcohol or acetone.

This type of arrangement would minimize color changeover and provide a system that is fully maintainable and simple. With a programmable logic controller, a color change could be achieved in 30 seconds or less. Whether you use separate fluid supply sources and lines to a manifold or simply use a single fluid supply to the spray devices, it is important to flush the coating from the lines and through the fluid regulation and spray equipment on a regular basis. This keeps the internal components clean and working freely.

Best Practice Suggestion

Another good practice (if you use pressure pots for your fluid supply) is to have your coating pressure pots positioned on scales (See Figure 8). When the pressure pot is empty, the scales are set to zero pounds. Then, when the coating is added, it will provide a visual indicator of the actual amount of coating inside the pressure pot. With this method, there

is no need to open the pot to check the coating level or, worse, to run out of coating because of having to guess how much coating is left.

Maintaining UV Lights

Question: When was the last time you cleaned the reflector in your UV system?

Typically, it's a simple question—but it has a complex answer. Most companies do not adequately maintain their UV lighting systems (Figure 9). In this section, we will provide a pictorial overview to show the importance of maintaining UV bulbs, reflectors, power supplies, filters and blowers. Greatly improved production uptime will be achieved by the adequate and thorough maintenance of a UV system.

There are many types of UV lamp sources in use today:

- Low-pressure UV fluorescent tubes
- LED-lamp technology
- Medium-pressure UV arc lamps
- Microwave-powered UV Lamps
- High-pressure short arc lamps

FIGURE 8

Pressure pot on scale



Courtesy of Finishing Technology Solutions

FIGURE 9

UV reflectors that have not been maintained



Courtesy of DoctorUV.com

Figure 10 shows some examples of UV lamps available today.

There are two primary types of UV lamps installed in manufacturing today:

- Medium-pressure UV arc lamps
- Microwave-powered UV lamps

A clean bulb and reflector delivers all the UV Spectrum in the ranges of UVA, UVB, UVC and UVV. A dirty bulb and reflector delivers very little of the UV spectrum such as no UVB, no UVC and reduced UVA and UVV (Figure 11).

Simple routine service intervals and major maintenance intervals should be followed.

- Measure the UV lamp regularly.
- Record it in the log book so you know when the bulb reflector is bad or dirty.
- Clean the UV lamp and reflector regularly to achieve consistent UV output.

The above three items are recommended monthly maintenance

FIGURE 10

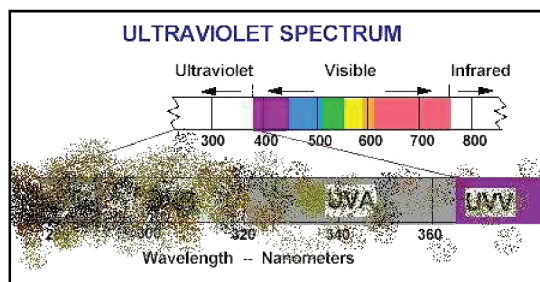
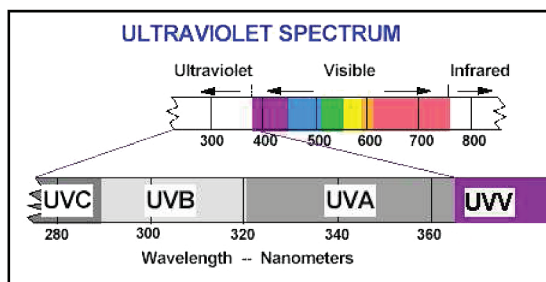
UV lamps available today



Courtesy of DoctorUV.com

FIGURE 11

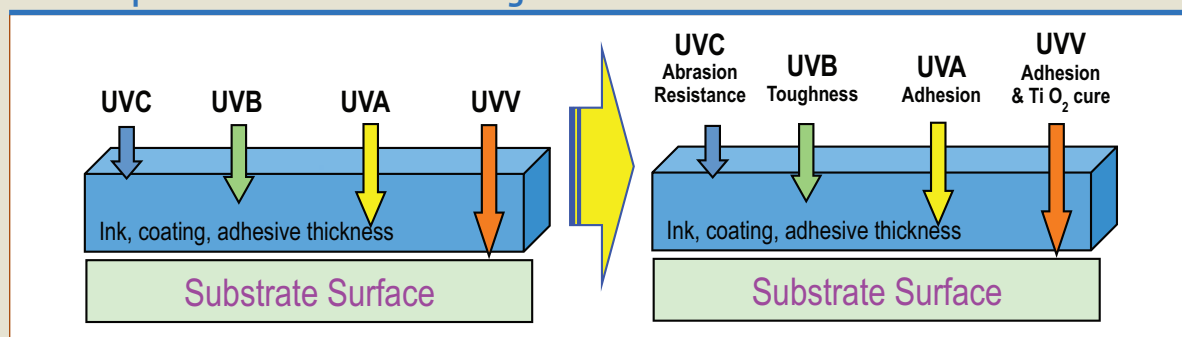
Clean UV spectrum versus dirty UV spectrum



