

UVA, B, and C Glass Optics Designed to Mix Wavelengths, Increase Irradiance, and Improve Uniformity: Design, Simulation, and Analysis

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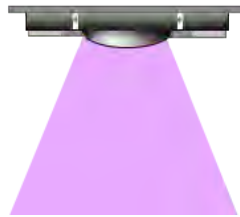


UV LEDs

- (a) Directional Light Source
- (b) Flexible LED Configurations
- (c) Monochromatic

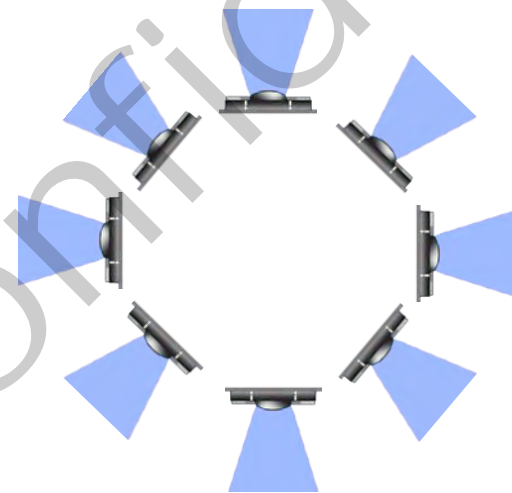
(a)

Directional light which can be controlled with optics



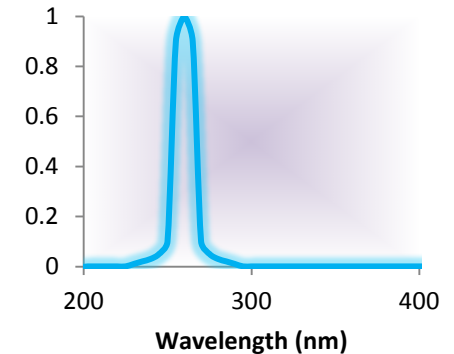
(b)

Flexibility in placement and configuration with individual LEDs and arrays



(c)

Peak wavelength and monochromatic spectrum

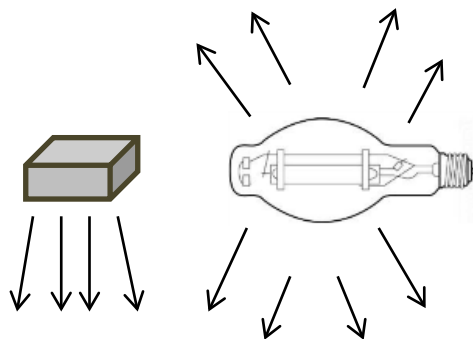


UV LEDs

- (a) Enable Compact System Designs
- (b) Provide Only Relevant Spectra
- (c) Enable Tunable Intensities

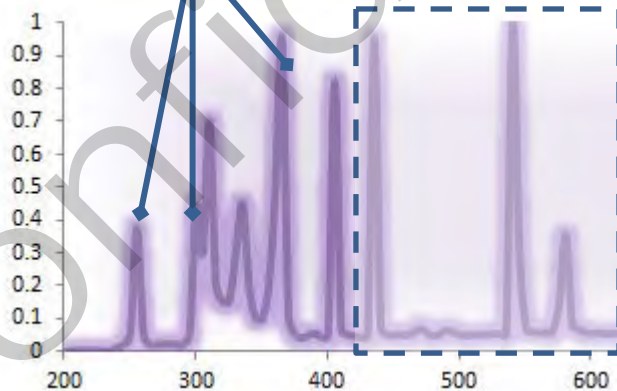
(a)

Compact system designs



(b)

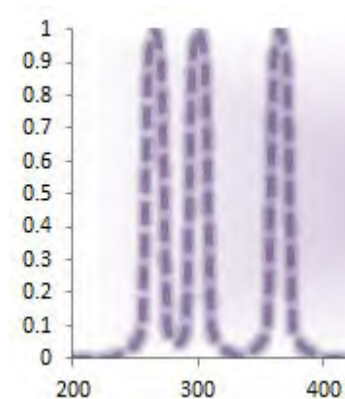
Only photoinitiator relevant λ



Mercury Vapor Lamp Spectrum

(c)

Tunable intensities

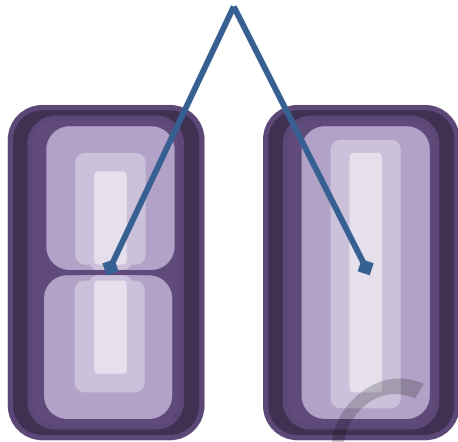


UV LEDs Spectrum

UV LEDs (d) Eliminate Striping & Optics (e) Provide Flexible Irradiance Footprint (f) Increase Irradiance

