

High Refractive Index Nanocomposite Material for OLED Applications

Vincent Jao, Peter C. Guschl, Selina Monickam

Pixelligent Technologies, Baltimore, MD 21224, U.S.A.

Tel: +1-443-529-8310, E-mail: marketing@Pixelligent.com

URL: www.Pixelligent.com



Abstract

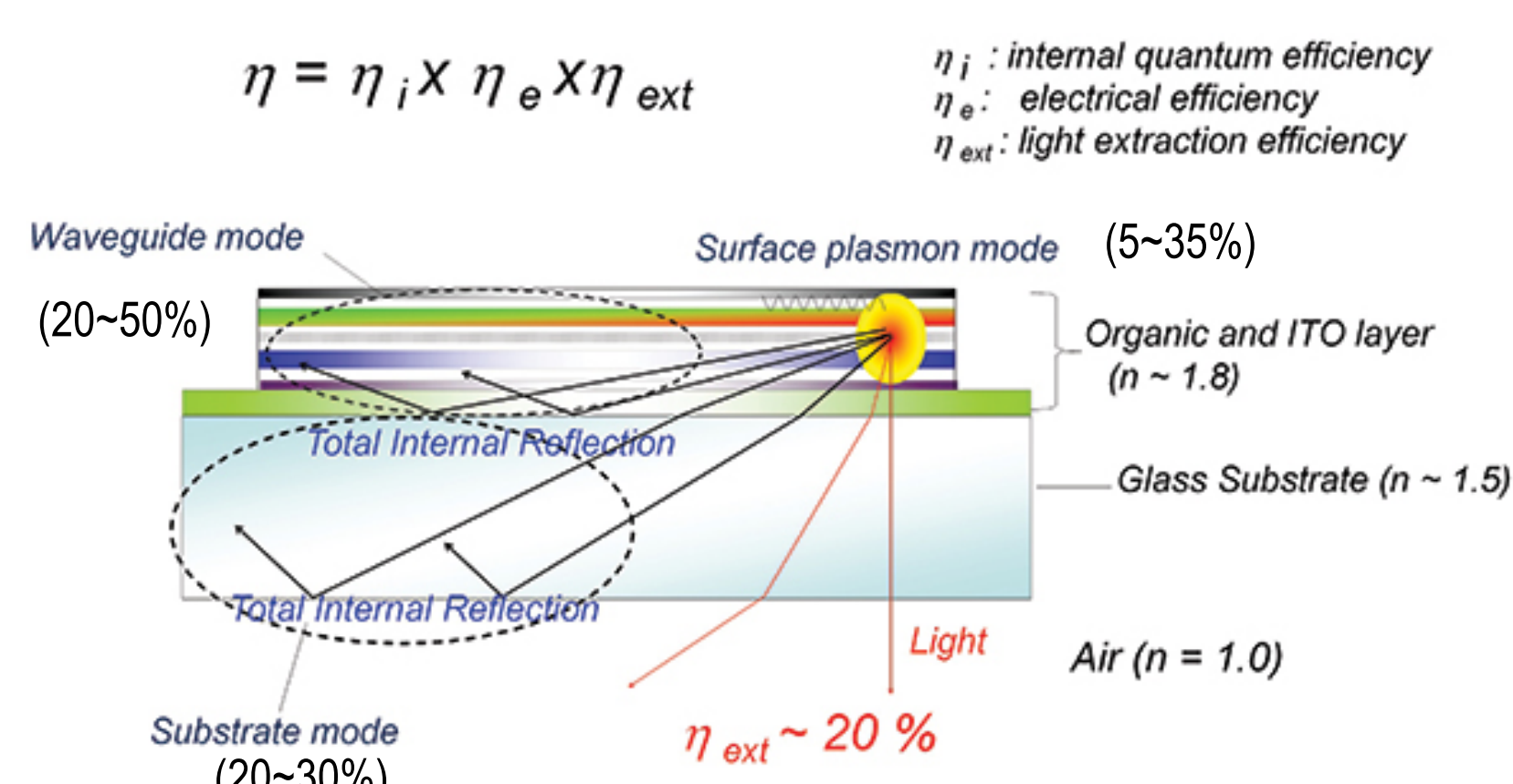
High-refractive index (HRI) materials have uses for many applications to enhance optical characteristics. Pixelligent Technologies has developed PixClear® HRI nanocomposites for solution-processing such as inkjet, slot die, and screen-printing which are most commonly used in electronics manufacturing. Using the award winning PixClearProcess®, Pixelligent synthesizes metal oxides to create Designer Compounds™ that bring unparalleled light extraction and clarity to across AR/MR, Sensor, OLED, as well as Mini and Micro-LED applications. Pixelligent's PixClear® HRI materials have excellent optical and mechanical properties, offer high transmittance and low haze, and dramatically improve the overall operating efficiencies of various display and optoelectronic devices.

In addition to ready-to-use PixClear® Fully Formulated products, Pixelligent HRI dispersions can also be easily incorporated with multiple solvents, monomers and polymers.