Courtesy of DoctorUV.com

FIGURE 12

Relative penetration where the UV goes in



Courtesy of DoctorUV.com

items. Intervals any longer than a month will raise the risk of having production/quality issues.

UV Preventive Maintenance

Some typical questions regarding UV preventive maintenance service:

- When should I do simple preventive maintenance service?
- Is it when I measure the UV power and it drops below the threshold of my documented process window?
- How do I do measure this UV drop with a calibrated UV radiometer (Figure 13)?

UV Power Puck is a self-contained, electro-optic instrument designed to measure and display peak UV irradiance and total UV energy density used in the UV curing process.

A carefully designed optical sensing system measures total UV energy density on four different channels simultaneously (Figure 12). These four different channels represent four different UV bandwidths of interest for most curing applications—UVA (320-390nm), UVB (280-320nm), UVC (250-260nm) and UVV (395-445nm).

Establishing and Maintaining a UV Process Window

By using the data provided by the radiometer, true process control can be achieved. At startup each day, the operator exposes the radiometer to the curing process, takes readings and observes if the readings are within the curing parameters for a satisfactory cure for the particular product to be run.

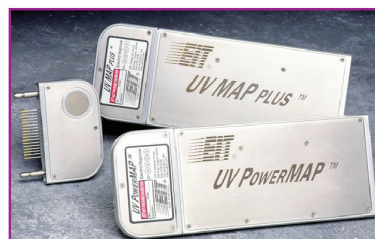
Process

The operator can make adjustments by changing the length of exposure time, cleaning reflectors or even relamping in order to obtain the desired UV levels, thereby assuring consistency in the curing process. The radiometer quantifies the UV curing system and takes a great deal of guesswork out of the overall curing process.

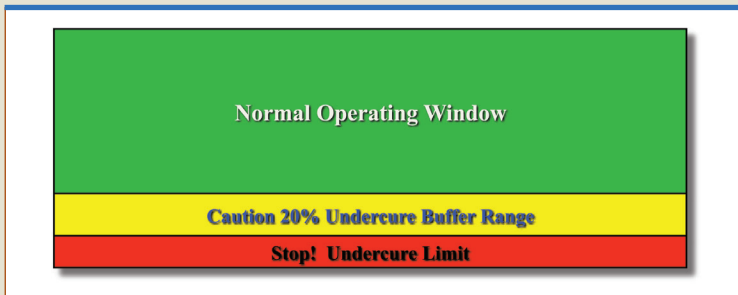
Another choice for measuring UV is by using UV exposure tags. The UV FastCheck1 is a tag that provides UV-exposure dose monitoring (including narrow web, difficult-to-access, partially covered and three-dimensional applications). FastCheck tags provide good linearity color change versus exposure dose; a large dynamic range of exposure doses; and

FIGURE 13

Radiometer products



Courtesy of EIT Inc.

FIGURE 14**Process or cure window**

a broad spectral. It also offers a good comparison of multiple sources and is a good quality control tool.

Process Window

- The process window is the range in which a process will work to achieve the desired results (adhesion, hardness, flexibility, gloss, texture, stain or scratch resistance, chemical rub, cross-hatch, abrasion rub, color ID and registration). See Figure 14.
- It is ideal if the process window is forgiving and has a wide latitude. It takes work and time.
- Invest before production and confirm when things are working!
 - Refer to the starting guidelines from the formulator.
 - Complete operator Training and ISO/Procedure Documentation.
- Define your lower limits and document the readings.
 - Increase line speed/decrease applied power until you undercure, note readings and cushion by 20%.
- What are the upper limits?
- Monitor the readings by job, hour, shift or day as required to maintain quality.
- Establish the process window during the design/development phase.
- Establish the process window when things are working.

