OmniCure®
UV Curing • In Control

Making the Switch to LED UV Curing

Manufacturing Thermally-Fused Laminates with the OmniCure® AC9 Series LED UV Curing System

A Challenging Industrial UV Curing Application

When it comes to implementing industrial UV curing systems, few companies place such demands on these systems as Duracote. Based in North East Cleveland, Ohio, the company manufactures products that are resistant to chemicals, abrasion, heat, or fingerprints, for example, and make up the top layers in end products such as countertops, cabinets, and other surfaces in a wide range of industrial applications.

Duracote employs a continuous roll-to-roll process in which UV-curable compounds are coated to a specific thickness, partially cured with intense UV light, and rewound upon themselves. The partially-cured rolls are shipped to the end customer where they undergo a final cure to a base substrate using heat or pressure. Duracote's process must ensure fast, repeatable, and even partial curing over a product with a width of up to 66" without undercuring, overcuring, or heating, and it must do so even as the UV light source ages. It is a challenging application.

OmniCure AC9 Series installed in a Duracote unit

Author: Roy Kayser, *Senior Global Application Manager, Excelitas Technologies*
Credit to: Eric Couch, *President, INPRO Technologies Corp*

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Duracote has long used microwave powered UV lamp systems with multiple heads for curing. These systems offer a known, established technology that works with standard UV-sensitive monomers, oligomers and photoinitiators.

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> *John Petroski, R&D Director, Duracote*

But when their original UV lamp curing system approached its end-of-life, Duracote's team had to make a decision. According to John Petroski, Duracote's R&D Director, "We needed to decide whether to stay with the more traditional bulb system we already had, or whether we wanted to plan for the future. And we felt that LED UVs were the way the future was going to go."

Duracote understood the claimed advantages of LED UV curing systems, advantages that include low power consumption, longer lifespan, uniformity of illumination, and customizability. But they were skeptical. Jack Pallay, the president of Duracote, said, "We had been watching LEDs for a while, but we were reluctant to make any moves when they were in their infancy because we were unsure whether their promise would be delivered."

According to Pallay and Petroski, the most important characteristics of a UV LED curing system for their application are:

- Minimal heat generation to prevent unwanted curing or substrate deformation
- Low electrical consumption and longer life, both of which contribute to lower overall cost of ownership
- Uniform irradiance, even over time as the LED UVs age, across the multiple UV heads needed to span the 66" width of their product
- Potential for higher throughput in their production line
- Increased flexibility in developing new products

To assess the potential of a LED UV curing system, Duracote turned to INPRO Technologies Inc., a supplier of custom industrial UV curing solutions. INPRO had already worked successfully with Duracote to install UV lamp curing systems. The team at INPRO suggested Duracote evaluate a customized Excelitas OmniCure® AC9 Series LED UV curing system. Duracote agreed to test this system.

Evaluating the OmniCure AC9 Series LED UV Curing System

Since INPRO Technologies had extensive experience with UV curing installations, they worked closely with Duracote on the customization and integration of the Excelitas OmniCure system into a production setting for evaluation, test, and process development. Given the width of the laminates, the application required six curing heads including five OmniCure AC9300 heads with an active optical area of 300mm X 25mm, and a single AC9150 head with an active optical area of 150mm X 25mm. The engineers at Excelitas also developed and delivered a custom controller for the system.

The OmniCure AC9 Series heads emit UV light in the UV-A band at 395nm, while UV lamp systems emit UV light over a wider bandwidth including the UV-A, UV-B, and UV-C bands. Since the compounds and photoinitiators used by Duracote were optimized for curing with lamps, experimentation and modification of formulas, feed rates, and line speeds were needed to optimize curing with LED UVs. Photoinitiators for LED UVs are available, therefore, experimentation was needed to select suitable materials and process modifications. Duracote's customers supported the efforts to establish and qualify new processes and materials, which made testing of the AC9 Series LED UV system possible.

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Duracote needed to address risk management when installing the OmniCure LED UV system by retaining the microwave UV lamp system. According to Pallay, "We configured the installation so we could have the old UV lamp system and the new LED UV system together. So, if we ran into a process that did not respond well to LEDs, we could turn back to the lamp system as a de-risking strategy." INPRO Technologies' ideas were valuable to this process.

Because of the relatively compact size of the Excelitas AC9 Series system, no retooling or major modifications of the line were needed to accommodate both curing systems. It was also easy to move the OmniCure system from one production line to another and back again as needed.

Duracote's testing of the OmniCure AC9 Series curing system involved running small batches of product, typically a few hundred yards, and sending it to their customers for evaluation. The material was tested for durability, flexibility, and resistance to chemicals and abrasion and compared to material cured with UV lamps. Duracote's customers were entirely satisfied with the results. After three rigorous line trials, Duracote decided to fully incorporate the six OmniCure AC9 Series heads into their production line.

Real-World Advantages of LED UV Curing

The evaluation of the OmniCure AC9 Series system revealed several advantages of LED UV curing to the Duracote team. The patented individual LED UV module control and factory calibration of the OmniCure AC9 heads enabled fine control of UV irradiance over the full 65" to 66" wide product, even when all four heads were adjoined. This level of control enabled the heads to deliver UV irradiance with a high degree of longitudinal uniformity to better than +/-10%. Precise control of the UV irradiance using intelligent system monitoring ensured that the correct dose of UV energy was delivered on every exposure. This level of control was very difficult to achieve with microwave UV lamps. The controllability of the system also enabled Duracote to easily use the OmniCure system in a number of manufacturing processes, each of which use different materials and require a different curing profile.

Duracote also noted the following benefits of the Excelitas OmniCure AC9 Series system:

- **Reduced heating.** The heat generated by UV lamp curing systems can cause wrinkles and other uniformity problems in the laminates. LED UV curing systems deliver virtually no heat to the curing site, a big advantage in this application.
- **No microwave seepage.** Unlike UV lamps, the LED system does not generate errant microwaves, so no additional microwave screens or RF detectors were needed. The absence of microwaves also benefits workplace safety.
- **Lower power consumption.** Duracote estimates the power consumption of the OmniCure AC9 Series heads is about ¼ that of UV lamps in this application.
- **Reduced fan noise.** Because the LED UV heads and controllers generate less heat, their cooling fans produced far less noise, which again helps with workplace safety and comfort.

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- **Ease of Inerting.** Because it's more straight-forward to manage gas flow near the cure site when using the LED UV systems, an inert atmosphere of primarily N_2 is easier to establish to reduce the effects of O_2 on the cure.
- **Controllability.** Duracote also found that monitoring and controlling the power, status, and operating characteristics of the LED UV heads is also much easier and convenient than with Hg systems.

The OmniCure AC9 Series LED UV curing system is also set to improve the bottom line of Duracote's production process. When they decided to install the OmniCure system, the Duracote team hoped to match the yields and throughput of the older microwave UV lamp systems. But the LED UV system exceeded their expectations, and they plan to improve throughput by 10% or more over UV lamp curing after further process refinement.

Jack Pallay, Duracote's president, sums up the integration of the AC9 Series LED UV curing system for this application: "It exceeded expectations".

Duracote unit

> "The performance of the system validated the vendor's claims. The LED UV curing concept, in general, is 'as advertised'. There is no doubt that, in our opinion, it is the way to go."
>
> *Jack Pallay, President, Duracote*

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