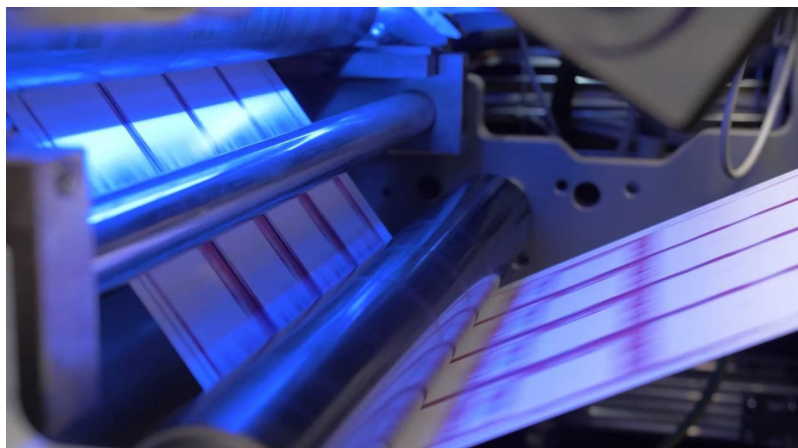


# Technical Considerations to Ensure Optimal UV LED Curing

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Printing with LED curing. *Photo courtesy of Excelitas.*

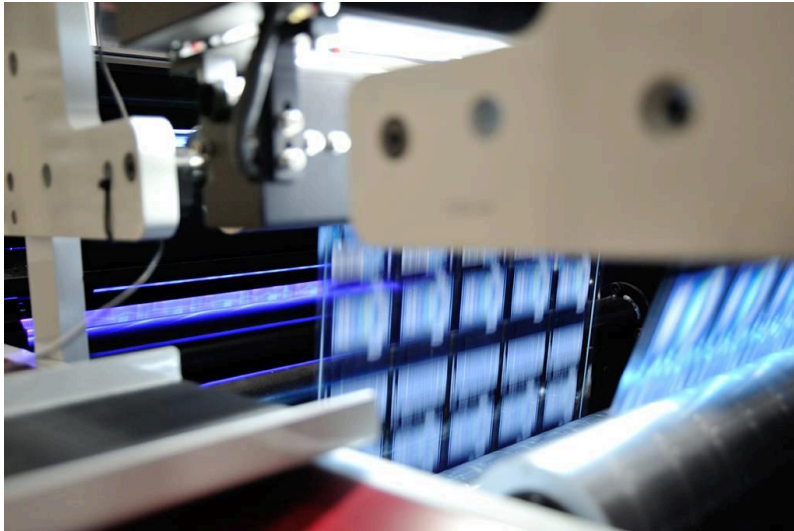
*By Stacy Hoge, Marketing Manager for UV Curing, Excelitas*

Several technical requirements are needed to ensure optimal UV LED curing for any printing process. UV LED technology performs well when UV output is correctly matched to the application needs and paired with a suitably formulated ink, coating or adhesive. Unfortunately, one size does not fit all curing applications. With the abundance of UV LED curing systems and vendors out there, many claim very similar product features and operational benefits – but they are not all the same.

When evaluating features for UV LED curing systems, it's often unclear which of the many metrics and benchmarks are the most important selection criteria. Which are most critical for ensuring optimal UV curing of inks, coatings and adhesives?

Five fundamental parameters to focus on are: **spectral output** (UV wavelengths), **peak irradiance** (measured in watts per square centimeter) and **energy density** (measured in Joules per square centimeter), **reliability** and **LED inks and coatings**.

**Spectral Output** describes the radiant output across different wavelengths in a light source. For UV curing it is critical that the spectral output of the light source matches the spectral absorption of the photoinitiator to be cured. The chemical reaction will only start when sufficient energy of the correct wavelength is absorbed by the photoinitiator.



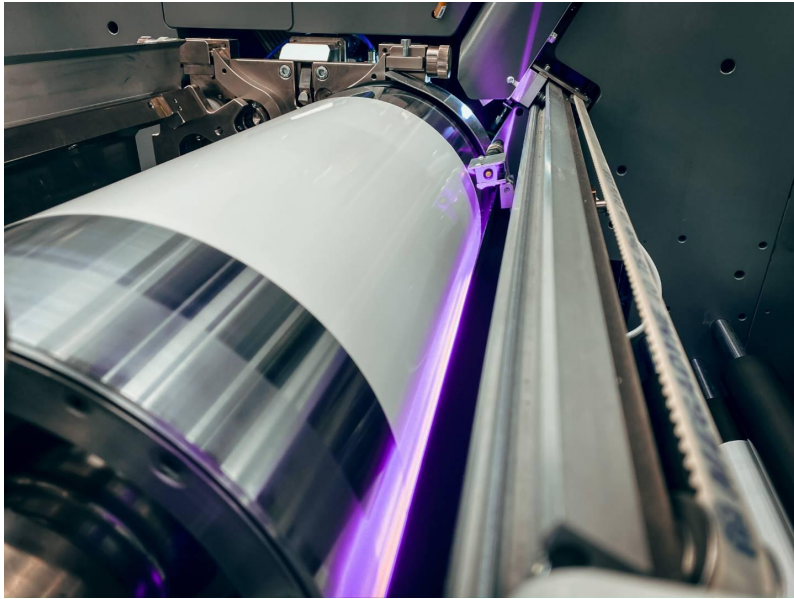
Traditional UV lamps such as microwave or medium pressure mercury produce a broad spectrum of light, making them very flexible for curing almost any UV formulation. LED curing sources have a very narrow spectral output which can be produced at specific wavelengths such as 365nm, 385nm, 395nm or 405nm, but additional care must be taken to ensure the photoinitiator of the formulation is matching with the output of the LED source.

