UV LED CURING TECHNOLOGY: IMPROVING ELECTRONICS MANUFACTURING PROCESSES

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INTRODUCTION

1. QUICK INTRO TO UV LED CURING TECHNOLOGY AND TRENDS
2. TOP 5 BENEFITS FOR ELECTRONICS MANUFACTURING
3. ELECTRONICS APPLICATIONS
4. CHALLENGES AND NEXT STEPS
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WHO WE ARE.

A GLOBAL TECHNOLOGY GROUP focused on themes such as the environment, energy, health, mobility and industrial applications.

OVER 12,400 EMPLOYEES AT OVER 100 SITES IN 38 COUNTRIES

2015 PRODUCT REVENUE: €1.9 BILLION.
2015 TOTAL REVENUE INCL. PRECIOUS METAL TRADING: €12.2 BILLION

OVER 5,750 PATENTS AND PATENT APPLICATIONS

TRUST AND RELIABILITY AT THE CORE OF OUR BUSINESS

WE CREATE HIGH VALUE SOLUTIONS and substantially strengthen competitiveness for our customers in the long term combining material expertise with technological know-how.

Family-owned for 165 years
Focus on innovations, operational excellence and entrepreneurial leadership
Financial stability
Global compliance & environmental standards
THE INCREDIBLE POWER OF LIGHT®

Photonics-based solutions from ultraviolet to infrared
INTRODUCTION TO UV LED CURING

3 narrow, nearly monochromatic, wavelengths

Less wasted output, but…

requires chemistries responsive to these wavelengths
INTRODUCTION TO UV LED CURING

Compared to traditional mercury arc UV lamp

- No mercury
- No ozone
- No heat from infrared
INTRODUCTION TO UV LED CURING

Applications already commercialized since ~ 2005

**Printing**
- Wide format inkjet printing for signage and posters, narrow format inkjet for packaging marking and coding, rotary screen for plastic bottles, offset printing, flexo printing for labels

**Adhesives**
- Bonding electronic components, medical devices, sealants for electronic devices

**Coatings**
- Wood coatings, protective coatings for furniture foils

**Industrial coatings**
- Optical fiber production, composite manufacture, wind turbine blade repair, coatings in printed electronics
# DRIVERS FOR IMPLEMENTATION OF UV LED SYSTEMS

## Technology features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>Instant on / off</td>
<td>Ready to use / no warm up time, energy savings and positive impact on lifetime</td>
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<tr>
<td>Low electricity consumption</td>
<td>Energy savings</td>
</tr>
<tr>
<td>Low heat output</td>
<td>Positive impact for heat sensitive substrates</td>
</tr>
<tr>
<td>No ozone, no Hg</td>
<td>Environmentally friendly and easier integration</td>
</tr>
<tr>
<td>Long lifetime, constant output</td>
<td>Lower maintenance costs and better process control</td>
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## System features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>Format selection</td>
<td>Less stray light, positive impact on lifetime and energy savings</td>
</tr>
<tr>
<td>Small form factor</td>
<td>Easier integration, available in spot cure units</td>
</tr>
<tr>
<td>Smart sensors</td>
<td>Higher reliability, better process control</td>
</tr>
<tr>
<td>Optics</td>
<td>Flexible working distance and less stray light</td>
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Successful UV LED applications take full advantage of UV LED features.
ADVANCEMENT TRENDS IN UV LED CURING TECHNOLOGY

RAPID UV LED CHIP TECHNOLOGY ADVANCEMENT – 10 TO 20% INCREASES IN EFFICIENCY EVERY 9 TO 12 MONTHS!
ADVANCEMENT TRENDS IN UV LED CURING TECHNOLOGY

UV LED system manufacturers made significant advances in cooling techniques and optics

Tighter packaging of LED chips into arrays and significantly improved optical control

Higher UV energy onto the substrate

NEW CURING APPLICATIONS REQUIRING FASTER LINE SPEEDS AND HIGHER ENERGY DENSITIES BECOME FEASIBLE!
ELECTRONICS APPLICATIONS – COMMERCIAL AND IN DEVELOPMENT

- Adhesives bonding
- Electronics encapsulating and potting
- Marking
- Gasketing
- Flexible electronics
- Optically clear adhesives for displays
- Conformal coating PCBs

APPLICATIONS USING LONGER WAVELENGTH ADDITIVE ARC LAMPS ARE A NATURAL FIT!
TOP 5 BENEFITS FOR ELECTRONICS MANUFACTURING

- Increased production rates
- Increased process flexibility and control
- Easy to retrofit
- Improved process reliability and global consistency
- Reduced operating costs
INCREASED PRODUCTION RATES

