

UV LED Webinar



Agenda

- Introduction
- How UV LEDs Work
- Current Capabilities
- Benefits & Challenges
- Implementation
- UV.EB East Preview
- Q&A

Introduction

- UV LEDs (Light Emitting Diodes) first used for UV curing in early 2000s
- Offshoot from Blue LEDs for lighting
- Rate of improvement is rapid
- Continual innovation in both systems and diodes means that it is important to stay 'up to date' with current capabilities

UV LED Overview

- UV LEDs are semiconductors
 - Half of a standard transistor
 - Long-term reliability of a transistor
- UV curing is the primary use (also used in counterfeit detection, disinfection, mineral analysis, medicinal...)
- 7 companies producing UV diodes
- Many system manufacturers buying diodes or diode packages and engineering curing systems

How UV LEDs Work

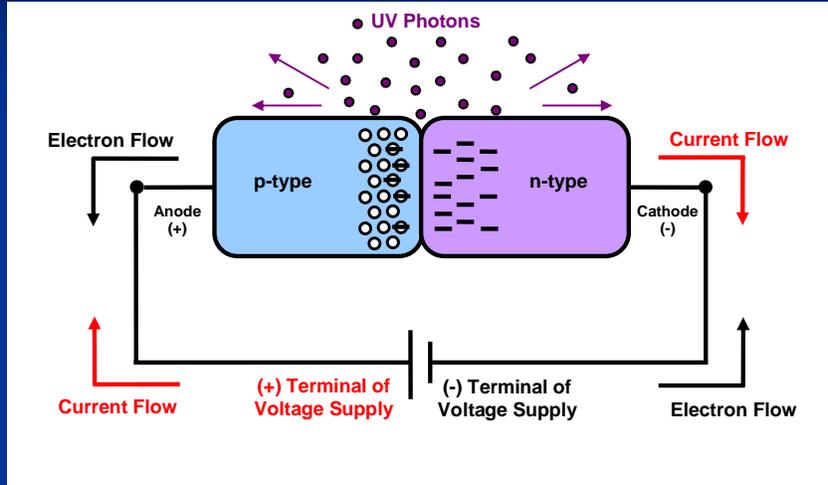
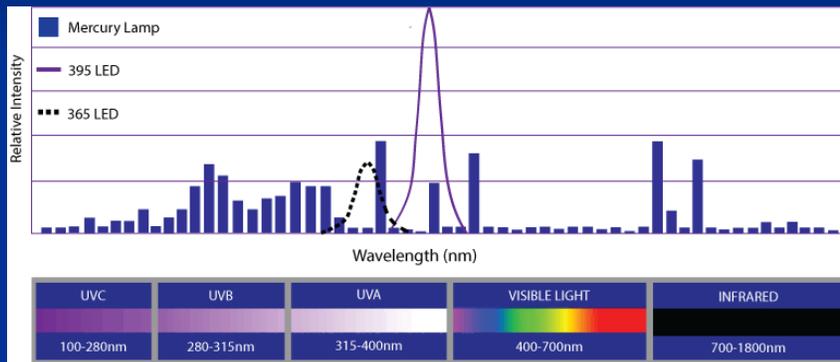


Illustration of a single Positive-Negative Junction, Light Emitting Diode (LED), Chip, Diode, Die, Semiconductor...

How UV LEDs Work



How UV LEDs Work

- When connected to a DC power supply, UV LEDs emit photons that initiate the polymerization process
- Narrow band UV-A output with high peak irradiance centered at 365, 385, or 395 nm
- Peak irradiance is related to 1) efficiency of the diode, 2) electrical current through the diode, and 3) junction temperature
- Energy density is related to 1) irradiance, 2) number of diodes, and 3) line speed or dwell time

How UV LEDs Work

- Formulations (photoinitiators) must be able to absorb in the range of UV LED emission
- A minimum irradiance threshold is necessary to initiate cure
- Higher peak irradiances or chemistry formulation appear to help with oxygen inhibition
- Energy density determines maximum line speed or total dwell time until full cure

Always try with your application

Current Capabilities

- Used in a broad array of applications
 - Printing: digital ink-jet, screen, flexo, offset, ...
 - Coatings: wood, plastics, glass, laminates, ...
 - Adhesives: medical, bonding, metallics, ...
 - Industrial: fiber, automobiles, carbon, ...
- Many UV output possibilities
 - Irradiance of $<1 \text{ W/cm}^2$ up to $20+ \text{ W/cm}^2$
 - Energy Density is variable and is a factor of the irradiance, the number of diodes, and the line speed or dwell time

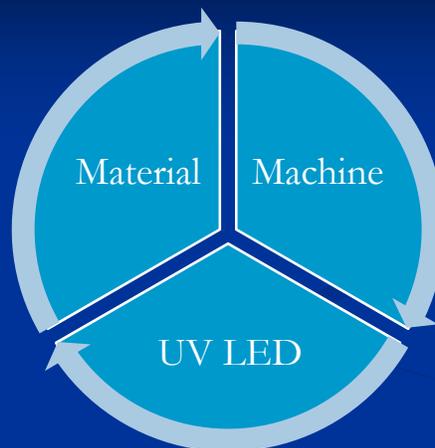
General market diffusion of UV-LED innovation

First Movers	Second Movers	Later Adopters
Inkjet Pinning and Full Cure— Slower Speed Inline Graphics	Inkjet Full Cure— Scanning Graphics	Litho/Offset
Inkjet Marking and Coding	Inkjet—Under White	3-D Finishing
Spot-Cure Adhesives and Sealants	Inkjet Industrial	High Speed Coatings
Slow Speed Coatings	Screen	High Speed Adhesives
	Flexo	UV-B Curables
	Wider Area Sealants/Adhesives	UV-C Curables
	Photoresist	

Benefits for Curing

- Compact, energy efficient, solid-state technology, with easy integration
- Near ambient array housing temperatures (no IR)
- Negligible heat transfer to cure surfaces (no IR)
- Instant On/Off curing
- No warm-up/cool-down cycles
- No shutters needed
- On-time life in excess of 20,000 hours
- Relatively consistent UV output over time
- Deep curing
- No mercury filled UV bulbs
- No ozone production or system exhaust / no conditioned plant make-up air
- No UVC or RF emissions
- Low maintenance
- Often results in lower total cost of ownership

Implementation



All three must work together
Not a drop-in replacement

Summary

- UV LEDs are just one type of radiation curing source with same basic physics and chemistry of all UV curing
- A UV source will only be successful if it can deliver the correct Wavelength, Irradiance, and Energy Density
 - 1) required by the formulation
 - 2) at the desired process speed
 - 3) within an acceptable form factor and
 - 4) at a reasonable capital investment cost
- There is no one-size-fits-all solution
- Most radiation curing equipment, including UV LED, is often tailored to a given market application

UV.EB EAST Topics

- The Evolution of UV LEDs: A Review of the Technology, Device Trends and Future Possibilities
- UV-C Light Emitting Diodes for Water Purification and Instrumentation
- Formulating for UV LED
- Measurement of UV LEDs: Establishing, Monitoring, Maintaining and Troubleshooting a Process Window
- Economics of UV LED Curing in Production – General Comments & Case Study
- Emerging Applications for UV LED Technology
- Lean and Green: UV LED Spot Source
- Real Life Label and Packaging Experiences

In addition:

- UV LED Summit: Road mapping Session
- NIST Dinner + UV LED Discussion