Dirty Versus Clean Arc Lamp Parts

Up to 70% of the UV light is bounced off of the reflector, so a clean reflector is critical to the maintaining the reliability of the manufacturing system (Figures 16, 17 and 18).

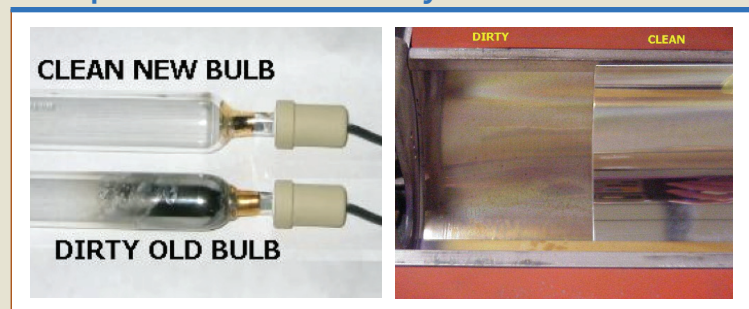
Simple Preventive Maintenance Service for Arc Lamps

- Start with a cool lamp system.
- Turn off the main power to the UV lamp system.
- Remove the lamp housing/reflector assembly.

FIGURE 15**UV log book example**

Keep a log book² for each machine and document the UV readings (Figure 15). You will get a good feel for the preventive maintenance schedule needed for your unique operating environment. Obviously, a dirty environment will need more frequent cleaning than a clean room application.

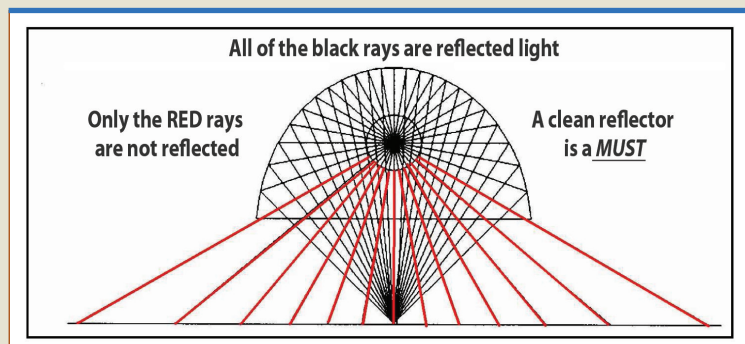
With cotton gloves, remove the bulb being careful not to touch the bulb with your bare hands. Clean with a Windex-type glass cleaner and a lint-free cloth. Alcohol (IPA) can also be used to clean the UV bulbs and reflector. **Important:** External deposits on the bulb are difficult to remove and can eventually

FIGURE 16**Examples of clean versus dirty bulbs**

Courtesy of DoctorUV.com

FIGURE 17

Reflector review



Courtesy of DoctorUV.com

contribute to a reduction of UV energy at the focal point.

Metal reflectors—Inspect the reflector for signs of deposits. Clean the reflectors with Windex-type glass cleaner or isopropyl alcohol (IPA) and a lint-free cloth.

Note: The reflector should look like a mirror. Can you look at it and shave in the reflection? *If you can't see your face in the reflector, it is time to clean or replace that reflector.*

Simple Preventive Maintenance Service for Microwave Lamps

Power Supply

There are no regular maintenance procedures that apply to the power supply except to check the cooling fan(s) and replace filters, if so equipped.

Irradiator

There should be regular maintenance at a minimum every 30 days of operation. (Dirty operating environments may require more frequent service.)

1. Remove the irradiator from its light shield and place on a workbench with the lamp cavity facing up.
2. Remove the radio frequency (RF) screen assembly and inspect fine tungsten mesh for any signs of damage. Replace screen assembly if

there are any signs of damage (i.e., holes, tears, etc.).

3. Remove UV bulb and clean with Windex-type glass cleaner and a lint-free cloth. Alcohol (IPA) can also be used to clean the UV bulbs and reflector.

Important: External bulb deposits are difficult to remove, and can eventually contribute to a reduction of UV energy at the irradiator focal point.

4. Metal reflectors—Inspect the reflector for signs of RF damage.

This may be seen as a pitting of the reflective surfaces, dark discoloration on front face, top edges or at end of reflectors. Replace entire reflector assembly if any damage is observed.

Clean reflectors with Windex-type glass cleaner or alcohol and a lint-free cloth. Retighten all reflector screws. Normal irradiator operation may cause these screws to loosen, contributing to RF arcing or pitting on the rear surface of the aluminum reflector and wave-guides.