(d)

Inconsistencies in irradiance removed



Irradiance Maps

(e)

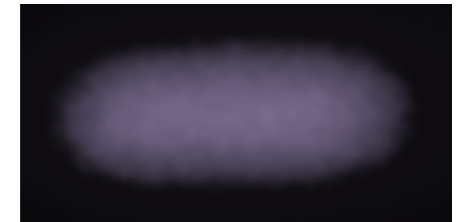
Unique light distribution for 3D or 2D surfaces



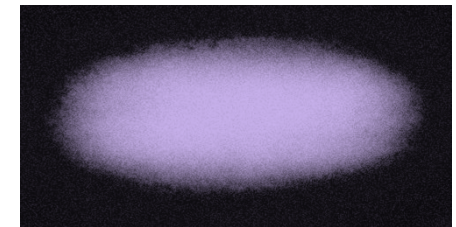
(f)

Increased irradiance on cure surface

WITHOUT OPTIC



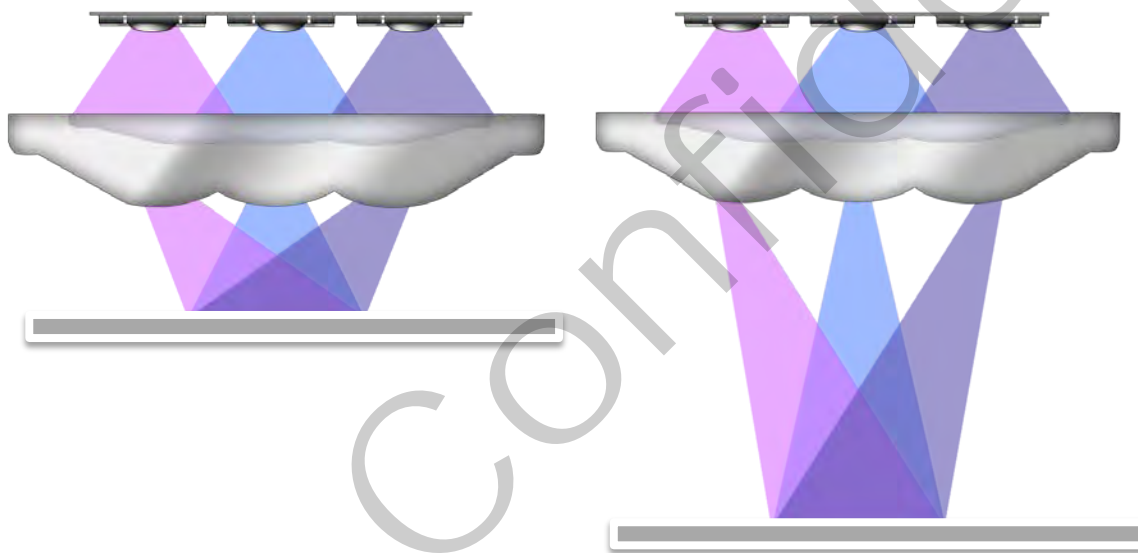
WITH OPTIC



UV LEDs (g) Tailor Working Distance & Optics (h) Protect Array and Reduce Reflection Loss

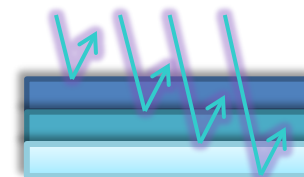
(g)

Set the working distance for unique applications



(h)

Protect the LED array and reduce surface reflection loss



Patent Pending

Collaborate in the design phase to achieve optimum results

OUR OPTICAL DESIGN EXPERTISE

OPTIMIZING UV LED ARRAYS AND OPTICS

- INCREASE IRRADIANCE
- IMPROVE UNIFORMITY
- FEWER LEDS LOWER COSTS

YOUR UV LIGHTING DESIGN GOALS

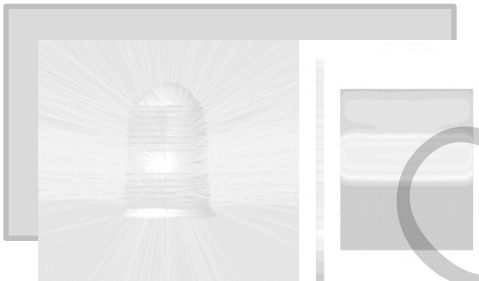
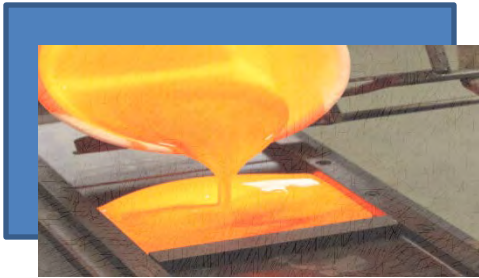
- Irradiance Pattern + Power
- Working Distance
- Spectrum
- Fixture Size
- Cost Targets

