Cd-Free Quantum Dots for Lighting and Displays

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2020: QUANTUM DOTS EVERYWHERE

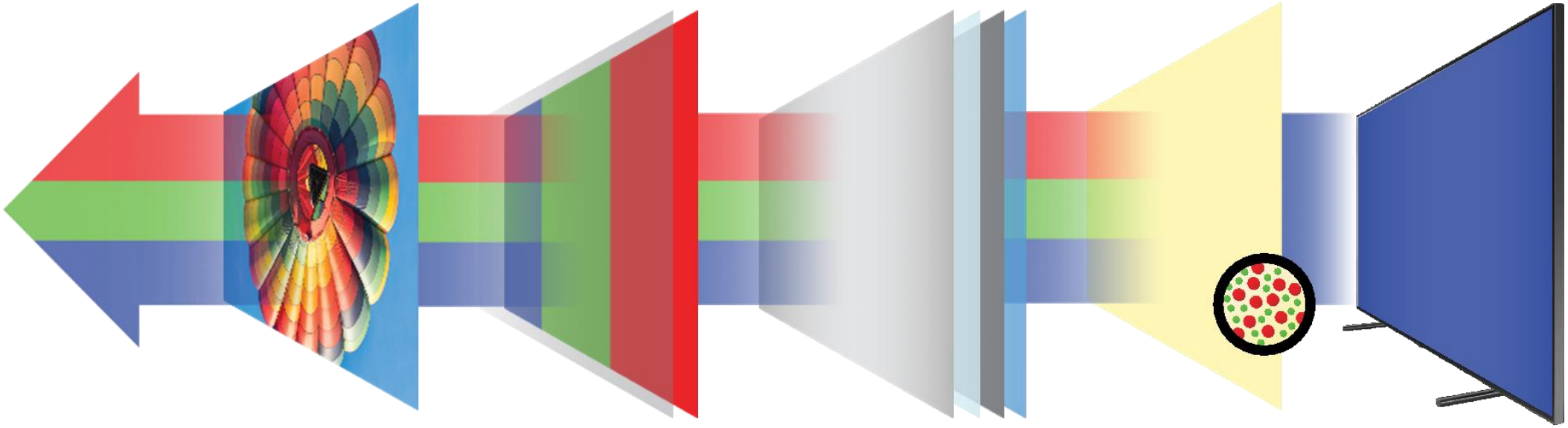
NANOSYS QUANTUM DOT TECHNOLOGY

(Monitor & TV SKUs)

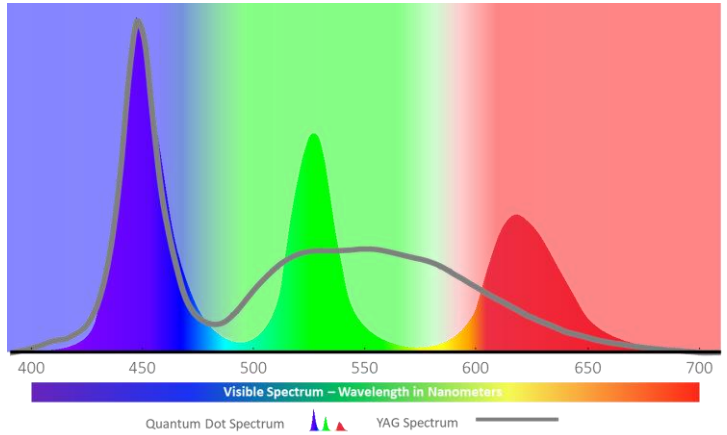
HIGHLIGHTED 2020 TV PRODUCTS

BRAND	MODEL	SIZE
Hisense	XD9G	65"
	H9G	65" & 55"
	H8G & H8RG	50", 55", 65", 75"
TCL	8- Series	75", 65"
	6- Series	65", 55"
Samsung	2020 4K QLED TV Lineup	32" – 85"
	Q800, Q900 & Q950 8K TV	65", 75", 82", 85" & 98"
	The Frame	43", 49", 55" 65"
	Serif TV	43" 49" 55"
Vizio	M-Series	50", 55", 65"
	P-Series	65", 75"
	P-Series X	65", 75", 85"
Xiaomi	M5	55", 65", 75", 82"
Konka	Q7 Series	50", 55", 65", 75"
Changhong	ChiQ miniLED & Artist TVs	65"

