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Unlocking the Transparent OLED Display Market with Novel Cathode Materials

OTI Lumionics

Company Overview

OTI Lumionics

- Founded in 2011
- 35+ employees
- Headquarters in Toronto, Canada + Offices in Asia
- Backed by VC, Strategic Partners + Government

Technology

- Advanced materials and process that solve large scale industrial problems
- Enabled by a proprietary materials discovery platform based on computational design
- Commercial materials in qualification with leading OEMs, display makers and tool builders

Materials

- High conductivity cathode materials
- High performance cathode materials
- Fine-tuned electro-optical properties

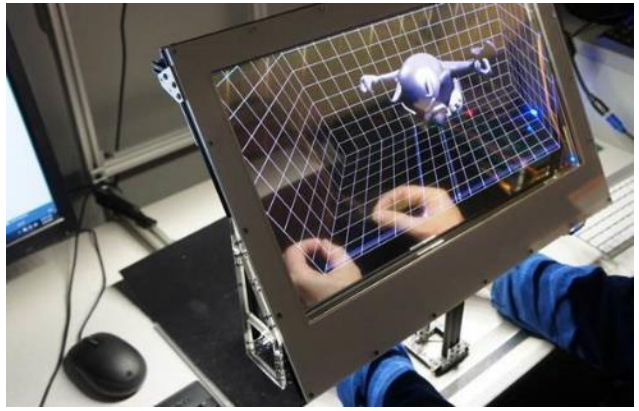
New Market Opportunities for Transparent OLEDs

Enabling new product categories and applications for OLED displays

1. Large area transparent panel for advertising
2. Medium area transparent panel for AR + Auto
3. Mobile transparent panel for under display sensor

Market Demand for Transparent OLEDs

Major OEMs looking for solution with high transparency



Augmented Reality

Automotive

Smart Home

Smart Speaker

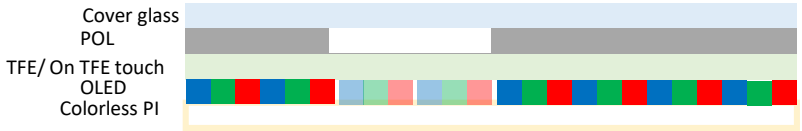
Microsoft Google amazon HUAWEI

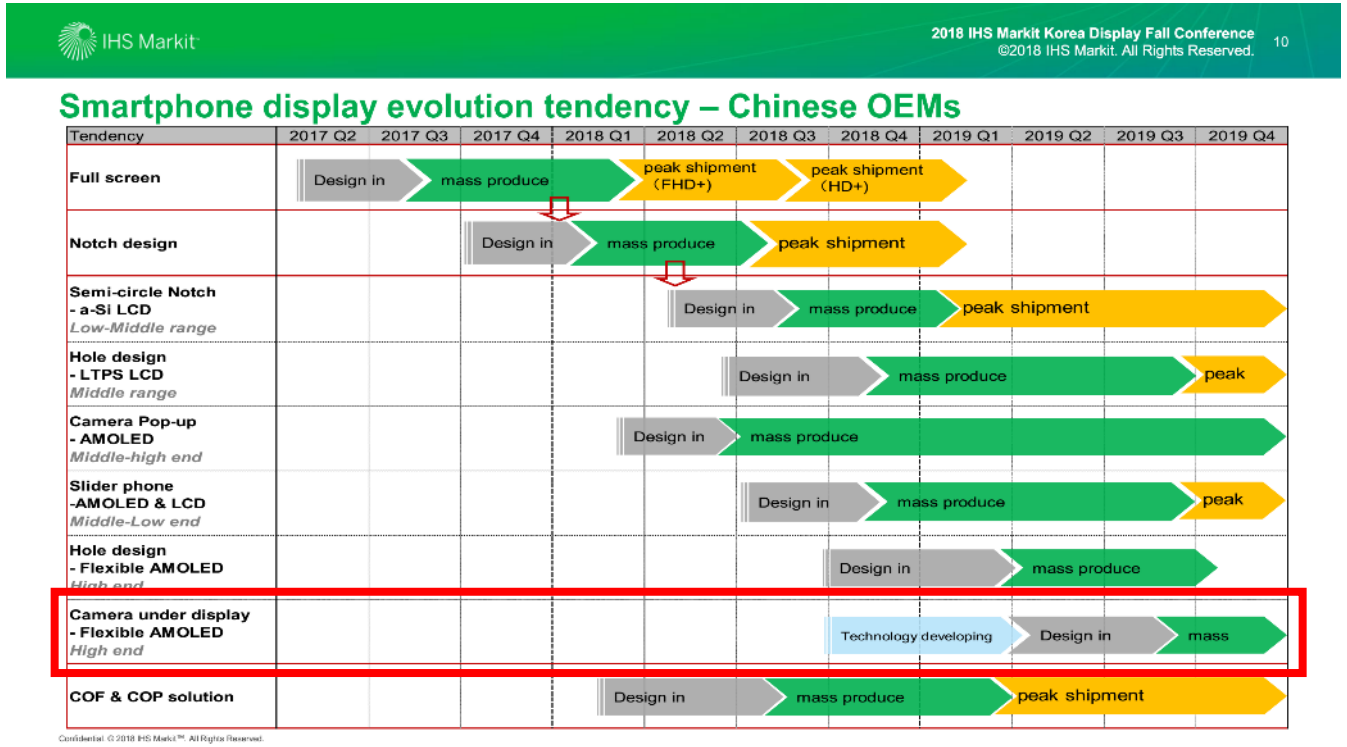
Leading consumer electronic brands seeking very high transparency OLED displays

