

Phosphor-Converted InGaN vs. Direct AlInGaP for Amber Lighting Applications

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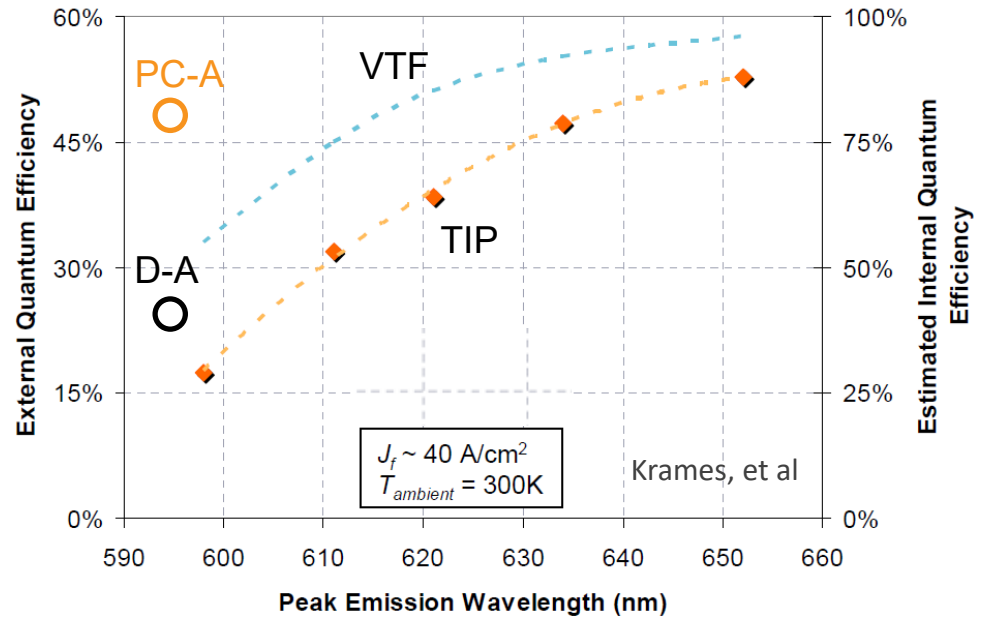
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DOE SSL Workshop, San Diego



Suitable Color Applications:

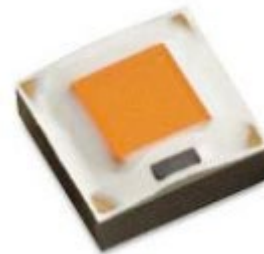
- Architectural Lighting
- Low Glare Outdoor Lighting
- Signage
- Wall Wash
- Automotive Turn Signal
- Fog Lamps



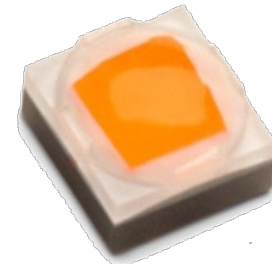
White+Amber
Auto Module



Luxeon FX

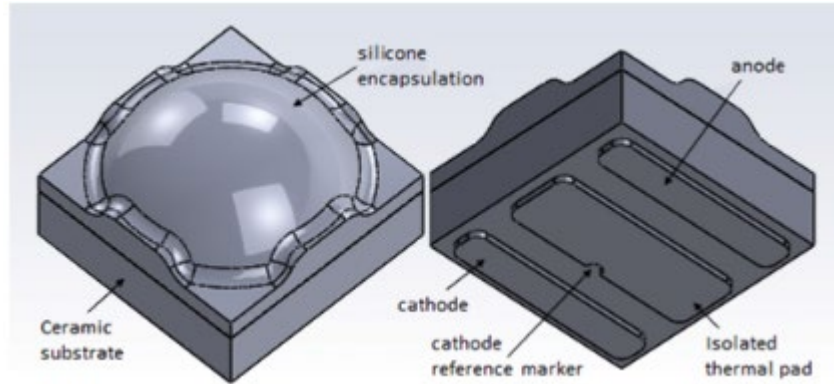


Luxeon CZ



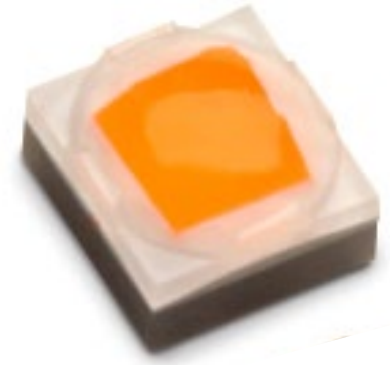
Luxeon C

Direct Amber



- Silicone Encapsulant, shallow dome
- Wirebonds
- AllnGaP VTF 1.1mm sq.
- Metal Solder die attach
- Ceramic Tile with Thermal/Electrical Pads