OLED Applications with High Refractive Index Materials

OLED Efficiency Problem

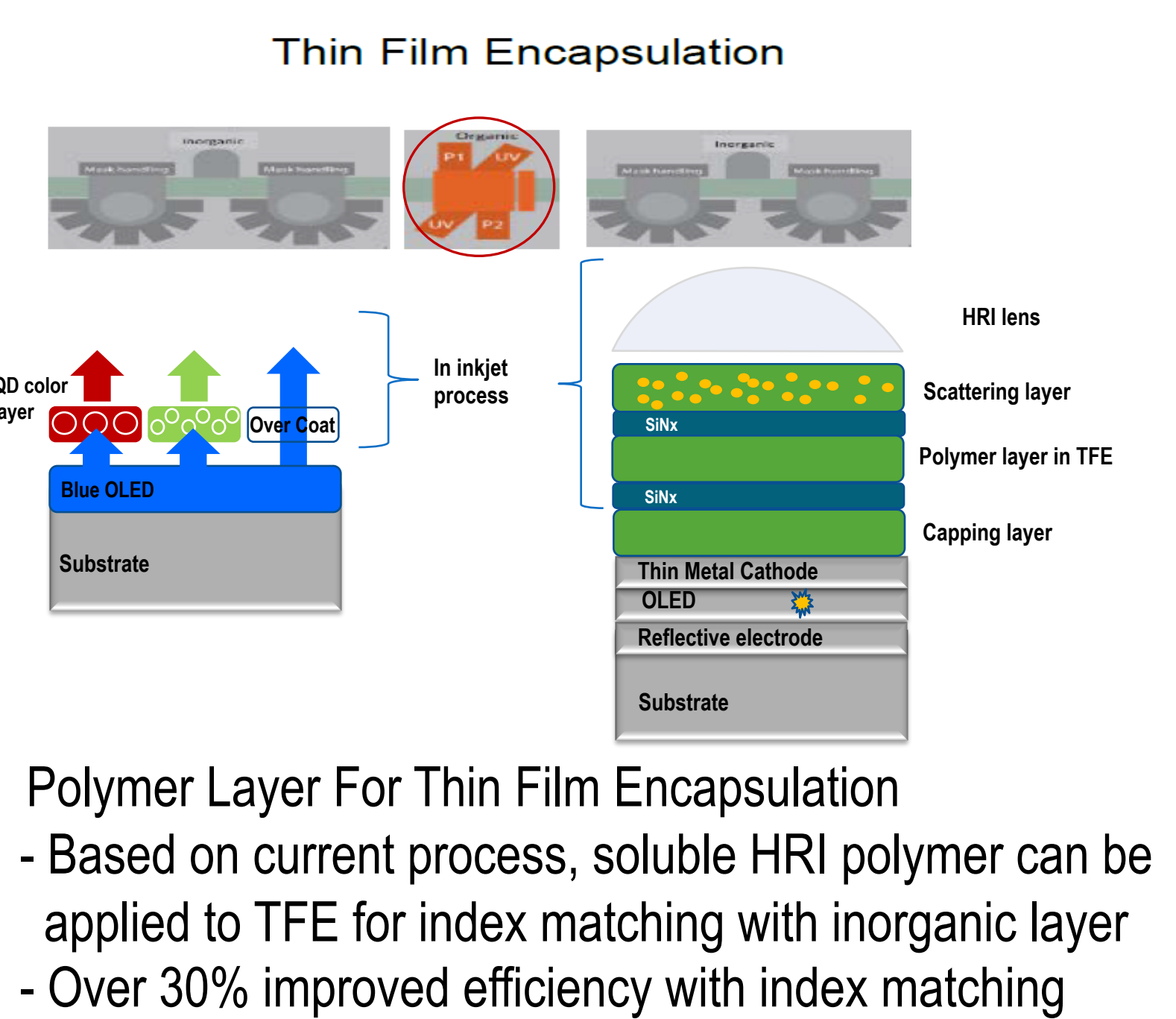
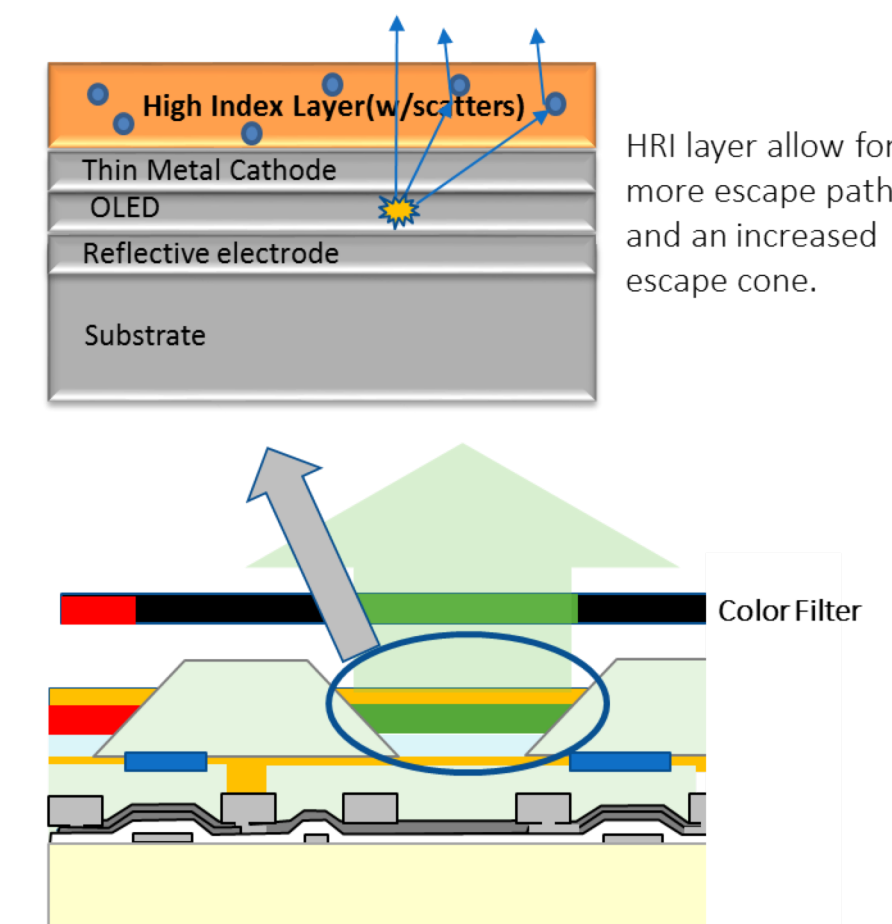
- Total Internal Reflection traps most of the light in the device
- Different light extraction schemes vary in how and where light is redirected
- SPM and substrate mode can be reduced by corrugation and surface control, respectively
- Waveguide mode (ITO/substrate interface) is where light should be redirected for maximum benefit



