

## UV Measurement: Prescription for a Better Cure, Part 2

The SGIA Free Webinar, “UV Measurement: Prescription for a Better Cure” was featured on May 4, 2016. Moderated by SGIA’s Dan Marx and presented by Laura Maybaum, Global Screen Product Manager for Industrial Applications at Nazdar Ink Technologies; and Jim Raymont, Director of Sales for EIT, LLC, this webinar addressed some of the most common “bugs” that befall the UV curing of inks, how to diagnose them and how to prevent them from happening. Part 1 was featured in the July/August issue of the 2016 SGIA Journal. Here, SGIA has transcribed Part 2.

**Maybaum:** What we wanted to do is give you some examples of some common issues or common problems that we see in the field and how we would start to diagnose or test those issues. One example is probably the most common. I’m calling it “the print flu,” but really what we get is a range or combination of symptoms — mainly losing adhesion. You’ll often see printers pick up a print and smell it. The stronger the smell, the more of a potential problem there is. You may see a loss of gloss or a change in gloss. A really big symptom is if the surface of the ink has become wrinkly or that it is soft. What that can lead to is

offsetting or blocking because the ink has been rewetting, and all of those symptoms are a result of being under-cured for some reason. Somehow the initiators in that ink are either only surface curing or are not curing fully through the total ink deposit.

There are common things we would recommend. One is to check your bulb and check your output. Make sure that it’s consistent with what you’ve been using previously that has shown good results. If nothing appears to have changed, quite often what we’ll say is if you are under-curing and you’re using a very dense color, to simply add clear to the color and if you get better results by adding clear, then you know there’s some sort of under-curing happening because the pigment load or the ink deposit is simply too thick. So adding clear is a method for assessing if you are under-curing.

Another easy thing to do is to increase your output. Ideally, increasing your intensity separate from your dose — meaning setting your reactor higher. If it cures by setting it higher, then there’s a potential that you just have not gotten enough energy to the ink. If you slow down your belt, you’re getting more energy at the surface or at the ink itself. Again, that is an indication that the result really is an

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By Laura Maybaum, Global Screen Product Manager for Industrial Applications, Nazdar Ink Technologies; and Jim Raymont, Director of Sales, EIT, LLC,

under-cured product. The other part of that is going to a lower ink deposit. That's a little bit harder — to switch out screens and go to a higher mesh. Typically, what we'll look at what mesh you're using, and if it's below a 355, you start to get into 305 or 200 mesh. That's a red flag, and you're going to have issues with trying to cure that completely. You can also adjust your flood or your squeegee and try to get less ink deposited. If you deposit less ink and you're showing better results, then that's an indication that you're under-cured.

**Raymont:** The only thing I would add is what we run into a lot of times with the intensity and the energy density or dose — many time players will run it through one time and then they'll go ahead and run that same work piece through the lamps again. You're not going to increase the intensity or the irradiance or the penetrating power. You will get twice as many mJ, or twice as much energy density or dose of that particular product, but running a work piece through a lamp twice does not double the intensity. It doubles the joules but not the watts. That's just an important thing.

**Maybaum:** Yeah, and that would also go along the line of using two bulbs to cure the ink. UV curing of ink is almost instantaneous. And although two bulbs may be very close together in a lamp housing, really most of the curing that's happening is happening with just that one bulb. As a general rule, we tend to try and get people to cure with one lamp. The second lamp may provide more overall dose, but if you're under-curing issues are coming from not having enough intensity, that second bulb or even a second pass is only going to help marginally.

Just to give an example of what under-cure is affecting: If you're getting good surface cure but you're not getting good through cure, what will happen is that ink at the bottom of the deposit will remain soft and you may get a good result when it comes off the press, but over time what could happen is that the under-cured ink at the ink-substrate interface, because it's not fully cured, may start to soften the ink above it and the more layers you do, the more you're trapping that ink there and what you could see is rewetting.