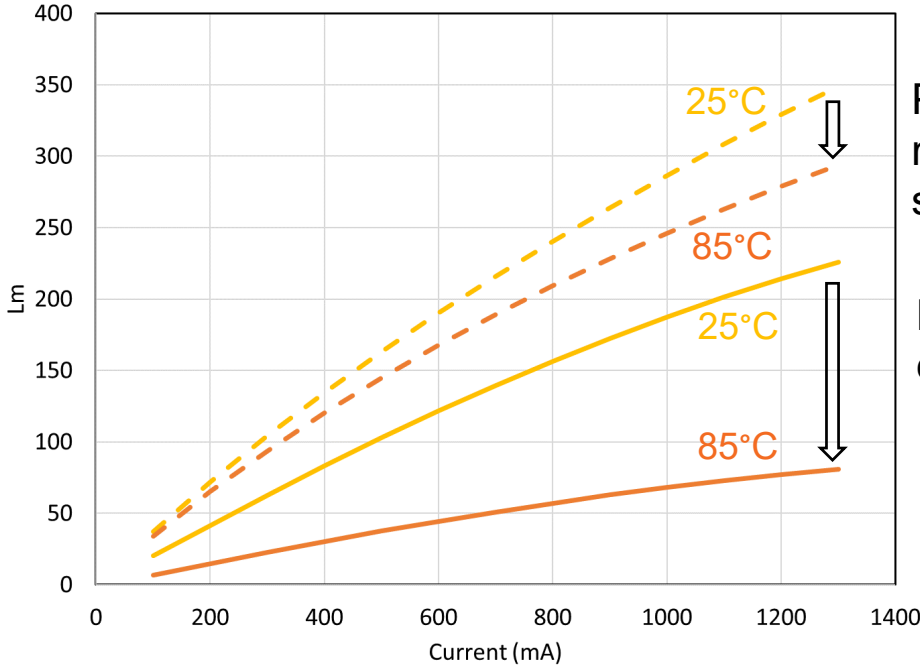
PC Amber



- Silicone Encapsulant, shallow dome
- BSSN* Phosphor Platelet with Sidecoating
- Silicone Glue Layer
- InGaN TFFC 1.0mm sq.
- GGI bumps with underfill
- Ceramic Tile with Thermal/Electrical Pads

Additional PC-A complexity results in higher manufacturing costs

*(Ba,Sr)₂Si₅N₈:Eu



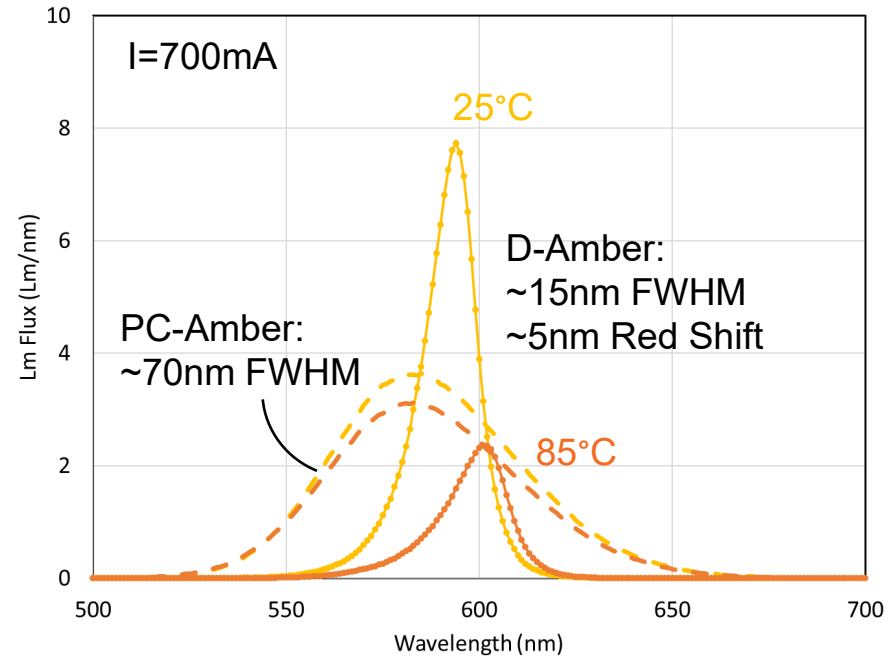
PC-Amber: 10-16% drop with temperature results from thermally enhanced phosphor saturation