OLED Display

Approaches For HRI Material Using Inkjet Process

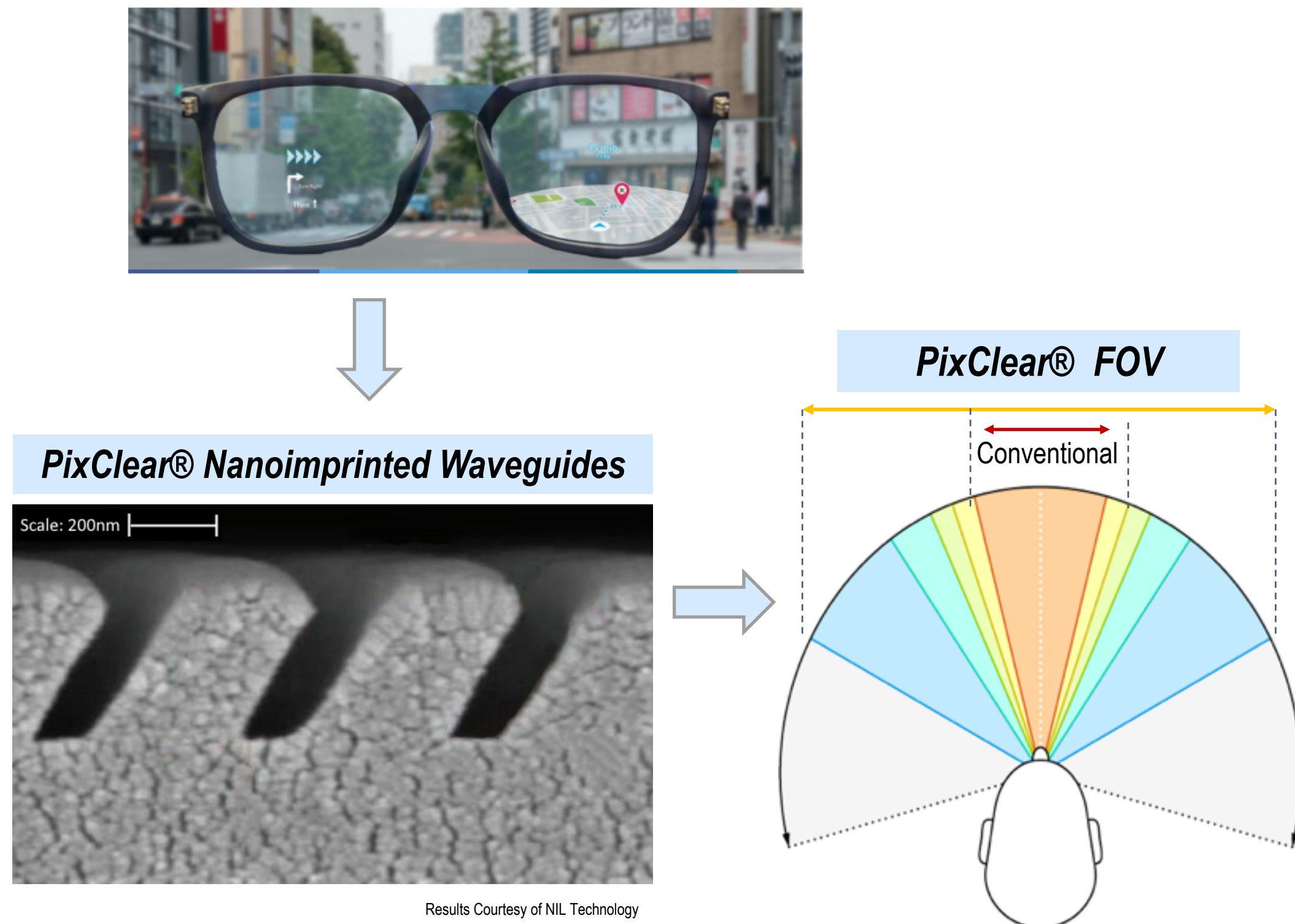
- HRI material for:
 - 1) Capping layer
 - 2) Polymer layer in TFE
 - 3) HRI with scattering layer
- Custom Designed HRI with
 - Solvent or solvent-free
 - Viscosity
 - Density
 - Polarity