QD for Display: QDEF-LCD

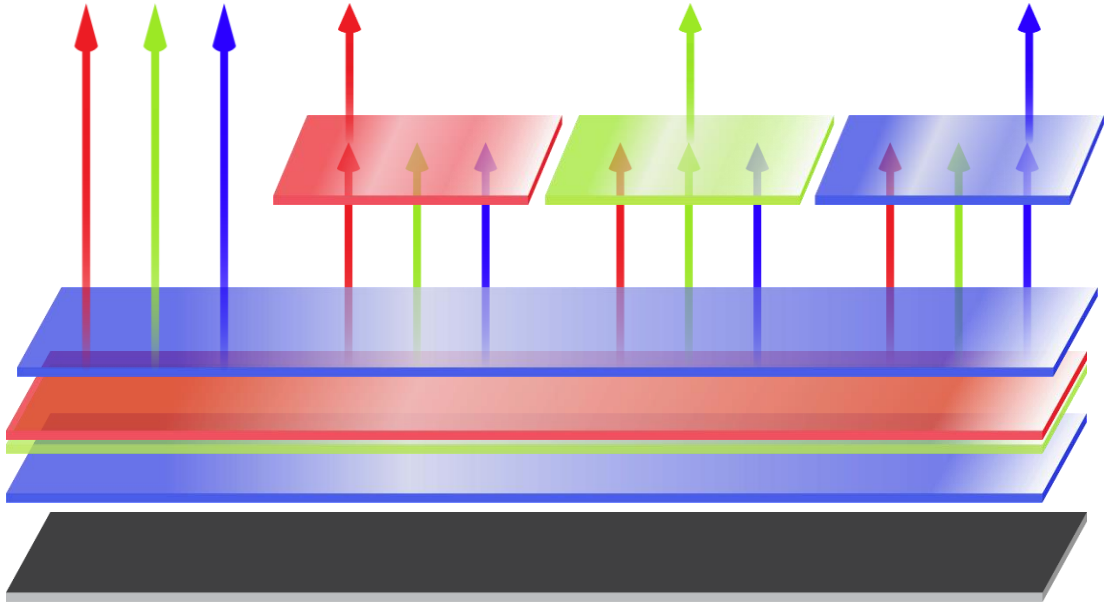


DISPLAY | COLOR FILTER | PANEL | QDEF | BLUE LED BACKLIGHT

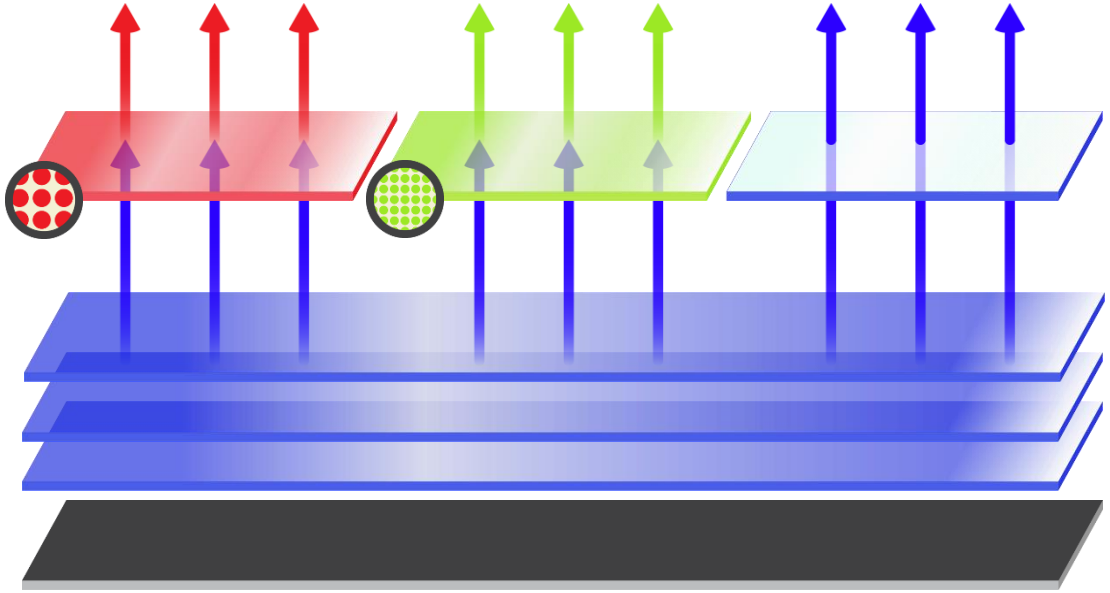


QD for Display: QD-OLED

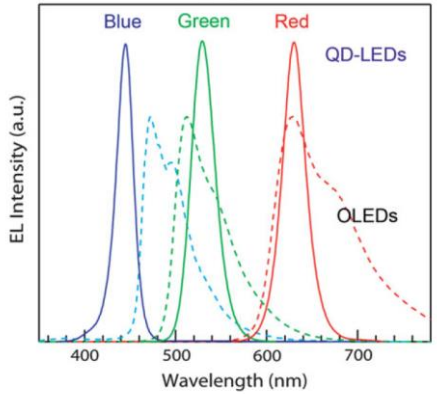
White OLED W/ COLOR FILTERS



BLUE OLED W/ QDCC



- Blue OLED + QDCC has potential advantages:
  - Better color, better viewing angle (no cavity)