Mobile Transparent Panel for Under Display Sensor

Enable IR, camera and other sensors behind active are of display panel

Transparent OLED +
Under Display Sensor



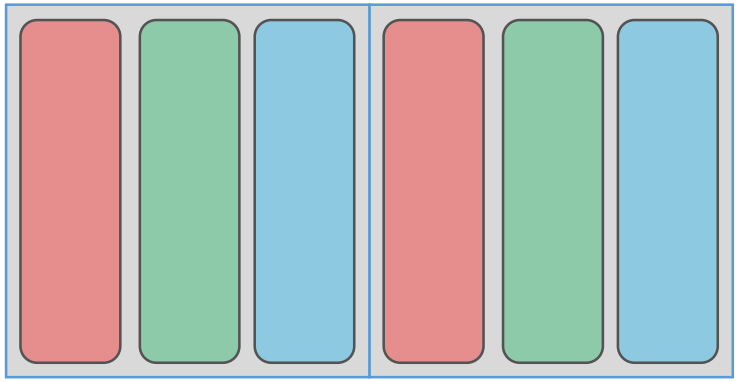


Under display sensor requires high transparency (including in the NIR) to function

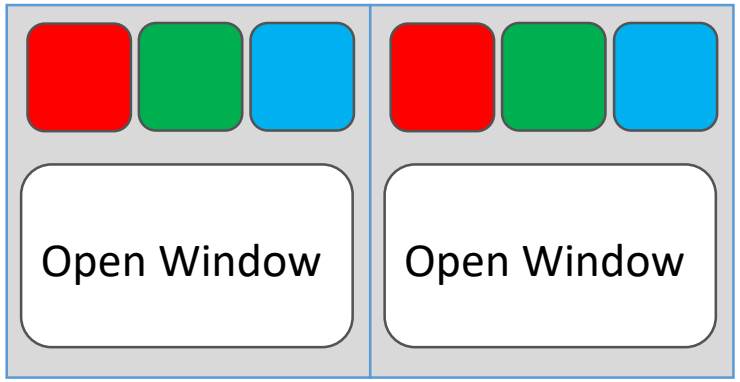
Transparent OLED Architectures

Transparent pixel vs transparent window

Transparent Pixel



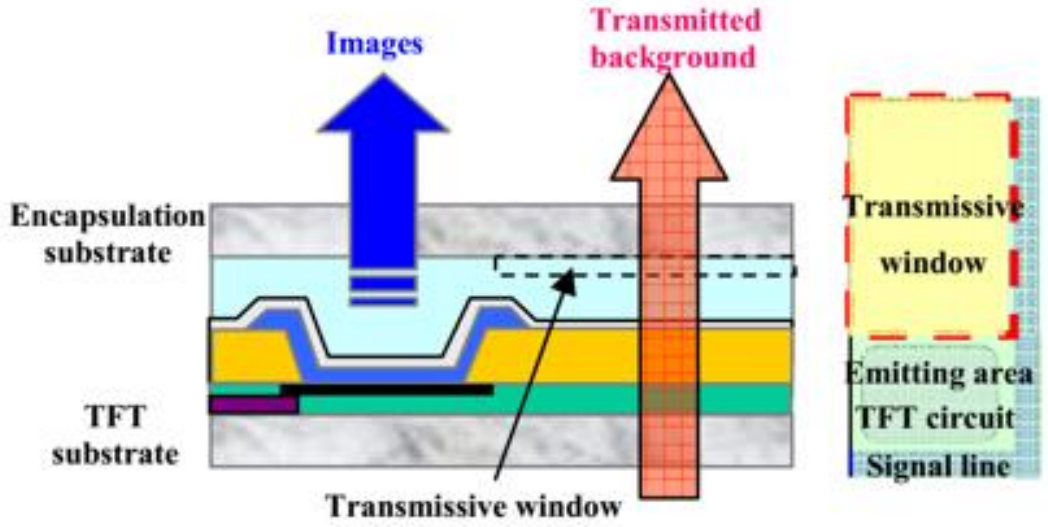
Transparent Window