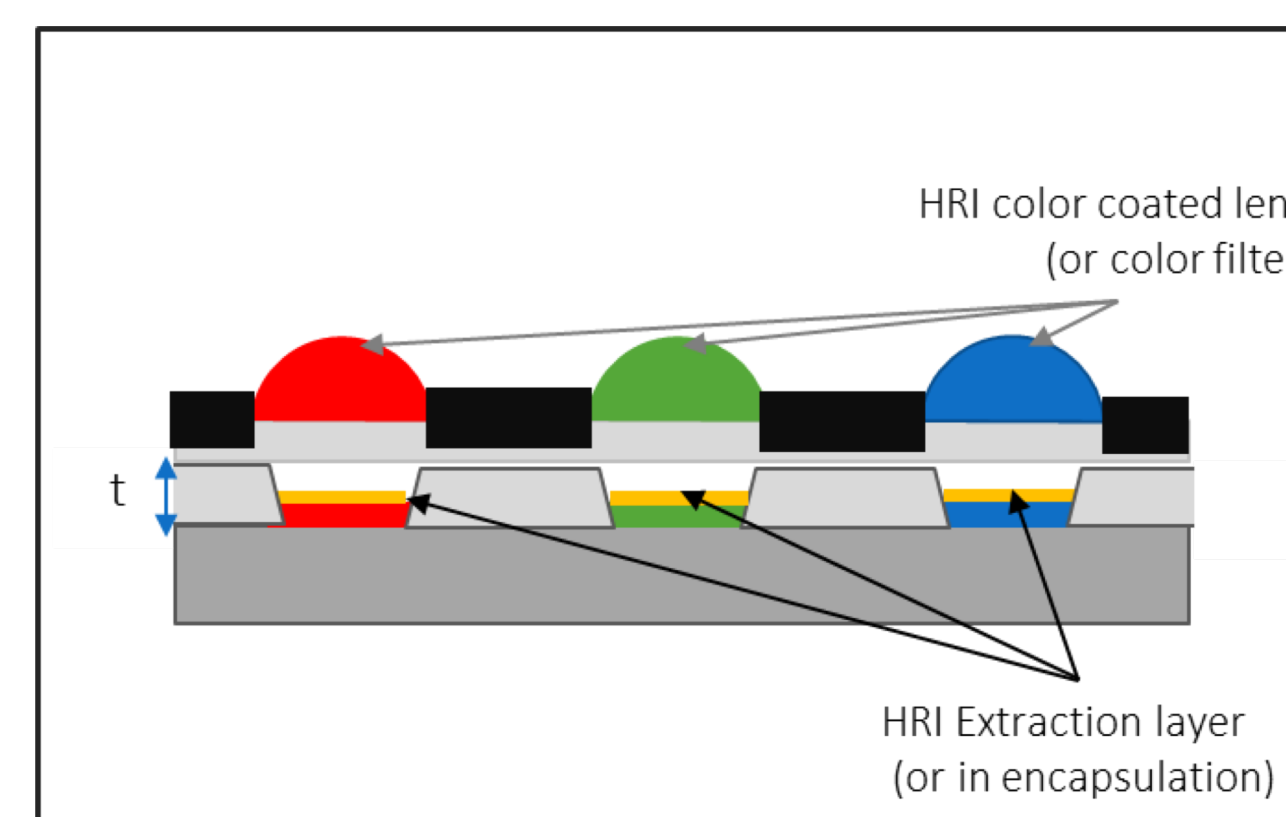
- HRI Capping Layer
 - A light scatters contained in HRI solution
 - HRI capping layer effect reduced waveguide mode
 - Broad cavity and wide viewing angle with high efficiency
- Polymer Layer For Thin Film Encapsulation
 - Based on current process, soluble HRI polymer can be applied to TFE for index matching with inorganic layer
 - Over 30% improved efficiency with index matching