RESULTS IN OPTIMIZED UV CURING SYSTEMS

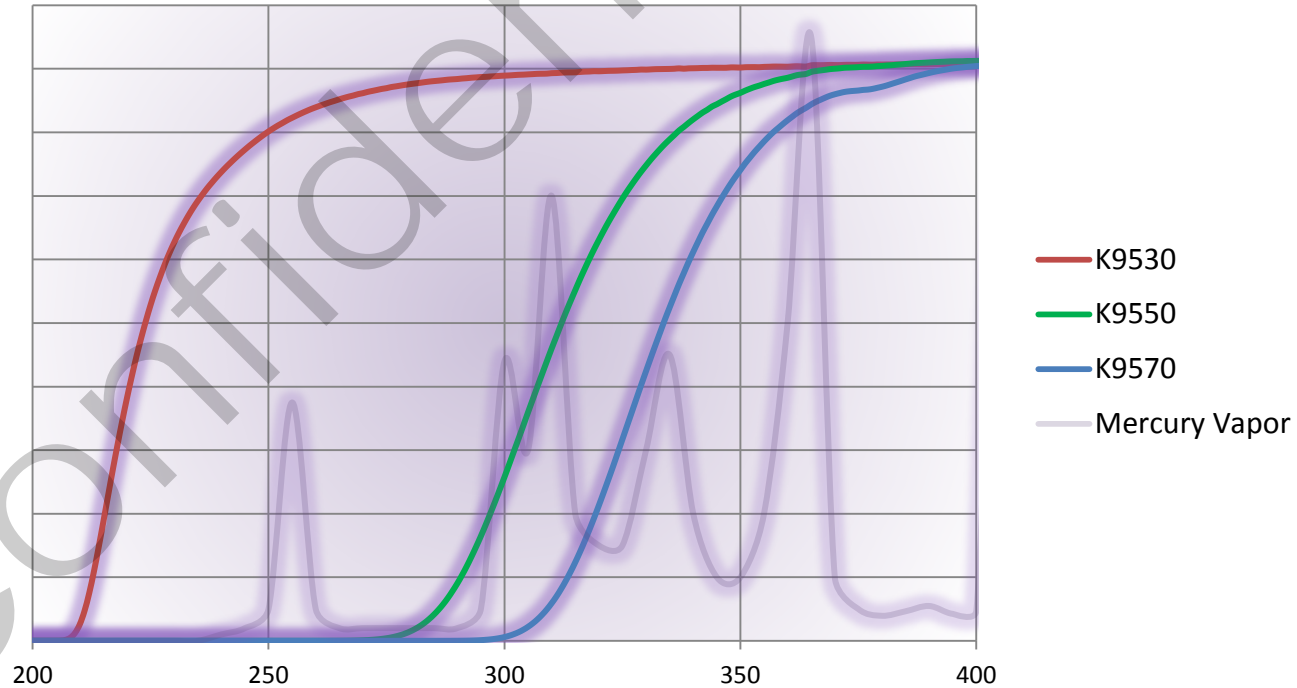
- Faster Cure Line Speeds
- Better Cure Quality
- Compatibility with Existing Photoinitiators
- Flexible Working Distances
- Lower Operating Costs

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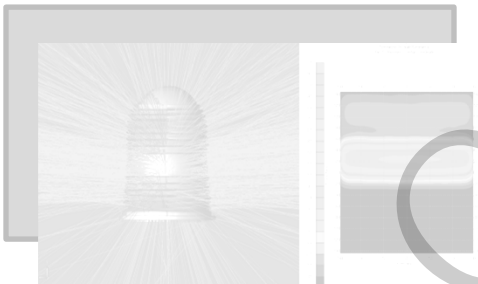
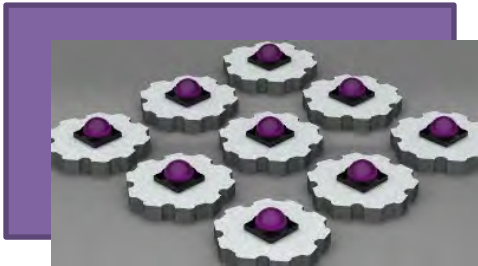
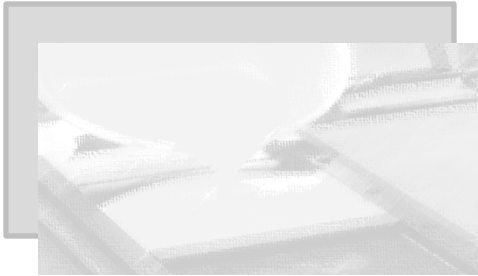
Collaborating: Materials, LED Array, & Optics