Both architectures require a highly transparent + conductive cathode solution

Cathode Transparency is a Significant Barrier

Worse for NIR to do strong absorption in metal thin films



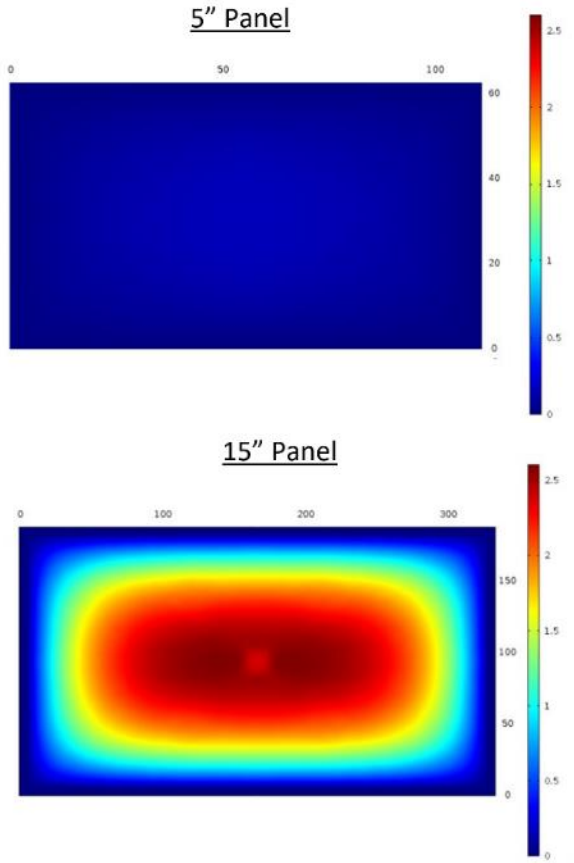
Optical Layers	Transmission
Glass	~90%
OCA	~100%
Organic	~100%
Cathode	20 – 80%
TFE	95-100%

Transmission = Window Size × Window Transmission

Cathode layer transmittance is limiting factor for transparent OLED

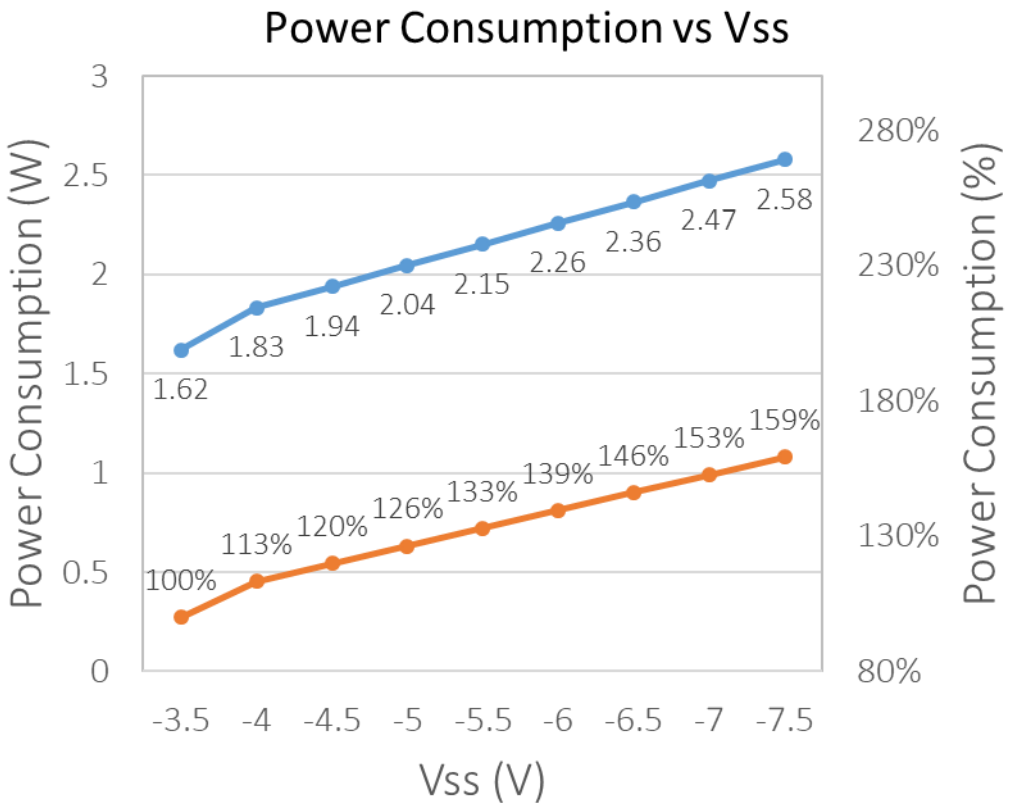
Cathode Conductivity is a Significant Barrier