**Peak Irradiance ( $\text{W}/\text{cm}^2$ )** is the punching power to kickstart the polymerization process where photoinitiators cross-link acrylate monomers and oligomers in UV curable adhesives, coatings and inks. UV curing difficult colors or high deposit inks at a higher speed requires higher peak irradiance to achieve a good depth of cure. Peak irradiance is affected by the output of the engineered light source, the use of reflectors or optics to concentrate or contain the rays in a tighter surface impact area, and the distance between the source and the cure surface. The irradiance for UV LEDs at the cure surface decreases quickly as the distance between the source and the cure surface increases. Achieving full cure requires an appropriate amount of peak irradiance.

**Energy Density** (also called dose) is important to uniformity of cure throughout the ink film. Energy density is the energy arriving at a surface per-unit-area during a defined period of time (dwell or exposure). A square centimeter is again the unit area and radiant energy density is expressed in units of joules or millijoules per square centimeter ( $\text{J}/\text{cm}^2$  or  $\text{mJ}/\text{cm}^2$ ). Energy density is the integral of irradiance over time. A sufficient amount of energy density is necessary for full cure.

**A reliable LED system** is critical to the success of curing inks, coatings and adhesives. Thermal management techniques are very important to remove excess heat from the system while providing a consistent operating temperature for the diodes to function at maximum performance over their operating lifetime. The optics of the LED system are also very important. While an end-user or OEM should not necessarily be concerned with how the optics are provided in the UV LED lamp, they should understand if the supplier has the ability to improve the design for their specific application needs.

**LED inks and coatings** are required to achieve a full cure with LED technology. Users must utilize inks and coatings that work with the narrow wavelength spectrum of LEDs. Inks formulated specifically for UV LED curing continue to be developed, offering the same, or better, level of performance as traditional UV-cured inks. Most formulators have addressed the gaps in the global LED portfolio and 95 percent of what is being done with mercury UV can be done with LED.



### Technology Benefits

UV LED curing solutions offer increased environmental sustainability, more uptime, faster throughput, less heat, increased stability, higher print quality and energy savings.

- **Environmental Sustainability:** UV LED technology offers consistent and reliable power output, eliminates greenhouse gas and removes toxic mercury from the UV curing process. Users can save up to 50 percent or more on energy bills.
- **More Uptime:** LED curing units have been proven to support trouble-free operation. There is no warm-up time due to the instant on/off nature of LEDs. No moving parts, shutters to clean or bulbs to replace leads to higher press usage and operator efficiency. LED also offers higher yields due to consistent energy output.
- **Faster Throughput:** Printers with LED perform at much faster speeds on average, assuming other portions of the workflow can operate at the higher speeds.
- **Less Heat:** With no IR heat, printers using UV LED technology can add new capability to a press, previously unable to run thin and heat-sensitive films.
- **Greater Stability:** Because of the uniformity and long-term consistency of LED lights, designers can develop safer, more stable, and more reliable processes for low-migration printing. LEDs last more than 60,000 hours of operation, with only a minimal drop-off in power over the life of the curing unit.
- **Quality Curing:** Users report that LED light sources produce higher quality cures and better adhesion on a wide range of materials, including recycled materials. They can also achieve higher speeds with black and white inks. Tough opaque whites and dense blacks are easier to cure as the LED wavelength provides deep through-curing. UV metallic range inks are stable and print well. UV adhesives for lamination and pressure sensitive adhesives (PSA), as well as for cold foil perform well. Inks do not cure prematurely in the press when exposed to overhead lighting.

### Ideal Applications:

- Higher quality opaque whites and dense blacks
- Multiple thick layers cured all the way through with good inter-layer adhesion
- Low/high Coefficient of Friction (COF) whites for shrink application
- UV Metallic range
- Fluorescent colors without fading
- Wide range of coatings
- UV adhesives, both for lamination and Pressure Sensitive Adhesives (PSA), as well as for cold foil
- Low migration/food packaging

## Conclusion

Finding the perfect combination of spectral output, irradiance, and energy density will vary given the unique nature of each printing application (substrate material, ink, coating or adhesive, environmental conditions, line speed). Working closely with your UV chemistry and UV curing supplier will result in a synchronized solution. In all cases processes using UV LED lamps with higher energy density will enable faster, more efficient and predictable cure at higher speeds.

## ABOUT THE AUTHOR

Stacy Hoge is the marketing manager for UV Curing at Excelitas. Excelitas develops light technologies across the UV spectrum that are integrated into equipment and manufacturing processes to enable the world around us. Excelitas offers customers the full spectrum of solutions from UV to IR, supporting a diverse range of applications worldwide.

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