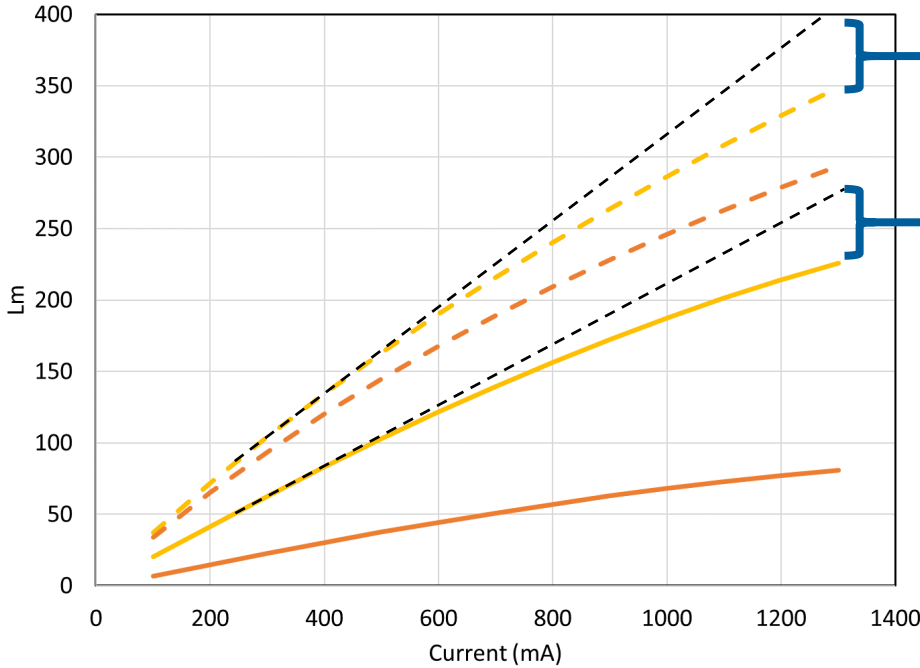
D-Amber: ~60% drop is a result of carrier confinement loss and spectral Red Shift