The other part is, for adhesion, a lot of times manufacturers will recommend that an ink system is suitable for a range of substrates. By far it's not all-inclusive. There are some substrates — for example styrene, paper, some vinyls that are fairly easy to

adhere to — and you can have a wide range of substrates that are acceptable, but there are other substrates such as polyethylene, polypropylene and maybe some very plasticized vinyls that will change over time. When you get poor adhesion, it's very important to know what substrate you're using as well as how old that substrate is. A common thing that is done in the plastics world is to use a dyne solution to assess the surface tension, and different substrates will have different requirements as far as surface tension. It is always good to know what is the acceptable range of surface tension that you need for your ink to adhere well to those materials. Therefore, when it comes to poor adhesion, not only look at under-curing of the ink, but also keep in mind not all substrates are built the same and the ages of substrates can be critical.

That brings us to the Goldilocks problem. Keep in mind we make the inks to perform within a range of processing and uses, so we want to make sure that when we're processing that the inks that they're not over-processed or under-processed. There is a window that needs to be established, and for the most part it's fairly wide for a specific application, but if you take an ink outside of that application, your upper range and lower range could change pretty significantly with regards to processing.

This is another area that we talk about, especially as we get into more critical applications: ink cracking. What you'll see is when you bend the ink — either physically bending it or let's say apply heat to bend the substrate — you get a degree of cracking. One diagnosis for this is that you can actually over-cure ink. There are some systems to where the output is three or four times the amount of recommended energy that is going to the print, and in that case, too much energy could result in too much cure. Normally people want to run their system to be as efficient as possible, so we get more towards full-cure and creeping into the under-cure. But keep in mind there is a point of over-curing depending upon the application, but it's an easy check. Simply turn down your reactor and see if that helps out the flexibility. If it doesn't, then it could actually be heat that's been involved in the process. Maybe your reactor is outputting a lot of IR, or that you just have to go to less layers of ink or a new ink all together.

Additional problems include rashes and spots: What we usually call this is “ink doesn't think.” What you get is spotty results across an image or throughout an

image area. You may see differences in gloss around the print or get offsetting or blocking in certain areas. It could be that you print a color down first and print over top of it and that first color could be a black or a yellow, let's say, and when you print that other color on top of it, now you're printing over a colored background versus, let's say, a white background. That's an example of differences in cure. You could be having differences in color background, but typically an ink will be fairly consistent. So as long as the cure is set up and measured to be even and the substrate background or the substrate itself is consistent, we expect to have consistent results with the ink overall. It doesn't tend to be intermittent depending on where it's deposited except if the ink is not mixed well. And so what we recommend is that prior to use, you're mixing the ink well so that the materials within it become consistent throughout. The easiest test for that is very much like what we assessed for under-cure — using clear, changing your settings. Another really interesting way to assess if your press is set up evenly, if your presses have damage, if your screens are being held evenly, or if it's your squeegee or flood bar, is to print an even half-tone pattern over the entire image. If you print an even half-tone, let's say a 50-percent image or half-tone percent over the entire image and you see splotching throughout the image area, then that's an indication you're getting different ink deposits across your press. Then, you can start to troubleshoot what that fix would be. Mix your ink again, or maybe you may have a substrate that has uneven surface properties and that's a test like a dyne test would come in.

What about uneven coloring? That's an easy one. If it's uneven in coloring, it's very possible that the ink hasn't been mixed up well enough. The components for inks, they can settle, they can separate. If you're using additives, those also can settle and separate depending on what they are. That can also not only be uneven color, but also differences in deposit effects like bubbles or pits. It's always recommended to mix before you print and mixing by hand a couple times may not be enough. We do recommend in general to have some sort of power mixing or extended mix time just to be sure things are incorporated into.

Another thing I wanted to bring up is that not every color is going to be the same. What we find are colors are either going to be reflective or absorbing. Some are very transparent, but our issues really come in when we're dealing with white or black.

They're the more extreme ends of the colors. So black is going to be very absorbing. White is going to be very reflective, and the more pigment you add to an ink, the more that's going to be exaggerated. The tricky part is when you start mixing colors together. If you're using a blue and you're adding black to it, that's even more absorbing, that could definitely affect how much energy is needed to get full cure. If you're adding a white and a black together and their initiators are formulated to really address how much they're absorbing or reflecting, and you put those two opposite inks together, they could actually be doing both things at the same time and require even more energy. So if you mix, let's say a gray, we can potentially get something that we call "windowing," and that's really the initiators in a white and black countering each other and you actually end up needing twice as much cure than what you would need if you were using a white or a black by itself. The test for that is the same as for what under-cure would be — add clear, change your settings and assess if you're not getting enough energy to cure that particular color mix.