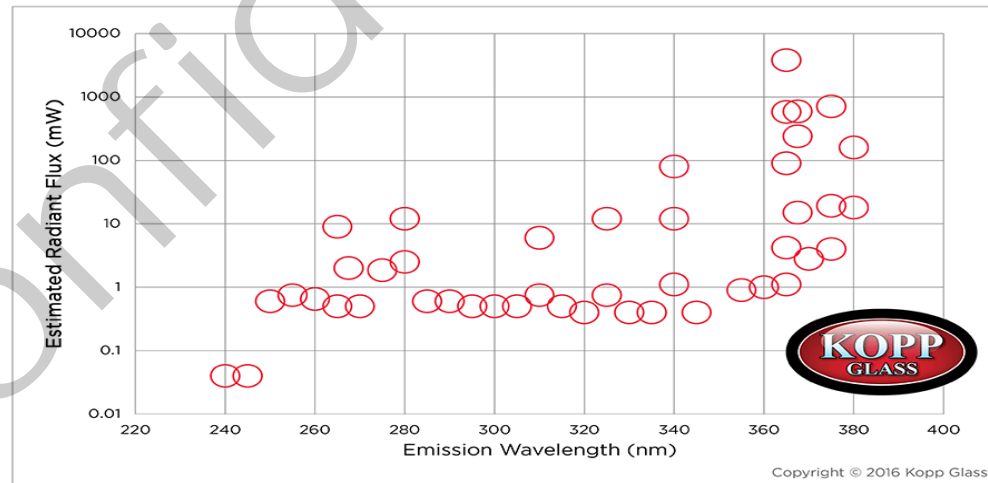
Transmission of glass formulations compared to Mercury Vapor spectrum



Collaborating: Materials, LED Array, & Optics

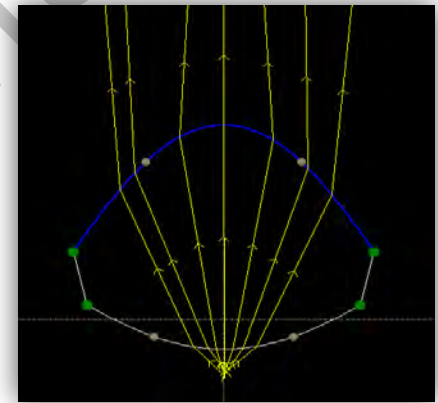
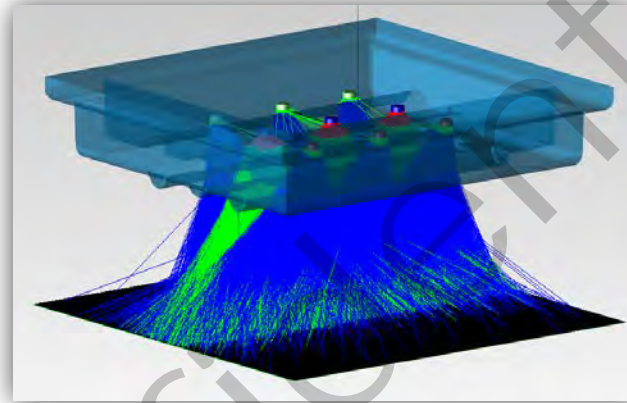
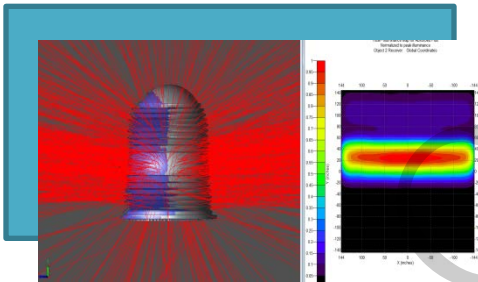
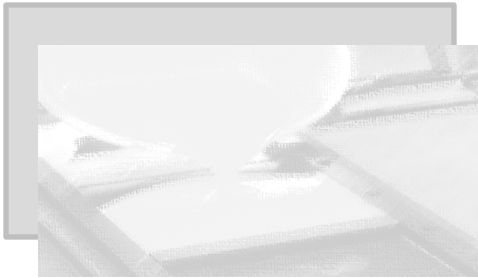


Small changes in LED array design to work better with optical components



Kopp Glass Blog, Glass Transforming Light
Current State of UV LED Technology - Justine Galbraith Ph.D.