  - Higher luminous efficiency: brighter, or less burn-in
  - Single color EL layers: design flexibility, no differential aging



Bae, MRS Bulletin 38, 2013

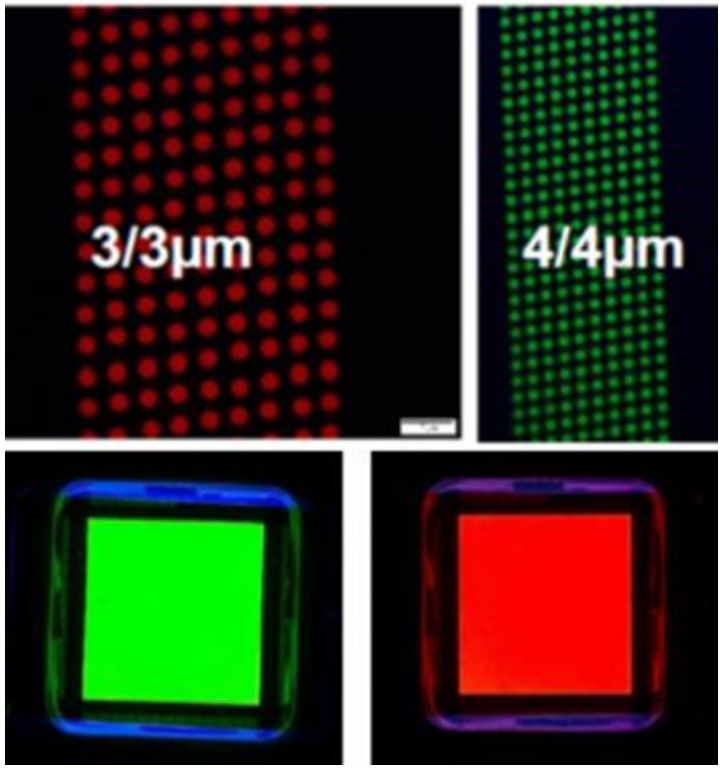
QD for Display: QDCC-µLED

µLED Advantages

- Low Power Consumption
- Brightness
- Contrast Ratio
- Response Time
- Breadth of Applications