AR/MR Optical Waveguide

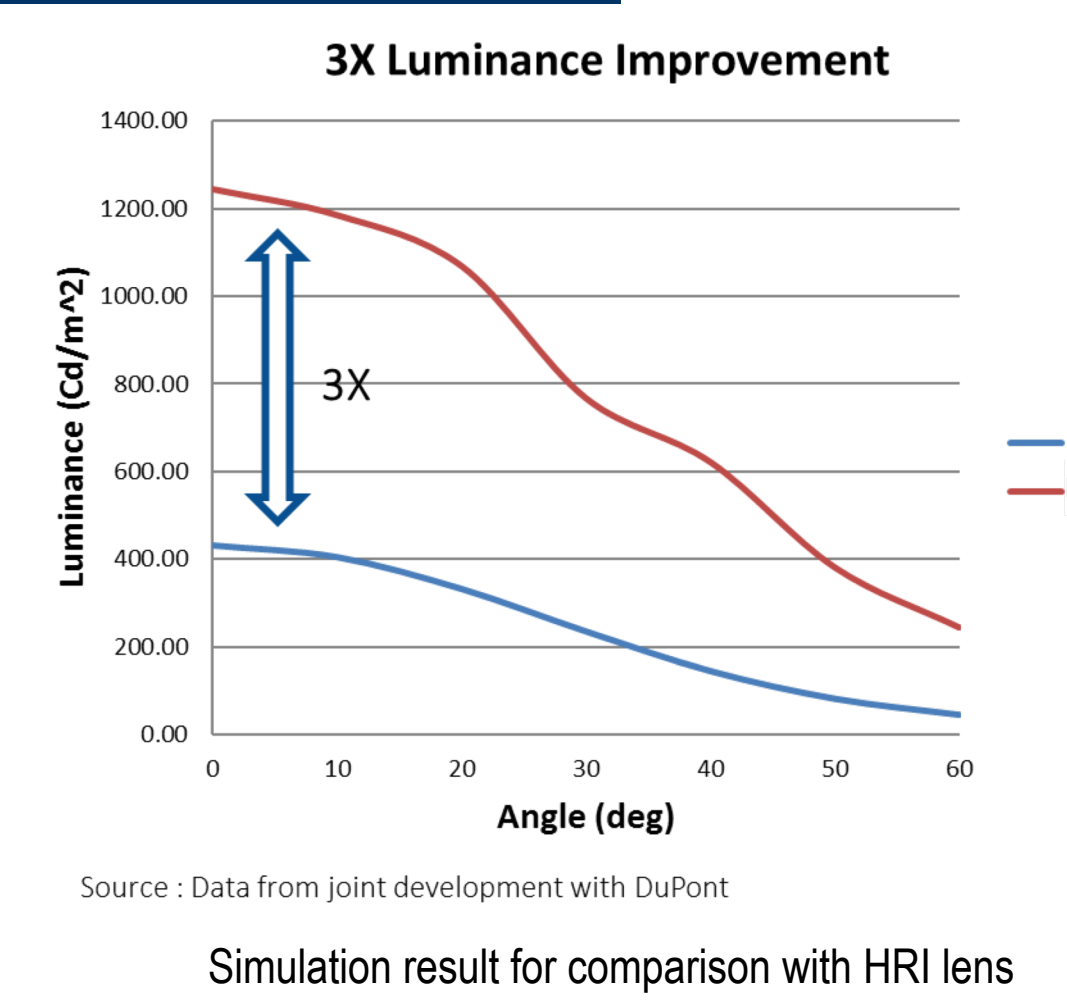
- Custom Designed HRI NIL Resin
 - Largest Field of View (FOV)
 - Most Immersive AR Experience
 - High RI 1.7+ to Ultra High RI 1.9+
 - Available for Matching Substrates
 - Solvent or Solvent-Free Options
 - Provide Manufacturing Flexibility
 - Tunable Viscosity and RI to Meet the Most Exacting Specifications



Micro-OLED



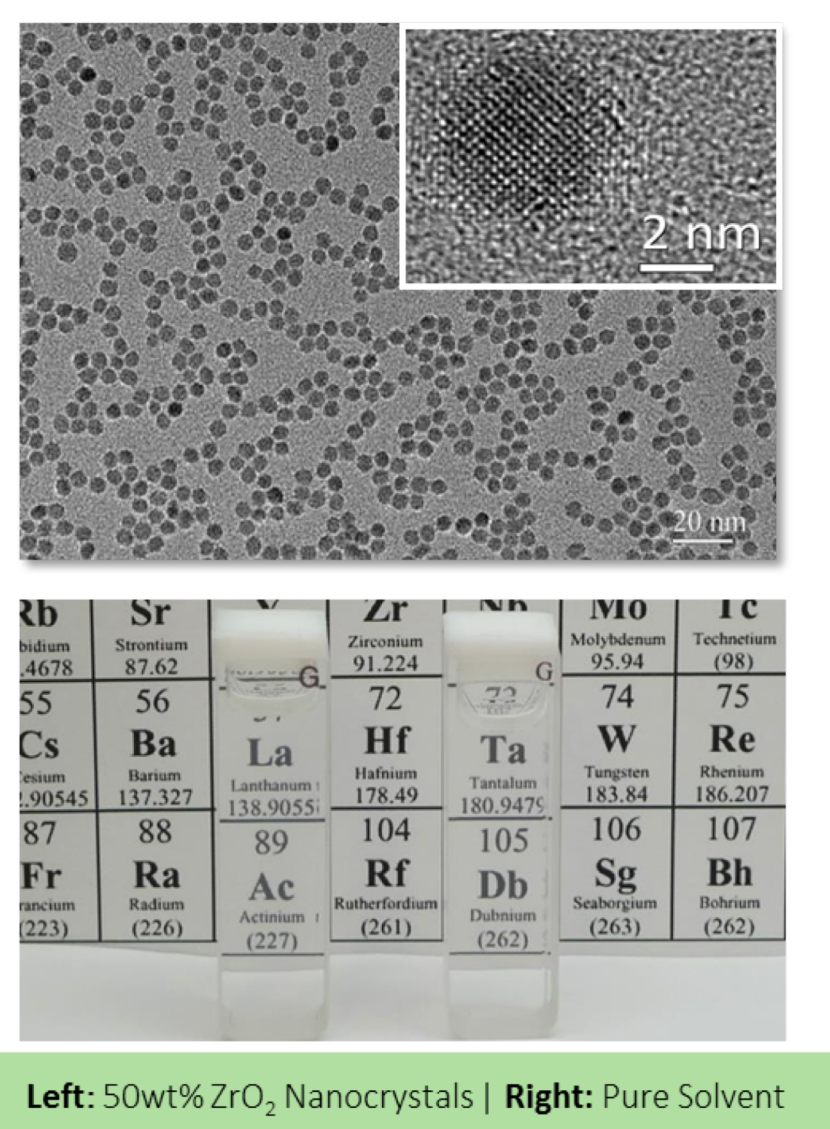
- For VR/AR application, high resolution over 1,000ppi is required
- As the aperture ratio is reducing, brightness and efficiency is decreasing as well
- High RI lens can increase 3X higher luminance with same current density level. And it shows more efficiency than low RI lens.



