Improved Light Extraction for a 130 lm/W OLED Lighting Panel

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pixelligent

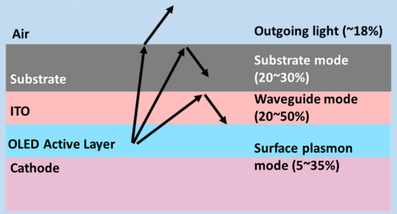
The Clear Solution®

Project Objectives

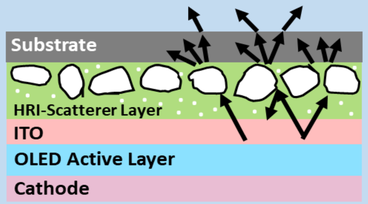
To develop a High Refractive Index – Light extraction (HRI-LE) formulation product for OLED lighting panel manufacturers. The HRI-LE should demonstrate an efficiency of at least 100 lm/W. This project is supported by DOE SBIR Phase I Grant# DE-SC0018604.

Project Technology

- One major challenge for an OLED lighting device is its low light extraction efficacy which is only ~ 20%
- Light is lost at different interfaces within the device
- Incorporating an **Internal light extraction** can access ~ 80% of the light but requires a high quality HRI layer
- Pixelligent's proprietary high quality ZrO_2/Acrylic nanocomposite embedded with scatterers provides an ideal material system for the HRI layer



Light loss mechanism



Pixelligent's ILE

Phase I Technical Objectives

Understand the fundamentals of our HRI-LE formulation to increase light out-coupling efficiency

- Determine optimum scatterer loading for light out-coupling
- Print light extraction layers with different scatterer sizes or combinations of sizes
- Investigate the effect of binder refractive index (RI) on light out-coupling

Project Update

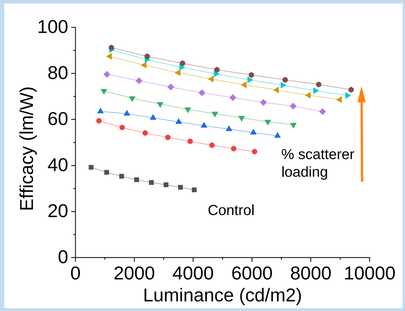
Project Completed January 2019

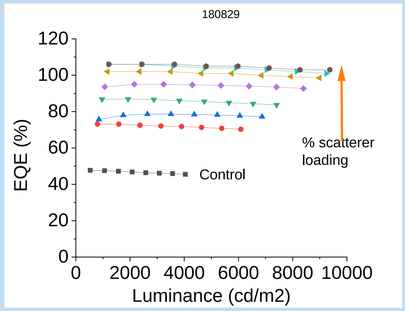
Phase I Results

Highest efficacy with HRI-ILE at 3000 cd/m^2

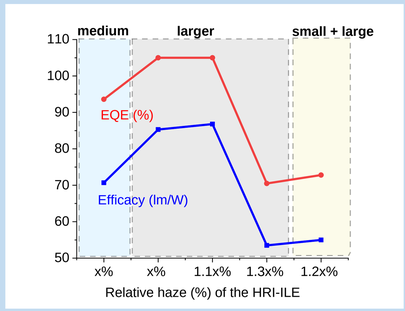
Device	Highest Efficacy (lm/W)		Extraction efficiency
	No EEL	With EEL	
Control (no ILE)	32	67	-
HRI-ILE	87	**90**	53% (2.3X)

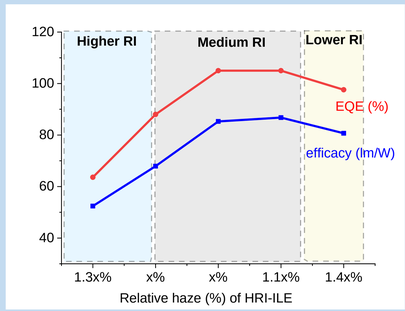
Effect of scatterer loading on the efficacy and EQE of the device