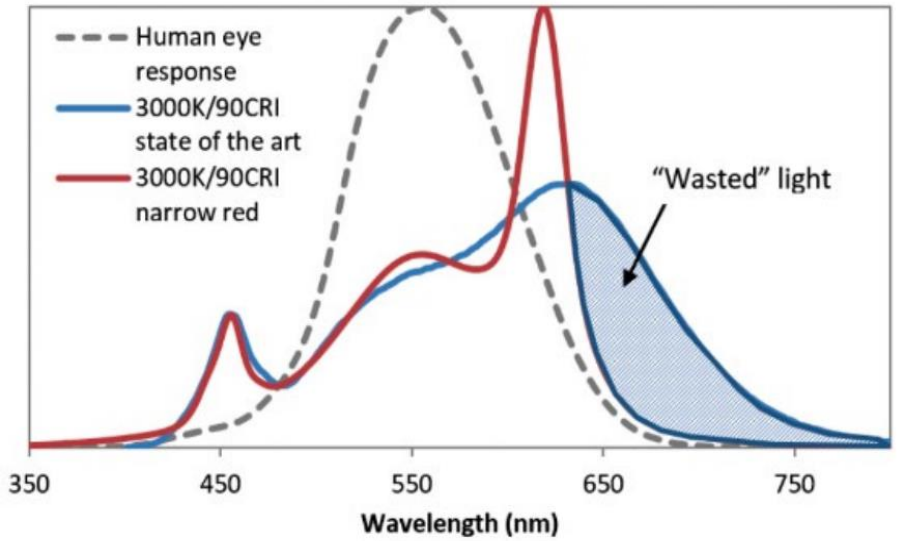
µLED Weakness

- Manufacturing Complexity
- Yield
- Design Circuitry Complexity



- µLED “weaknesses” can be solved using QD as a color conversion solution
- Nanosys demonstrated of photo lithography-patterned cadmium free color conversion layer for µLED