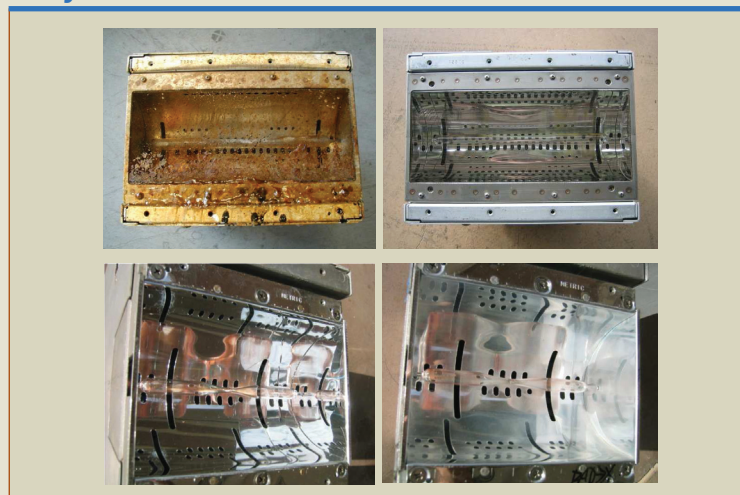
5. Reinstall UV bulb into lamp cavity, being careful not to touch quartz surface. If quartz bulb surface is touched, clean with Windex-type glass cleaner and a lint-free cloth.
6. Reinstall the RF screen over irradiator lamp cavity and fasten with screws provided. Hand tighten all screws. Do not over tighten these screws.

Note: Do not operate this equipment with missing or damaged hardware.

7. Reinstall UV irradiator into light-shield. (Be careful not to damage to the RF screen mesh.)

FIGURE 18

Dirty versus clean reflectors



Courtesy of DoctorUV.com

8. Change lamp air supply filters on a regular schedule to prevent the buildup of foreign material on bulb, reflector and magnetron assemblies.

What is Major Service?

Major service includes replacing:

- Lamps (when power drops below the set limit)
- Reflectors (every 2 to 3 bulb changes)
- Magnetron on Microwave lamps (as needed).
- Capacitors (if needed)
- Ballasts (if needed)
- Mercury contactor (if needed)
- Shutter Pneumatics (if needed)

These will generally restore the lamp to like-new performance. Remember to use common sense in maintaining the UV production system.

Please set a company goal to:

- Measure the UV regularly
- Document the UV readings
- Routinely clean the bulb and reflector for optimum performance

Measurement and Maintenance

Measurement and maintenance of these systems is critical for optimizing the UV coating system. In addition, it is very important to use the correct maintenance parts for all the systems

listed above. Production downtime and product rework will be considerably more costly to the operation than the actual cost of maintenance parts.

One final area of consideration is the use of written and pictorial work instruction sheets for each of the maintenance procedures. Outlined below is a clip of an example work instruction (Table 1).

UV Coating Material

It is critical to maintain the quality control on all incoming UV materials. UV materials are certified by the supplier and have a Certificate of Analysis (COA) that accompanies each shipment.

Some Best Practices

- Inspect COA against previous shipments to insure coating physical characteristic consistency.
- Properly rotate all inventory—insuring that older batches are consumed first.
- Make sure the coating is being agitated and held at a set temperature.
- In some cases, it may be appropriate to run a sample drawdown on a specific substrate and cure with UV lights.
- Then perform ASTM 3359D adhesion test to insure correct adhesion.

FIGURE 19

Good lesson



- Other specific ASTM-defined tests can be completed at this time.
- Contact your coating supplier for a list of specific ASTM tests that could assist in the coating validation.

Conclusions

The key to maintaining a UV production system is controlling variability in the process. In this article, three main areas were identified—fluid delivery system, UV lighting system and UV coating. Specific details and recommendations/best practices were explained with support documentation and pictures. ▶

Acknowledgements

The authors wish to thank Jim Raymont at EIT for his contributions to this article.


References

1. UV FastCheck is available from UV Process Supply (www.uvps.com).
2. For a sample Excel Spreadsheet example please visit www.themiracleofUVlight.com

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TABLE 1

UV calibration work instructions

UV Calibration Work Instructions:			
Reminders	Overview	Instructions & Explanations	Pictures (Support Data)
Wear Latex Gloves	Secure EIT PowerPuck 		
Wear Protective Eyewear			