Collaborating: Materials, LED Array, & Optics



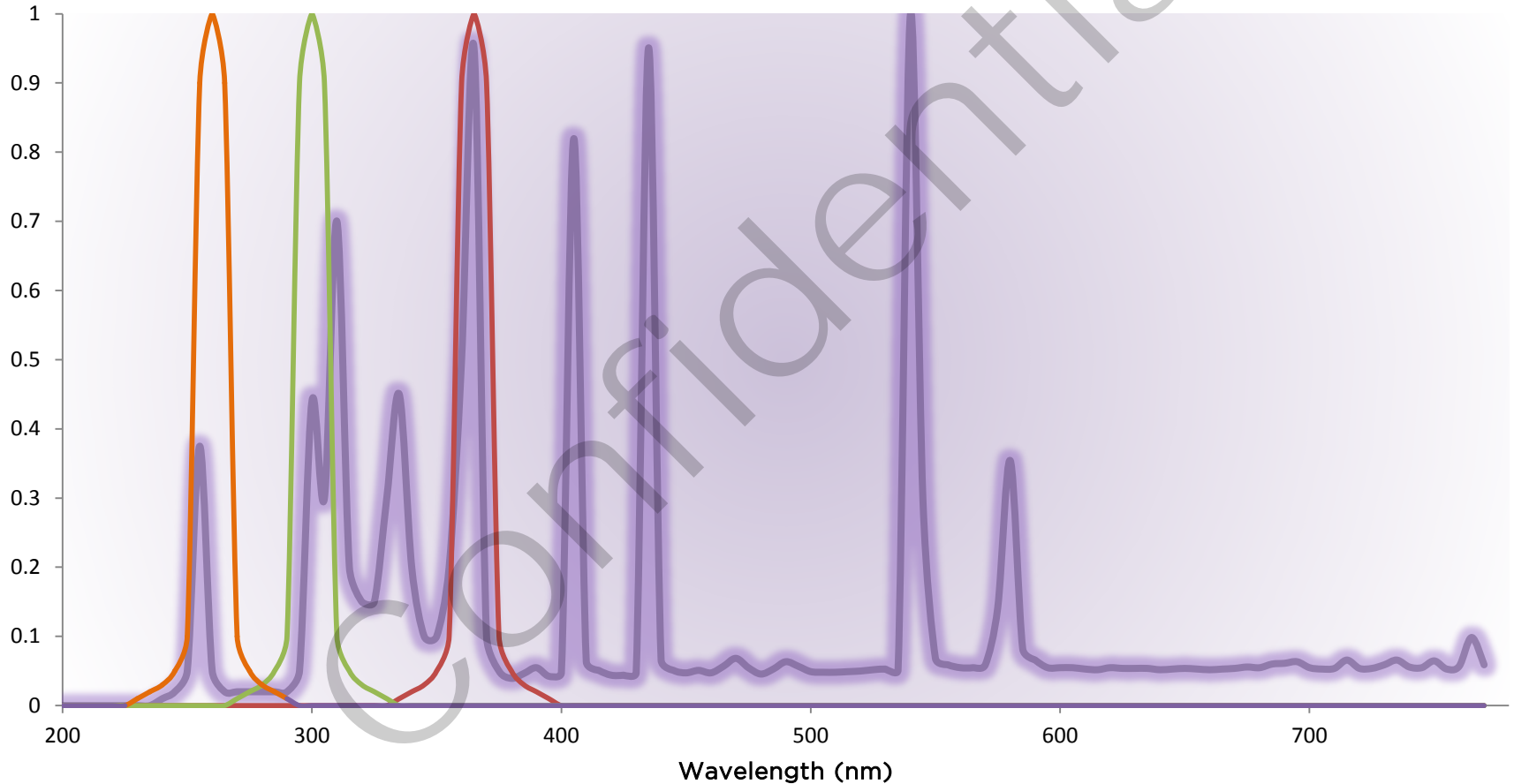
Lens designs with optical performance that improve cure quality