**Raymont:** This is something that the ink company would provide. You don't have to figure this out on your own. They've got the resources.

**Maybaum:** Yeah, absolutely. You know, most companies have a tech service department. We're there to support the end users. We're allowing them to figure out their problems to provide as much information as possible. There is a lot of information out there and we tend to ask a whole bunch of questions. The questions may seem simple, but what we're trying to do is get to a point of diagnosing what's going on, determining what your symptoms are so that we can get to a point of being acceptable again as far as getting good cure and good print.

**Raymont:** I always get a kick when you go to the SGIA Expo — you can always tell when the printers are out to dinner because everyone is scratching and sniffing the menu to see how well it's been cured or not cured. There's a lot of instrument products out on the market. They may be different in terms of the bandwidth that they're going to measure. What you want to do is make sure you understand what that particular radiometer is doing and what part of the spectrum it's measuring. Is it measuring 320 to 390 in terms of nm,

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or is it measuring from 250 to 415? Just to make sure that you're all talking the same language and we're not comparing apples to oranges. The biggest thing is you need to have a target, you need to track your readings and perform regular maintenance with a physical exam. You can't wait until it's broken. Use that radiometer to look at the watts and joules, and even more important the irradiance profile, and then put that data some place where you can go back and look at things. How were things when they were curing? What changed now that things may not be curing? And you really are like a doctor trying to diagnose the symptoms to get back into a healthy state with the UV system. It's all about making a profit with the process window, and then working so you can get to that cured state.

**Maybaum:** I think the last thing is, and we've touched on it, is really establishing what your baseline is, and not just for your overall shop, but especially for critical applications. And those critical applications versus general applications may have a very different processing window. There may be some jobs that are very easy and your process window is huge. That would be great to know that going into it, and a lot of defining what that process window is, is taking measurements and monitoring them on a regular basis, document what you're doing and really knowing your whole system as far as materials and equipment, as well as your tools that you use to monitor that system. It will make things a lot easier to communicate internally when you need to bring in your manufacturing support to solve problems.

**Raymont:** If you can't find help, there is always the ink company setup. Have technical services — we help out as best we can with the measurement aspect of that.

**Dan Marx:** Which control methods exist for UV lamps intensity control? Is there an ISO standard for that?

**Raymont:** In terms of the lamps themselves, that would be the applied electrical power. That's going to be a function then of the power supply design. And then also, if you're talking about the power that's arriving at the cure surface, we talk about electrical power generally watts per inch of applied electrical power — 200, 300, 400 being common — and

then the power arriving is measured in watts per square centimeter.

**Marx:** Is there any methodology to check the right ink curing? Similarly, is there a standard for that?

**Maybaum:** There is. There the ASTM Standard that is basically outlining conducting a crosshatch and tape tests, and then rating that as far as a five with no lift-off all the way down to a one with severe lift-off. The reason that you do a crosshatch is to break the ink surface, and then the tape is to make sure you have full adhesion down to the substrate. However, with that said, internally we have lots of discussion about how to check adhesion. Some people do just a thumb twist, there's just touching the surface to see if it's tacky, there's rubbing MEK over the surface to see if that degrades the ink to see if it's fully dried or cured that way — processing tape, crosshatch — there's lots of different ways that people assess adhesion and they're all acceptable if the part performs the way it's expected to perform in the field. We do tend to point towards the ASTM, crosshatch and tape, but really it's how you define it in your shop as being acceptable.

**Marx:** One more quick question: What kind of chemical would you suggest for UV protection printing on ceramic tiles?

**Maybaum:** If we're talking about weathering, then we're talking about putting UV inhibitors into a UV ink, and that's counter to getting it cured because the UV inhibitors will absorb a lot of energy. So there are inks out there that use UV inhibitors, although I don't know if ceramic tiles would be used outside — you would need that protection. If we're talking about surface protection, then you're starting to look at varying the chemistry and then also getting adhesion so it's really finding the right ink and there's really not a good general answer for that.

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