PixClear® High Refractive Index Products

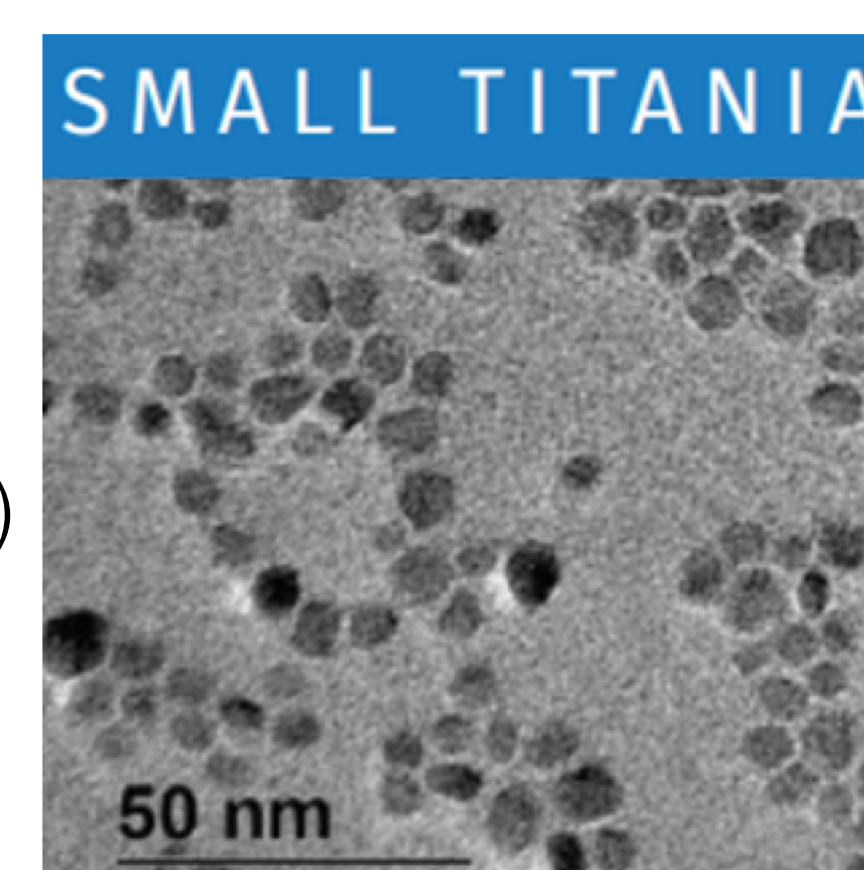
ZrO₂ Nanocrystal Properties

- ZrO₂ Nanocrystal
- Characteristics
 - 10nm Uniform Nanocrystals
 - No Aggregation
 - High Loadings (>80wt%)
 - >95% Transmittance
 - High RI >1.75
 - Broad Compatibility
- Highly Efficient & Scaled Process
 - 10MT Pilot Line Capacity