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Confidential

MIMICKING THE MERCURY VAPOR SPECTRUM WITH LEDS

Selected 265 nm, 300 nm, & 365 nm UV LEDs to mimic peaks of Hg spectrum

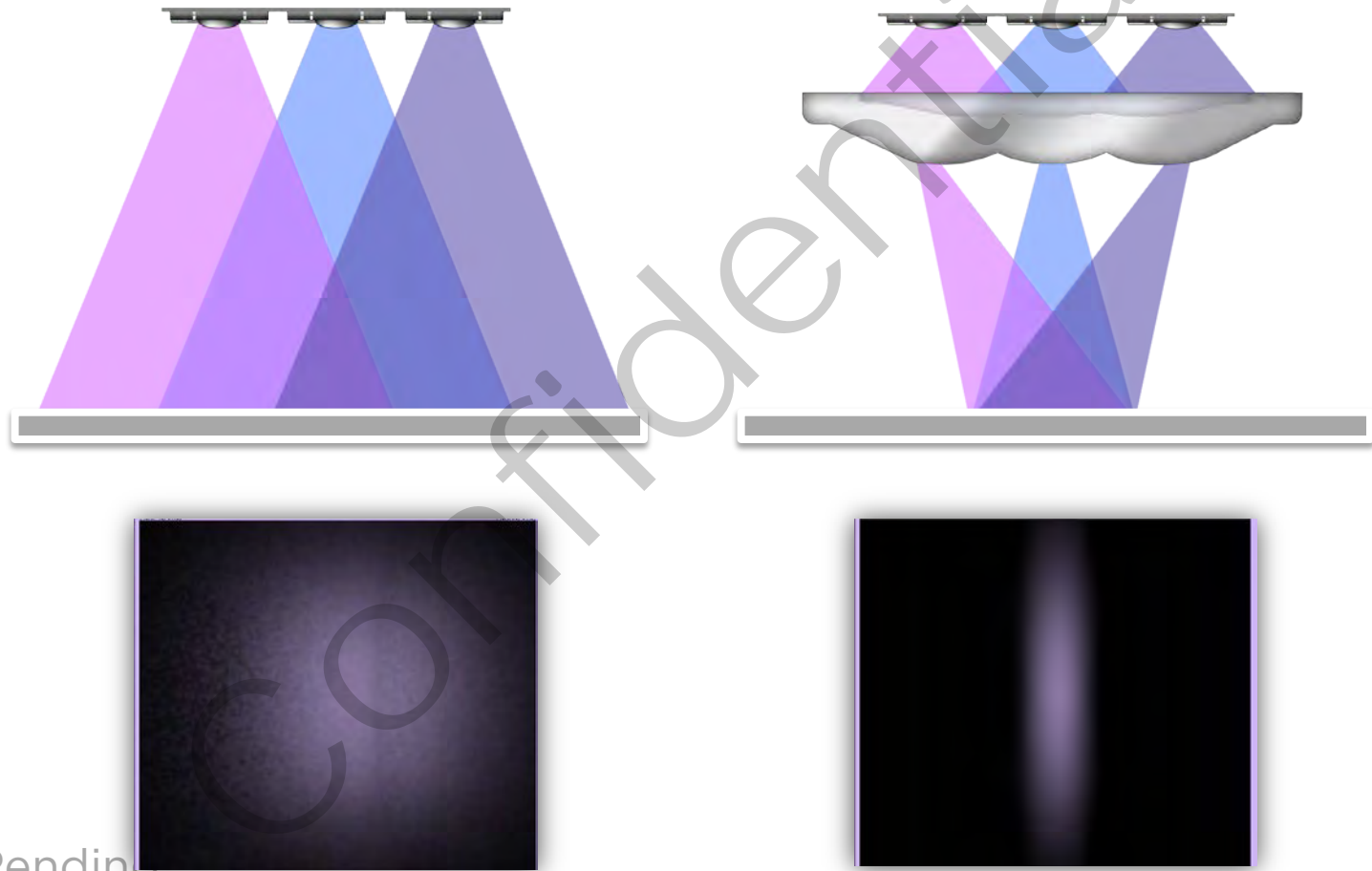


UV LED Selection

Manufacturer	Wavelength (nm)	Drive Current (mA)	Radiant Flux (mW)
Nikkiso	265	300	12
Nikkiso	300	150	12
LED Engin	365	10.5	12

Array Dimensions (mm)	Spacing (mm)	Size (# of LEDs)
60 x 60	18.5 to 20	3 x 3

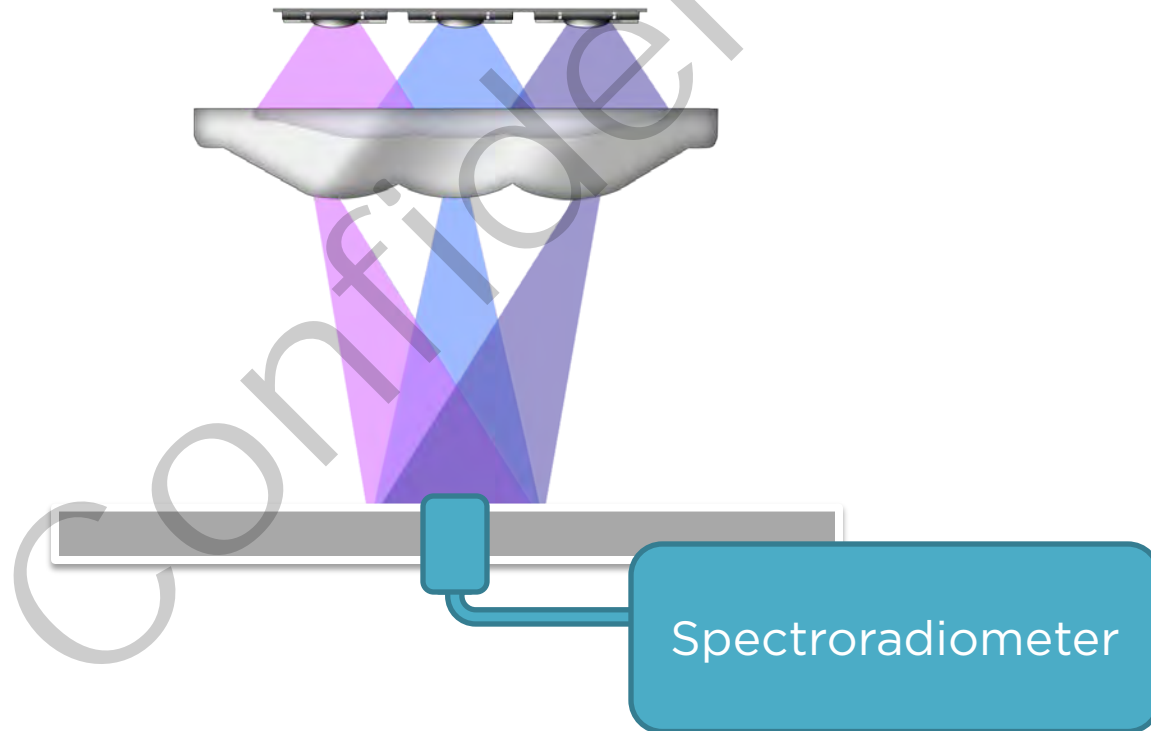
Combined 265 nm, 300 nm, & 365 nm UV LEDs into one uniform footprint