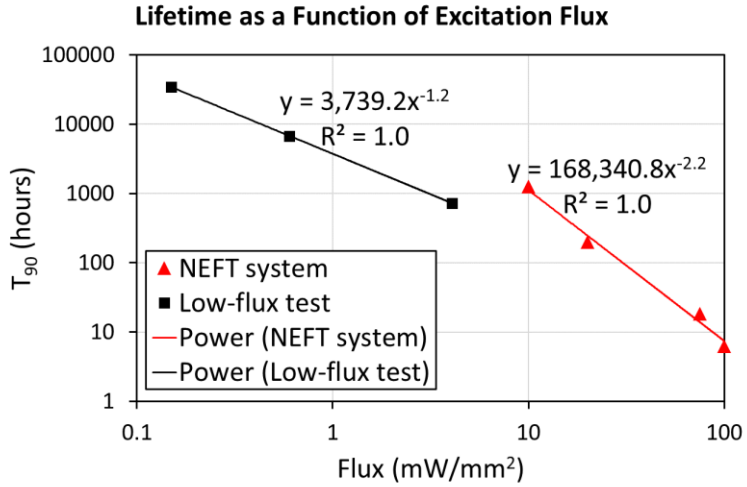
QD for Lighting: Narrow Down Convertor

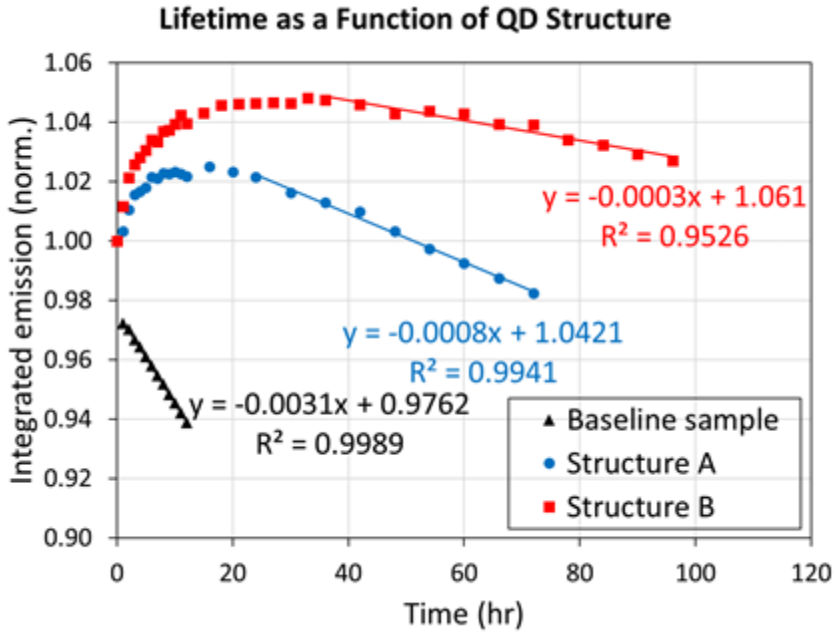


"Red QDs (40 nm) used in combination with a conventional (green) phosphor material can improve LED conversion efficiency by 5% to 15% over commercial (phosphor-converted) LEDs between CCTs of 2700 Kelvin (K) to 5000 K"

- Department of Energy, 2019 Solid-State Lighting R&D Opportunities, released January 2020

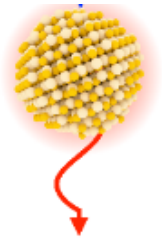
High Flux Challenge





QD for Lighting: QDEL Diffuse Light

"OLEDs can produce new form factors and lighting design flexibility not available with today's LEDs or traditional lighting technology, though **OLED efficacy** performance and **costs** lag those of LEDs." - *2019 Lighting R&D Opportunities*



HIGH EFFICIENCY

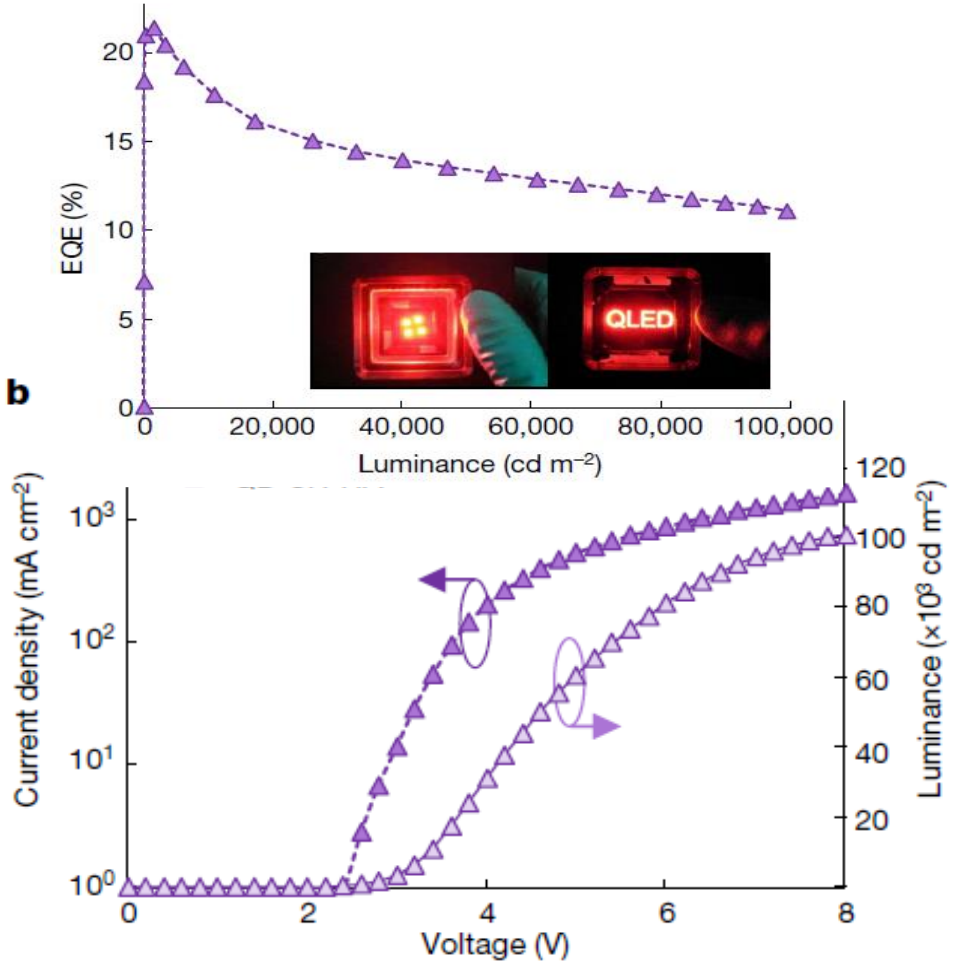
Quantum Dots are nearly perfect emitters with IQE close to unity for all colors including blue.