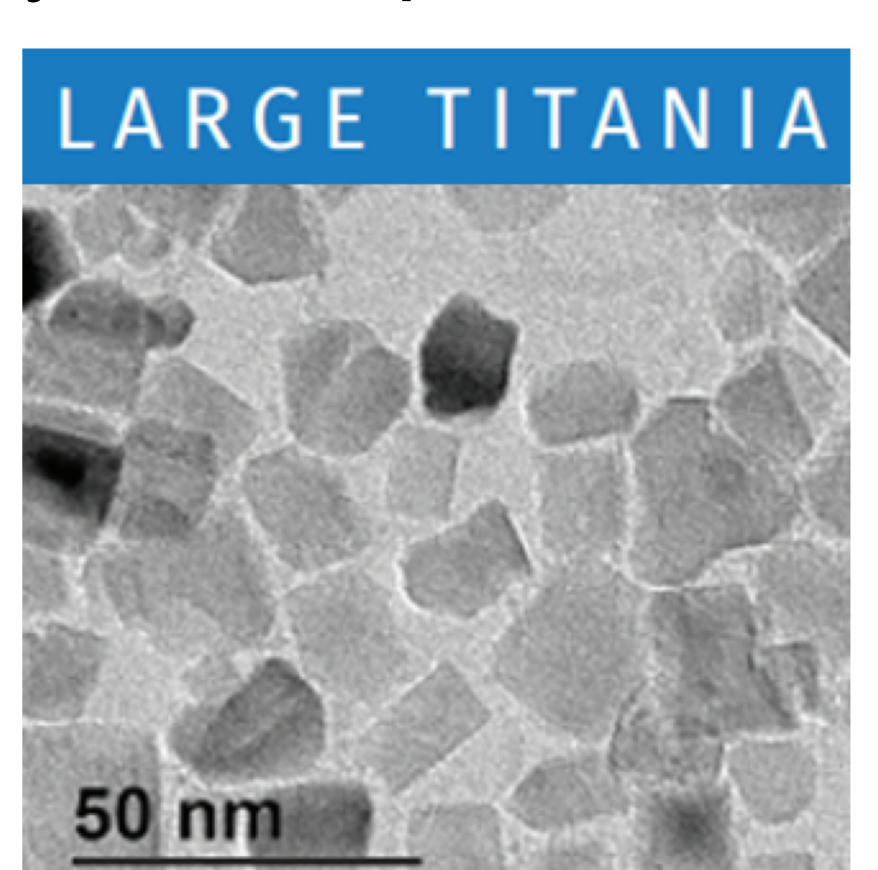
Small TiO₂ Nanocrystal Properties

- TiO₂ Nanocrystal
- Characteristics
 - 10nm Uniform Nanocrystals
 - No Aggregation
 - High Loading Capable (90wt%)
 - >95% Transmittance
 - High RI >1.8
 - Broad Compatibility
- Highly Efficient & Scaled Process
 - 5MT Pilot Line Capacity

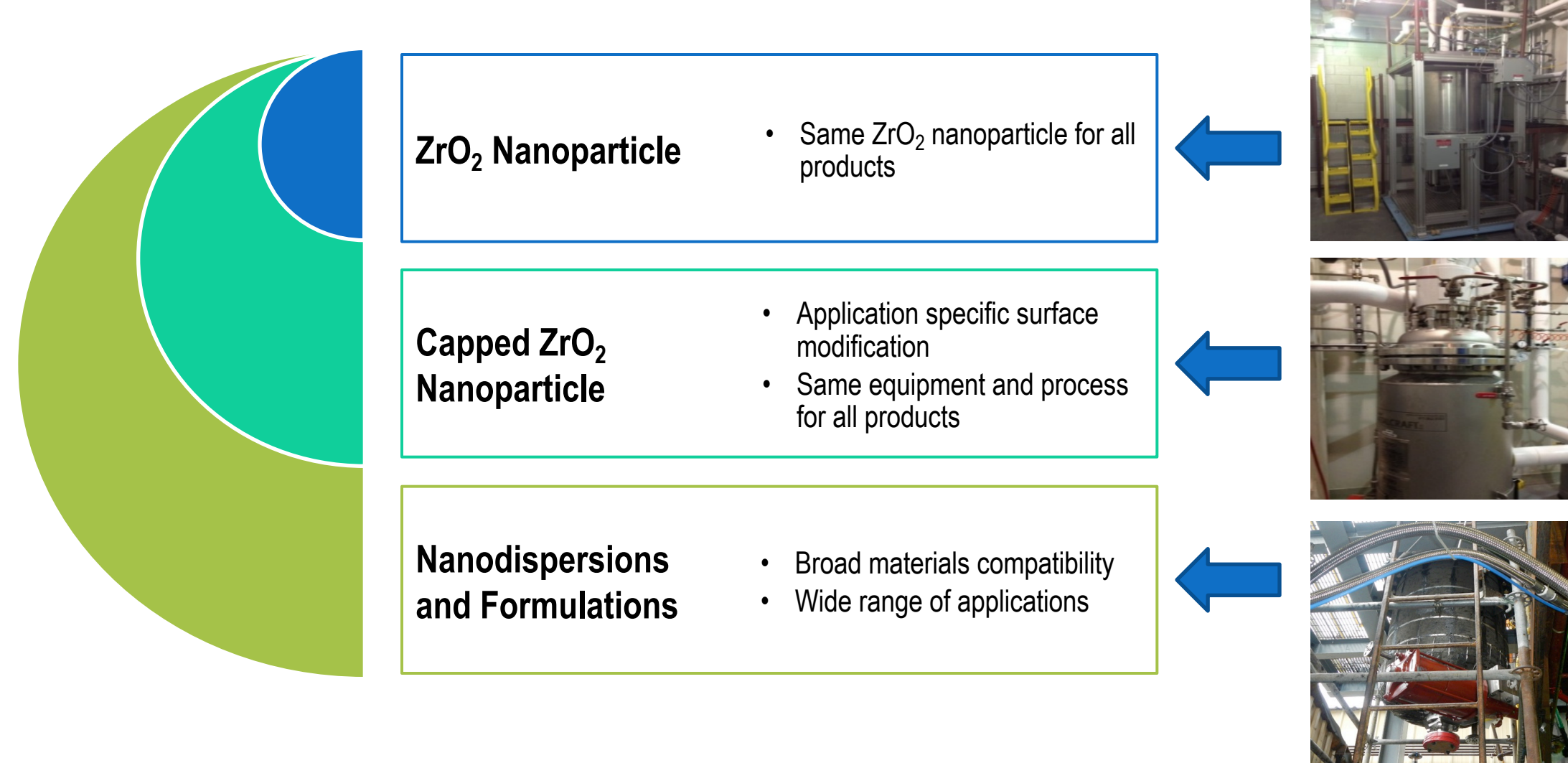


Large TiO₂ Nanocrystal Properties

- TiO₂ Nanocrystal
- Characteristics
 - 20nm Uniform Nanocrystals
 - No Aggregation
 - High Loading Capable (90wt%)
 - >91% Transmittance
 - High RI >1.9
 - Broad Compatibility
- Highly Efficient & Scaled Process
 - 5MT Pilot Line Capacity