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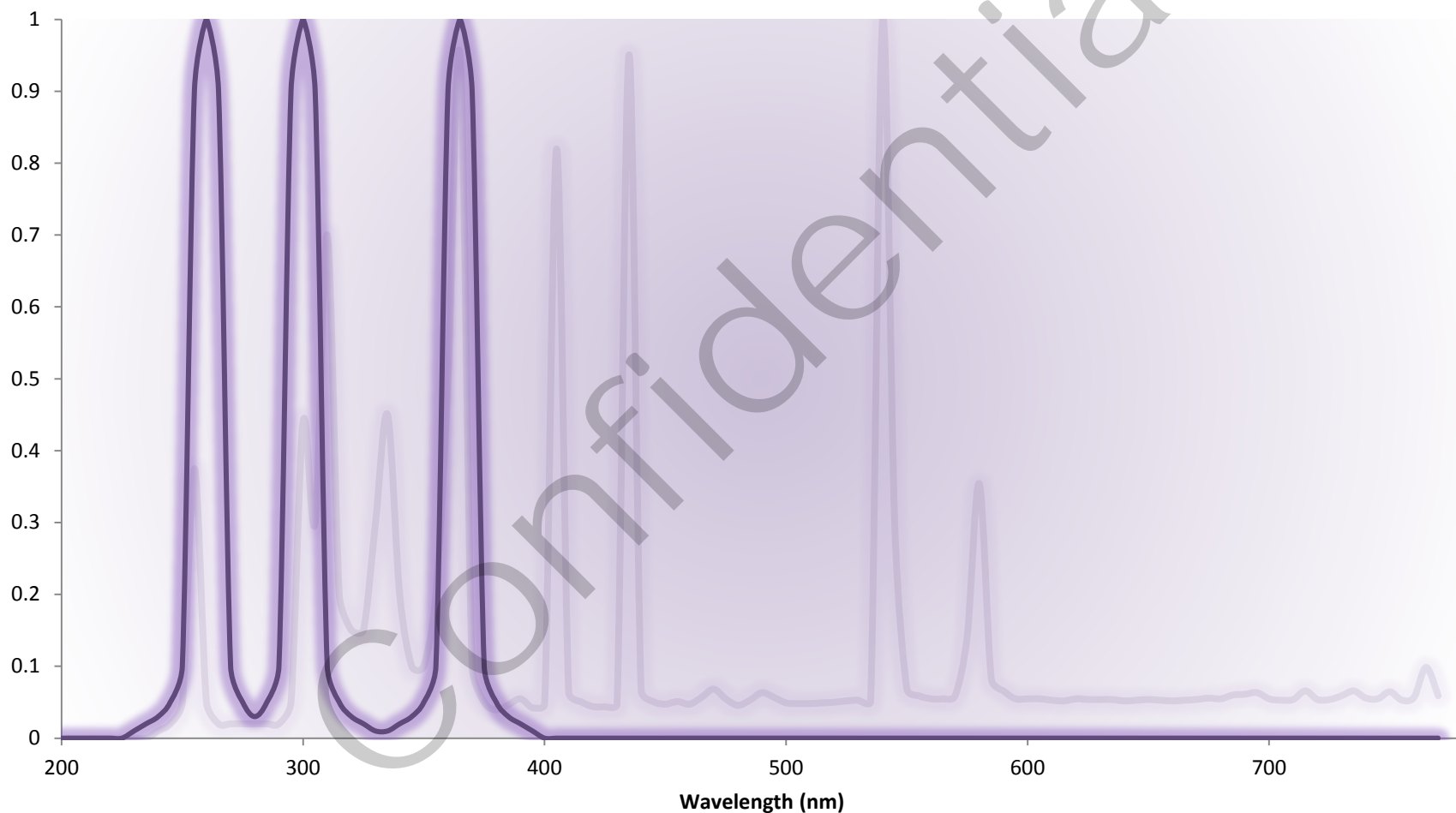
Equal relative intensity of each wavelength