Worse for transparent display due to transparency trade-off



0.5V

2.6V



Cathode layer sheet resistance is limiting factor for transparent OLED

ConducTorr™ Electrode Technology

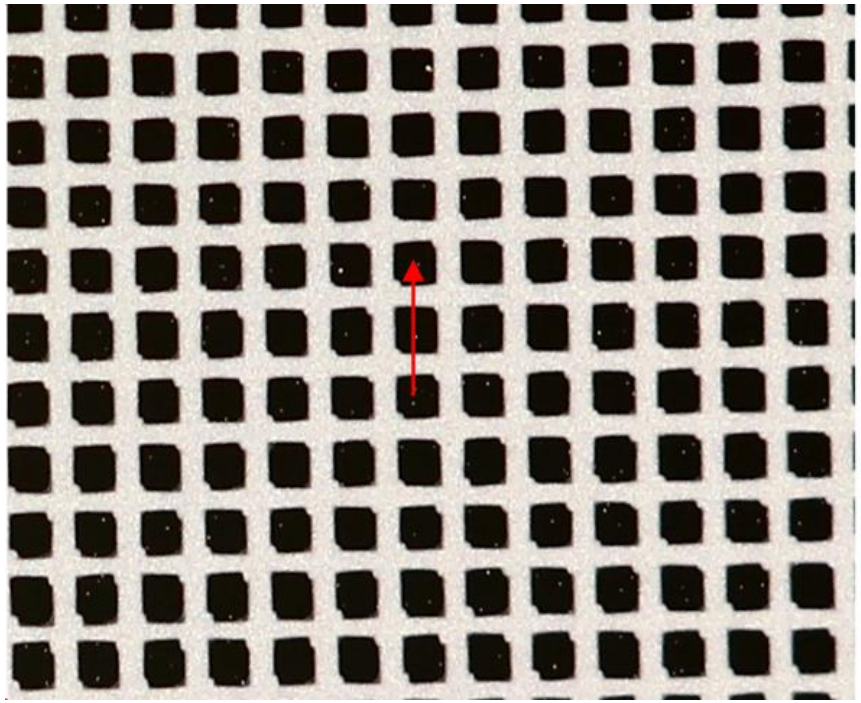
Micron-size patterning of top electrode

ConducTorr™ Patterning Material (CPM)

+

ConducTorr™ Electrode Material (CEM)