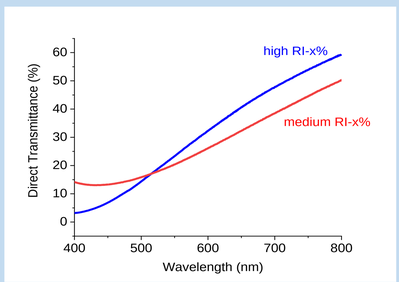


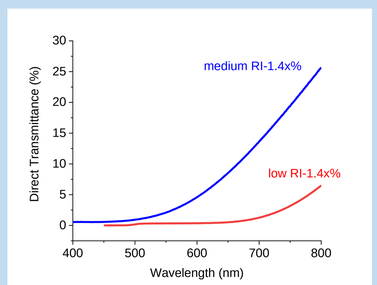
Scatterer size and binder RI influences the device performances. More data is required to make a conclusive judgement about increasing binder RI.





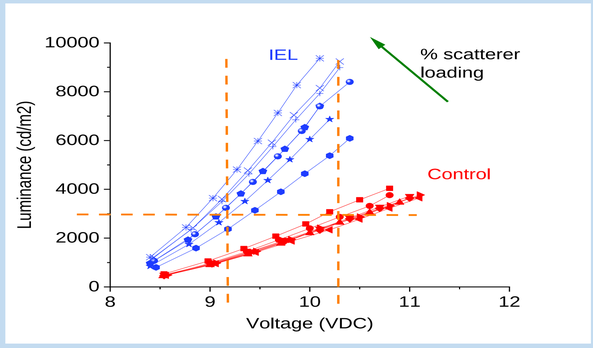
Binder RI has a direct effect on IEL transmittance, with higher RI binders leading to higher transmittance

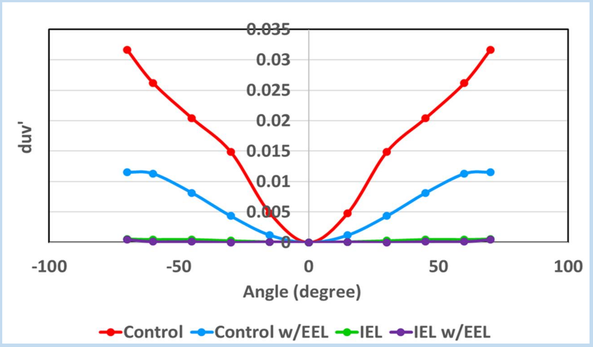




Phase I Results

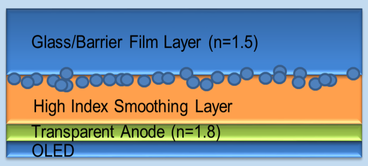
Devices demonstrate lower driving voltage at higher luminance and uniform color distribution at all viewing angles



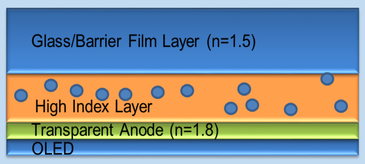


Technology Roadmap

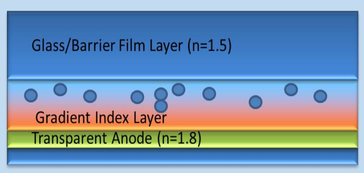
Pixelligent has shown feasibility of the following cost effective, easy to manufacture, and efficient light extraction technologies for OLED lighting



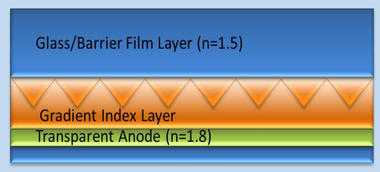
Gen 1
(Planarization of the scatterers)



Gen 2
(HRI-ILE with scatterers)



Gen 3
(Graded Index HRI-ILE)



Gen 4
(3D gradient)