Measuring spectrum on cure surface

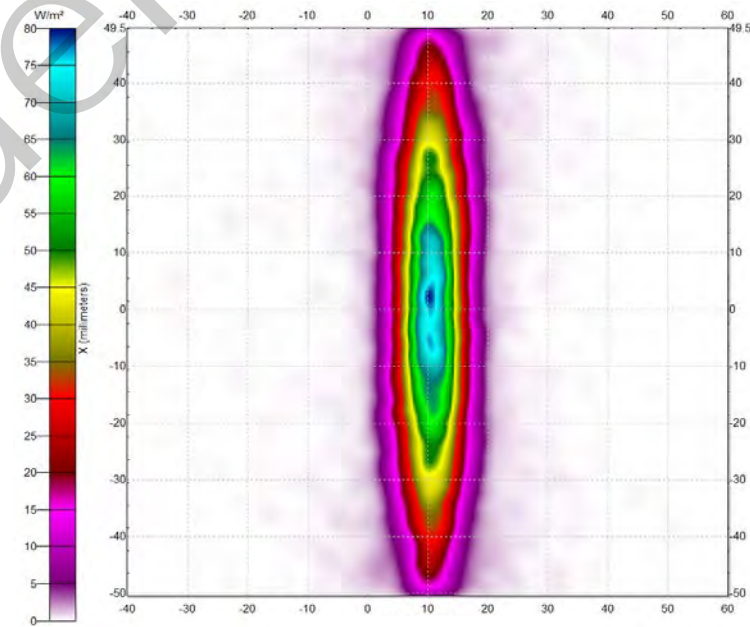
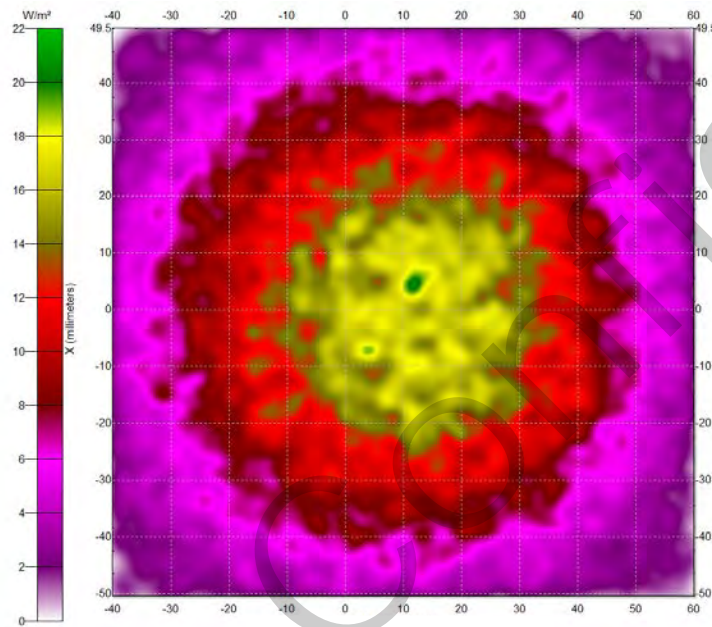
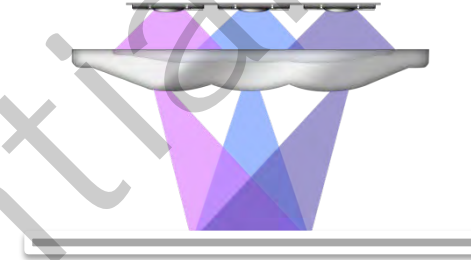


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Resulting spectrum with equal relative irradiance of each wavelength



Increased irradiance on cure surface



Patent Pending

*Simulated images

Advantage of Optics with LEDs

- (a) Compact System Designs ✓
- (b) Enable Tunable Intensities ✓
- (c) Provide Only Relevant Spectra ✓
- (d) Eliminate Striping
- (e) Provide Flexible Irradiance Footprint ✓
- (f) Increased Irradiance ✓
- (g) Tailorable Working Distance ✓
- (h) Protect Array and Reduce Reflection losses ✓

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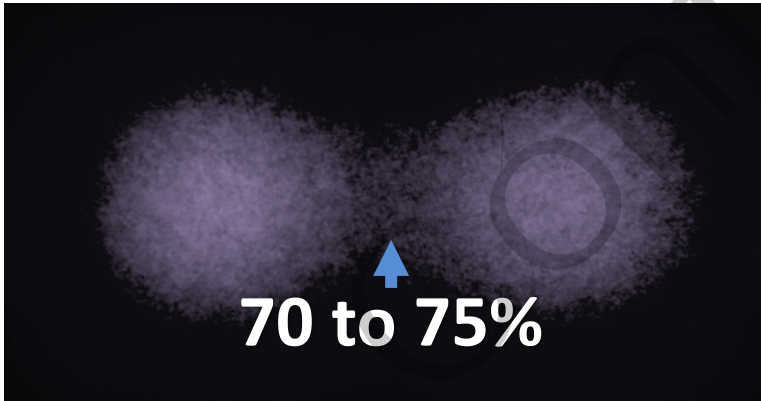
Eliminating Striping



WITHOUT OPTIC



WITH OPTIC



*Actual images

Patent Pending

Value to End User

- Increased or improved:
 - LED lifetime
 - Manufacturing flexibility
 - Ability to cure complex 3D surfaces
 - Quality of finished product
- Lower or reduced:
 - Manufacturing time
 - Energy cost
 - Capital equipment cost
 - Maintenance cost
 - Operational cost
- Prevents the need to change raw materials (e.g. photo initiators)
- Ability to tailor spectrum to a specific application
- Option to choose LED UV-C equipment



Thank You!

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