Richa Anand, Ph.D.

Product Marketing Manager
Phoseon Technology
7425 NW Evergreen Parkway, Hillsboro, OR 97124 USA

Presented at the 16th International Coating Science and Technology Symposium,
September 9-12, 2012, Midtown Atlanta, GA[1]

Advancements in UV LED Curing for Coatings and Adhesives

UV LED curing technology has advanced significantly in the past few years and is now readily available for a variety of coating and adhesive applications. There are many benefits driving companies to move toward acceptance of UV LED technology such as higher productivity and a more environmentally friendly solution which more and more end customers are demanding. As manufactures are developing UV LED curing systems, knowing how the key sub-components work together will help in creating the optimum solution and thereby reducing the overall environmental impact of the process and at the same time maintaining or improving productivity and product performance. To gain from UV LED based light sources there has been growth in developing high-performance UV LED energy curable coatings. Today, UV LED curing technology continues to win over many users in the coatings world replacing the traditional mercury arc lamps.

Coatings and Materials

UV LED lamp suppliers continue to work with the material formulation/chemical material suppliers to formulate UV LED wavelength optimized materials. UV LED optimized materials combined with UV LED curing units have become more efficient in delivering higher energy to the media thus driving not only environmentally clean, energy efficient solutions, but also increased throughput and process flexibility. The coatings' industry is driving towards various new challenging applications to use the latest and greatest UV LED curing lamps to benefit from improved yield, throughput and productivity.

Applications

Application areas in UV coating and adhesives include but not limited to: wood and vinyl, automotive, musical instruments, fixtures, medical adhesives and many others.

Wood Coatings

UV LED lamp suppliers have partnered with coating formulators and wood coating industry manufacturers to develop UV LED wood coating lines. This new curing technology has the possibility to cure UV top-coat lacquer and water-based UV curable coatings with drastically improved throughput, reduced energy consumption and significantly reduced work-piece surface temperature. The reduced work-piece surface temperature allows for a larger variety woods and other materials to be used with UV curable coatings.

Industrial Coatings

Coatings for industrial process have unique characteristics. They are typically delivered in large volume with a need for process consistency. UV LED curing lamps are an ideal fit for these requirements as they can be built in various configurations (lengths, widths, irradiance intensity) and well as monitored through industry-standard means to ensure consistency. By taking advantage of UV LED curing, industrial companies are able to lower their overall energy usage, regain floor space, and improve worker safety.

Adhesives

UV LED curing solutions are being utilized for curing adhesives because they offer lower operating costs in small form factor, enhanced system capabilities due to being a solid-state device, and environmental benefits of safer workplace environment. One of the key advantages of UV LED curing of adhesives is very low amount of heat generation in surrounding areas thus improving the productivity. UV adhesive curing applications include: electronics, medical, industrial and many others.

UV LED Cost of Ownership Model[2]

A detailed cost of ownership model was developed in cooperation with Tikkurila AB and Robert Bürkle GmbH based on actual findings from industrial coatings applications. When comparing costs between an Arc lamp and UV LED system, all of these factors were considered to assess the total cost of ownership.

Benefits	**Relevant Factors to Assess the Total Cost of Ownership**
Advanced Capabilities	• Increased yield and higher productivity • Ability to cure on heat sensitive substrates • Deep through cure • Small and compact machines • Controlled curing intensity
Economic	• Cost of energy and services • Cost of installation • Cost of maintenance and consumables • Cost of downtime • Depreciation and replacement costs
Environmental	• LED technology is mercury and ozone free • Workplace safety • UV-A wavelength range

Taking these factors into consideration Bürkle was able to demonstrate that for a 1.4M lamp savings of the order of €10,000 per lamp per annum can be achieved. About 60% of this comes directly from energy savings alone and the rest from reductions or elimination of the following:

1) Elimination of Ozone extraction requirement
2) Reduction in air extraction volumes by ~50% (UV cooling eliminated)
3) Reduction in down time associated with Repair & Maintenance requirements by ~80%
4) Improvement in Yield by ~5%

From a carbon footprint perspective each UV LED lamp consumes on average 50% less energy than an equivalent Arc lamp as a result of:

1) Instant on/off allows the lamp to be switched on/off immediately when required with no Stand-by mode. This duty cycle also considerably extends the useful life of the lamp by up to 6-8 years.

2) LED technology is more efficient at converting electrical energy into useful UV light 25-30% compared to <10% for an Arc lamp.

3) For a typical coating line the energy savings of the order of 30% are achievable for the line in total which more than off-set the increased investment cost of about 6.5% in selecting LED vs. Arc lamps and of course the energy savings are ongoing.

4) Each lamp uses about €6K electricity less per annum. This equates to about 25 Tons of CO_2 (electricity from a gas fired power station, 2x for coal). To offset the CO_2 emissions from a single 1.4M arc lamp around 200 trees would need to be planted annually or 10 cars taken off the road per year.

Conclusion

UV LED based curing is now an accepted user-friendly tool in coatings industry. The coatings industry continues to challenge and drive the formulation/chemical material suppliers with UV LED wavelength optimized materials. At the same time, UV LED curing units have become more efficient in delivering higher energy to the media thus driving not only environmentally clean, energy efficient and compact size units but also with increased throughput and process flexibility.

[1] Unpublished. ISCST shall not be responsible for statements or opinions contained in papers or printed in its publications.

[2] Mr Perttu Sutinen and Dr. Anna Zarembo PhD of Tikkurila Oyj for their work in "LED Curing of temperature sensitive pine wood". Mr Mikael Andersson of Tikkurila Coatings AB and Mr Tobias Schreck of Robert Bürkle GmbH for their input and analysis. Also we would like to acknowledge the contributions of Mr Paul Mills of UV Robotics for help with conducting testing and Dr. Jun Hu, PhD and Dr. Mark Soucek, PhD. for resources that aided this research. *Phoseon would like to acknowledge contributions from folks at Tikkurila AB and Robert Bürkle GmbH for cost of ownership data.