Pulsed Current, PW: 20ms

PC-Amber: Higher efficiency and greatly enhanced (3x) temperature stability

D-Amber: Greater Color Purity

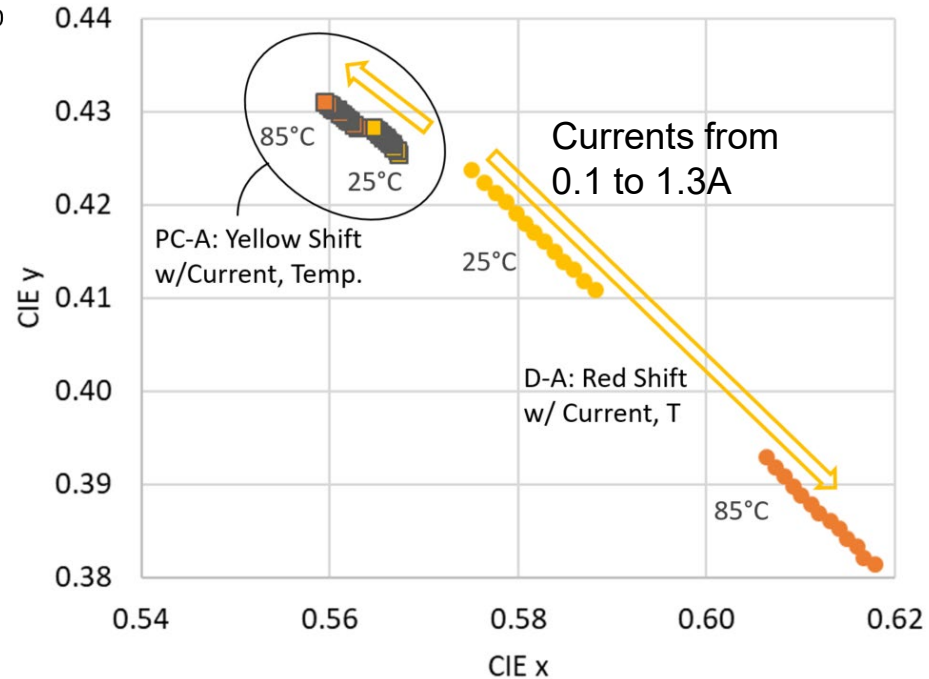


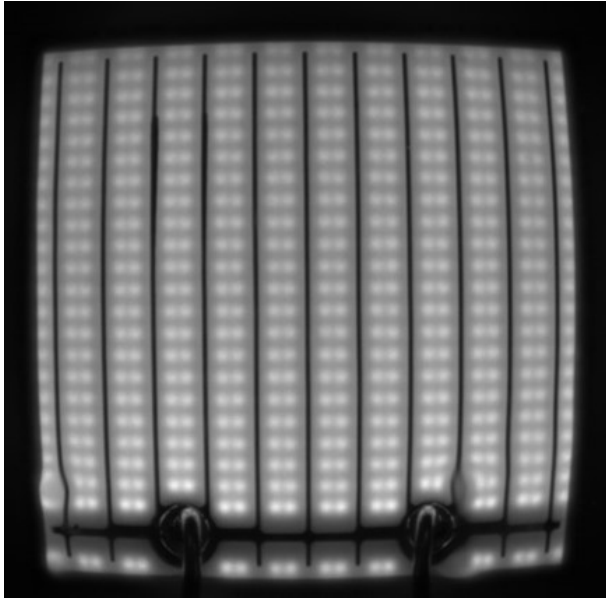


PC-Amber Droop is a combination of InGaN “droop”, phosphor saturation and heating

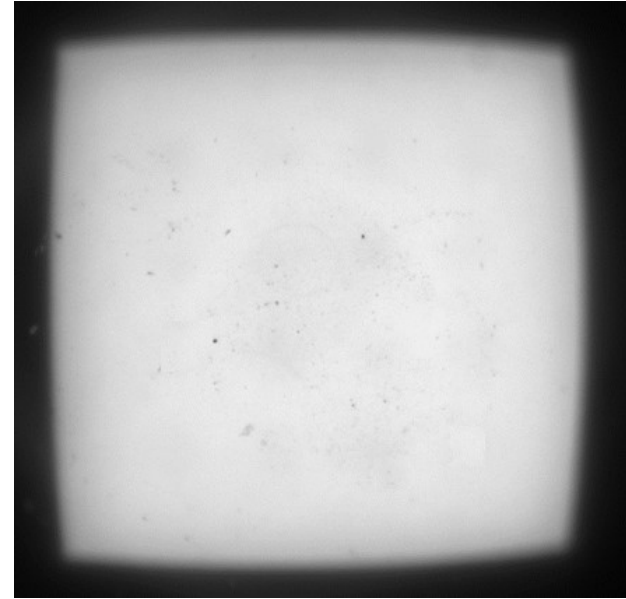
D-Amber Droop: increasing junction temperature causes carrier confinement loss and wavelength shift

Direct-Amber requires careful thermal management and is poorly suited to varying ambient temperature





D-Amber



PC-Amber

PCA Devices have a smooth nearfield with minor intensity variation. DA has current crowding around buried dot contacts and light blocking by topside contacts and bondpads.

Cyan shading indicates an advantage for either PC or Direct Amber

	PC-Amber		D-Amber	
I=0.35A	25°C	85°C	25°C	85°C
Lm	119	104	73	26.4
Lm/W	118	110	100	37.7
Ldom	589.4	588.8	590.6	596.2
Vf	2.91	2.78	2.09	2.00
FWHM	77.9	79.3	13.7	15.9
Color Purity	98.1	97.6	99.9	99.9

PC-Amber is the preferred choice for most applications but cost, color purity and high Vf must be considered.

	PC-A 25-85°C	D-A 25-85°C
Lm H/C	0.87	0.36
Ldom shift	-0.6nm	+5.6nm
I _{max}	1.3A	1.3A
ESD	8kV	>8kV



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