- 10 times longer operating life (10k+ hours) than medium pressure arc UV curing systems
- Instant on/off capability – no waiting to start (3-5 min. w/ arc lamps) or restart – no need for shutters
- UV LED curing system controls integrated – UV stops/restarts instantly when the line stops/restarts
- Modular, plug & play, UV LED systems make lamp replacement quick – seconds instead of 30 minutes or more

RESULTS IN MORE UPTIME TO DELIVER HIGHER PRODUCTION RATES.
INCREASED PROCESS FLEXIBILITY AND CONTROL

- Cooler operating temperatures, ~1/3 less heat enables processing heat sensitive materials, won’t damage heat sensitive components
- Dimming controls – dial in UV energy for changing process needs
- More precise bonding – instant cure of small components with higher precision placement and alignment
- Can supplement existing arc lamp curing
  - More production flexibility
  - Use as production “test bed” for UV LED

EXPANDS PRODUCTION CAPABILITIES – DELIVERS HIGHER PRODUCTION LINE UTILIZATION.
EASY TO RETROFIT

- Small form factor
- Low cooling and exhaust air requirements – no bulky and noisy fans, use internal muffin-type fans or water
- No shutters
- Heat and light shielding greatly simplified
- No ozone or mercury – safer working environment
- Commonly retrofitted onto flat conveyor lines or indexing machines
Higher process reliability
- More consistent UV energy output
- Longer operating life

Global process consistency
- Easy to duplicate process and less $ to relocate equipment – small and light weight
- No concerns about different cooling needs (cfm) at different elevations
REDUCED OPERATING COSTS

30 – 70% Energy Savings + Fewer Consumable Parts + Lower Maintenance = Reduced Operating Costs
SEMRAY® UV LED CURING PROVIDES SMART ANSWERS TO YOUR NEEDS WITH A MODULAR, PLUG & PLAY SOLUTION

- Higher Productivity
- Higher Output
- Convenient Retrofit
- Greater Flexibility
- Improved Performance

Learn more about Semray®
CASE STUDY – ADHESIVE BONDING

**Needs**
- Manual arc lamp spot curing, using longer wavelengths
- Higher throughput
- Flexibility to run variety of parts

**Development**
- Material evaluation and testing
- Trials at Heraeus lab and formulator demo center
- Customer validation tests
- Production line validation with appropriate UV LED curing demo equipment

**Solutions**
- Continuous conveyor or indexing systems
- Targeted UV LED 3D cure chamber
- Various UV wavelengths available to cure through blocking substrates

*Increase production rates and ability to cure a variety of products*
CASE STUDY - POTTING

Needs
- Have long wavelength iron doped UV arc or microwave lamp
- More consistent curing
- Less maintenance
- Reduced heat load to the substrate

Development
- Testing at Heraeus lab
- Evaluation and validation on customer’s line using UV LED curing demo equipment

Solutions
- Continuous conveyor or indexing systems
- Targeted UV LED 3D cure chambers available
- Various UV wavelengths available
- Custom solutions per process requirements

Reduced work in process and improved quality
CASE STUDY – CONFORMAL COATING

Needs
› UV arc lamp curing
› More consistent curing
› Less maintenance

Development
› Testing at Heraeus lab
› Evaluation and validation on customer’s line using UV LED curing demo equipment

Solutions
› UV LED retrofitted onto existing conveyor
› Easy maintenance concept
› 24 inches UV LED = 6 Semray® Segments

Reduced work in process and improved quality
CHALLENGES AND NEXT STEPS

UV LED curing will inevitably replace traditional UV curing technology for some electronics conformal coating, gasketing, and bonding/adhesive applications, just as LED technology has replaced some automotive lighting, interior lighting, and other traditional light sources.

Challenges

- Need suitable chemistry formulations
  - Commercially available
  - Meet end use requirements

- UV LEDs with higher output
NEXT STEPS

- Understand if UV LED curing is a fit for your electronics manufacturing processes – begin evaluating curing processes currently using longer wavelengths now!
- Every UV curing process is unique – type of substrates/component/device, orientation and handling, chemistry, etc.
- Reach out to experienced UV LED curing equipment providers and chemistry formulation partners
- Find knowledgeable partners to assist with lab testing and in-plant trials, process development support, assess feasibility and ROI
- Lab testing (done correctly) easily scales to pilot line and production processes

Learn more about UV LED technology and benefits.
APPLICATIONS AND PROCESS DEVELOPMENT CAPABILITIES

Heraeus Noblelight can help with next steps

- Application Competence Centers in Gaithersburg, MD & Torrance, CA
- Bringing together development team – chemistry formulation partners, machine builders
- Loan out Semray® UV LED systems for laboratory testing, pilot line and in-plant trials
- Many partners have Semray® on equipment & lines available for testing
THANK YOU FOR YOUR ATTENTION: QUESTIONS?

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