Patterning Process

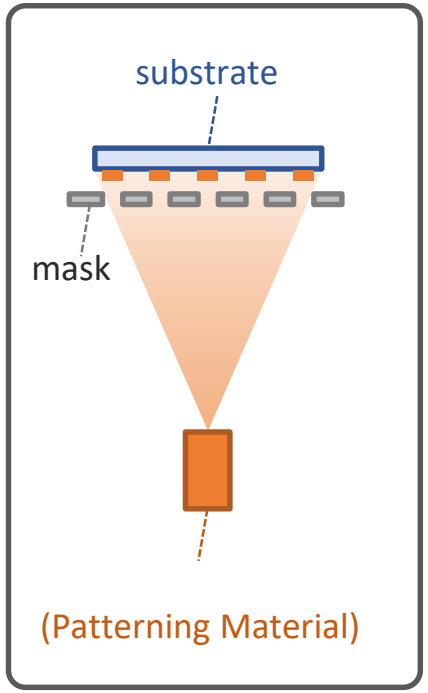


Self assembly yields low resistance electrode with micron resolution

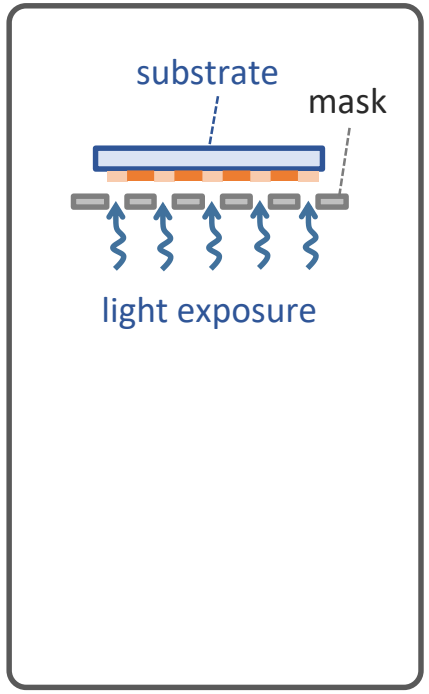
ConducTorr™ Patterning Process

Multiple MP compatible process methods

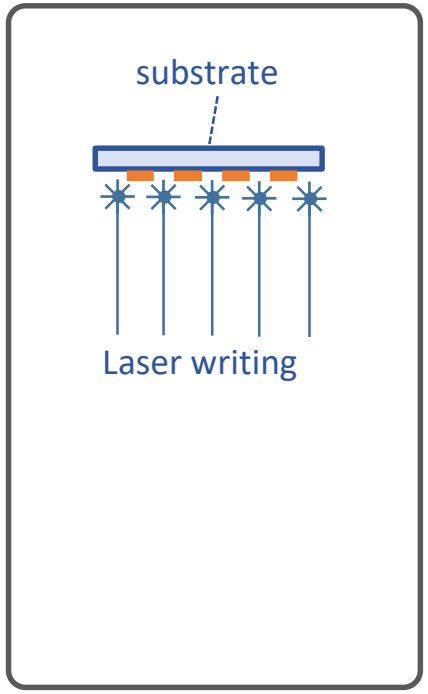
Shadow Mask Deposition



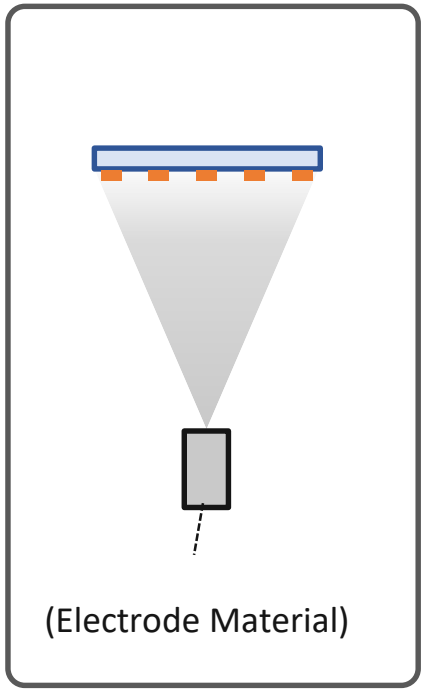
Light Exposure with Photomask



Direct Laser Writing (DLW)