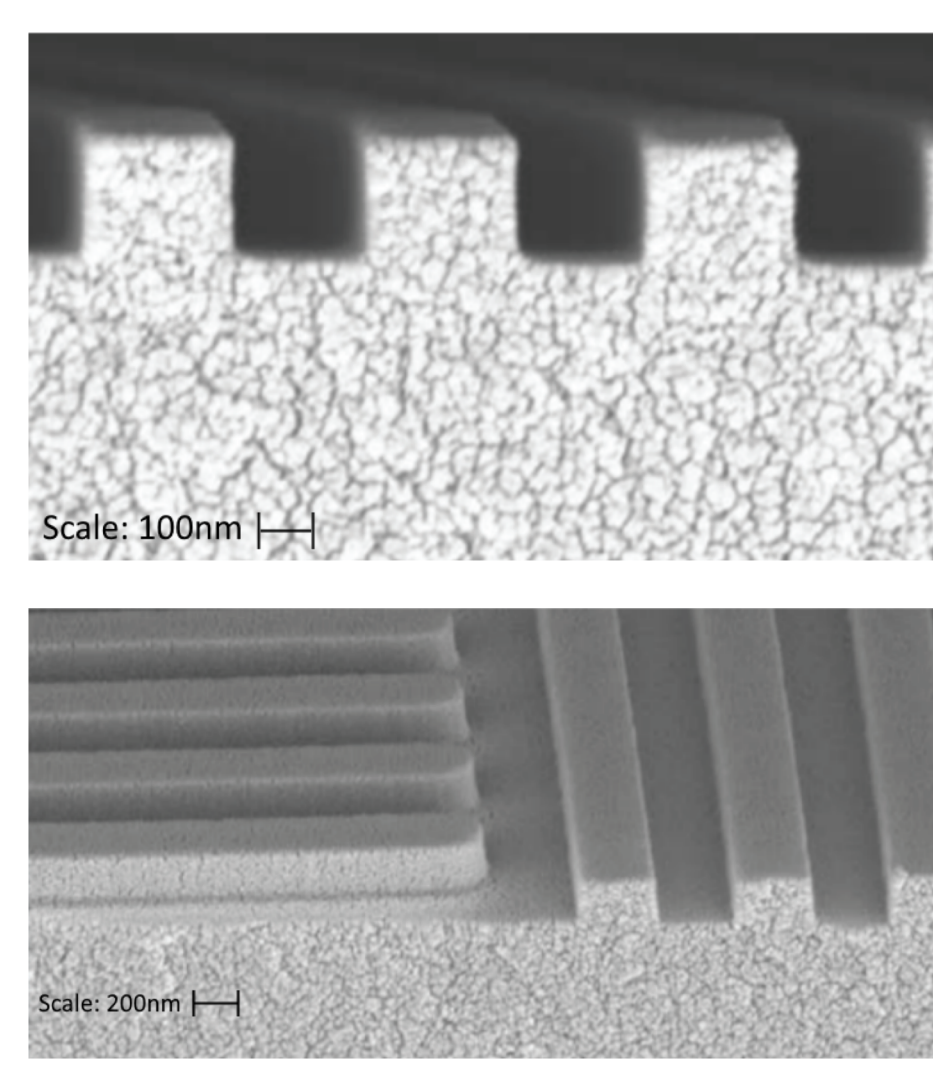


PixClearProcess®



PixNIL™ Nanoimprintable HRI Resin

- Formulation Type: Solvent Containing
- Coating Process
 - Spin Coat, Slot Die
- Viscosity (cP): 4cP
- Film Properties
 - RI (550nm): >1.90
 - %T (Avg): >93%
 - Thickness: 750nm
- Curing (UV)
 - 385UV LED, 320mJ/cm²



PixJet™ Inkjettable HRI Resin

- Formulation Type: Solvent Free
- Coating Process
 - Inkjet
- Viscosity (cP): 25cP
- Film Properties
 - RI (550nm): >1.6
 - %T (Avg): >98%
 - Thickness: 2.1µm
- Curing (UV)
 - 385UV LED, 4J/cm²



Conclusion

- The ability to create High Refractive Index structures that extract light and preserve image quality is key to improve efficiency in OLED devices.
- These extraction structures are best made with solution process-able HRI nanocomposite materials include flexible applications.
- Using PixClear® HRI enabled structures has the potential to boost light efficiency anywhere from 50% to 300%, dramatically improving overall OLED device efficiencies!

Contacts

- www.Pixelligent.com
- Pixelligent (@Pixelligent)
- Vincent Jao, Ph.D. (Director, Asia sales office) email: vjao@pixelligent.com
- Joon Yoon (Korea Country Manager) email: jyoon@pixelligent.com