LOW VOLTAGE

QDEL devices have much lower voltage comparing to OLEDs, leading to higher power efficiency.

SPECTRUM ENGINEERING

Quantum Dots emit light with narrow spectrum. Most colors in the visible spectrum can be easily and precisely created potentially leading to higher power efficiency (no "waste")



"Highly efficient and stable InP/ZnSe/ZnS quantum dot light-emitting diodes" Nature volume 575 (2019)

QD for Lighting: QDEL Diffuse Light cont.

BRIGHT

QDEL devices achieve much higher luminance at low voltage.

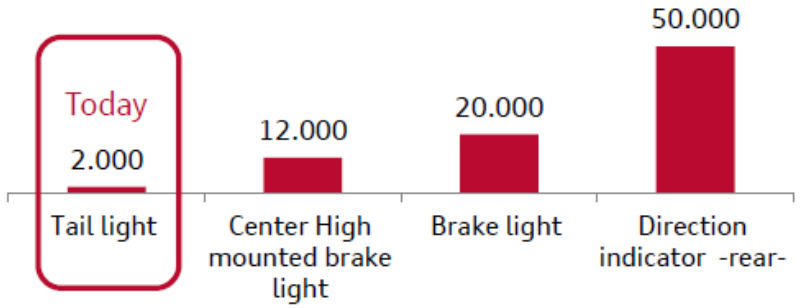
SOLUTION PROCESSABLE

QDs are versatile. They have been formulated with solvents, monomers, polymer films, inks, photoresists; attached to biomolecules, cells, and more.

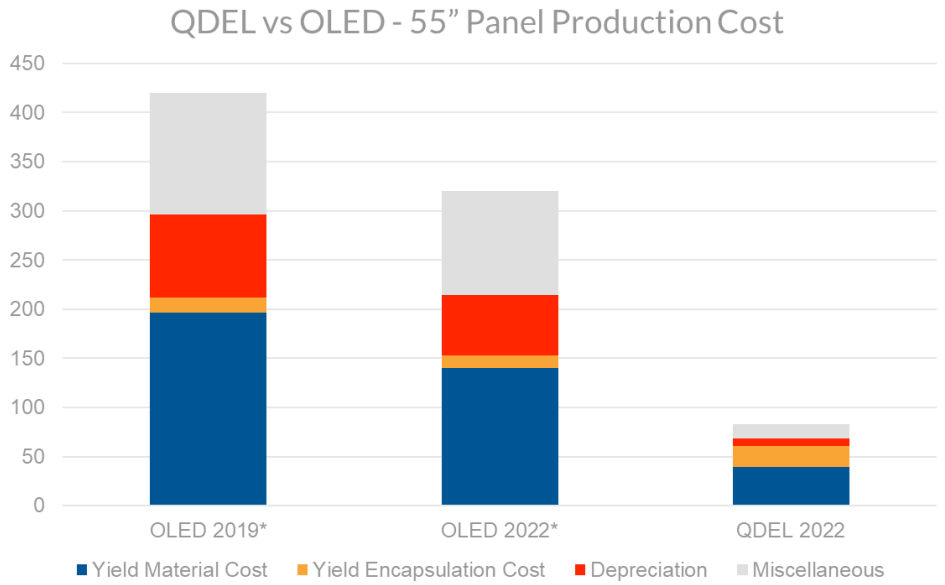
COST

QDEL devices can be produced by low cost printing process. No high vacuum is needed.

Brightness [cd/m²]:



Source: *Audi presentation, OLED Summit* (2019)



Source: DSCC, QD Forum 2019


THANK YOU
For more info, visit: www.nanosysinc.com