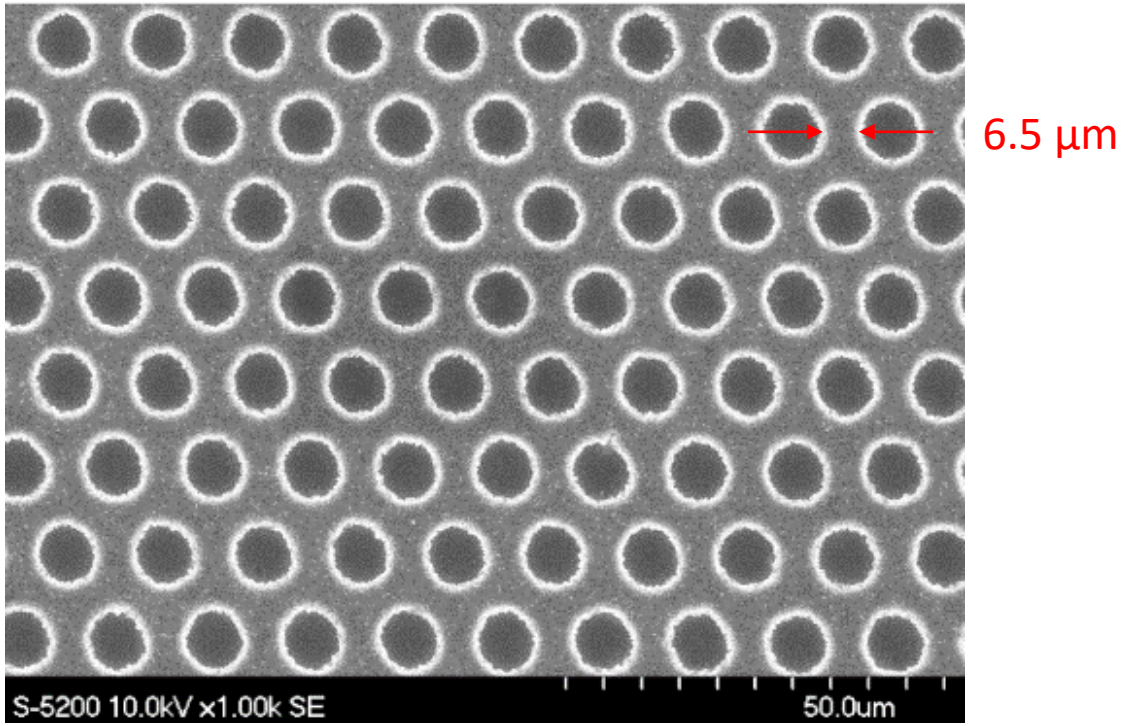


Open-frame CEM Deposition

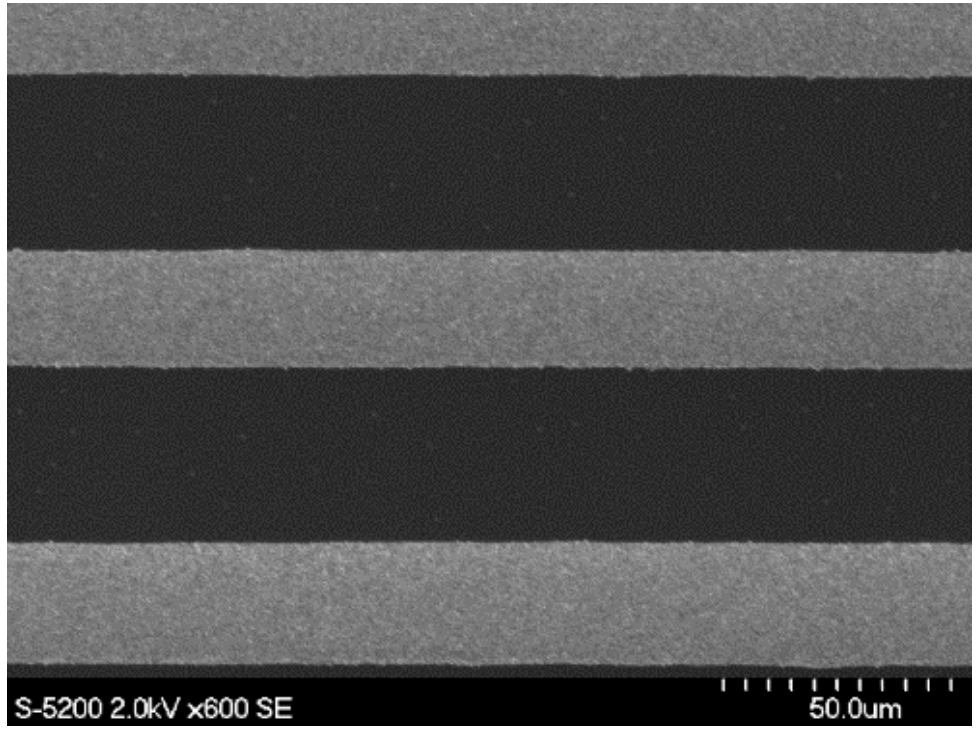


ConducTorr™ Enables Fine Features

Multiple MP compatible process methods



ConducTorr™ film with 6.5 µm circular mesh (mask patterning)

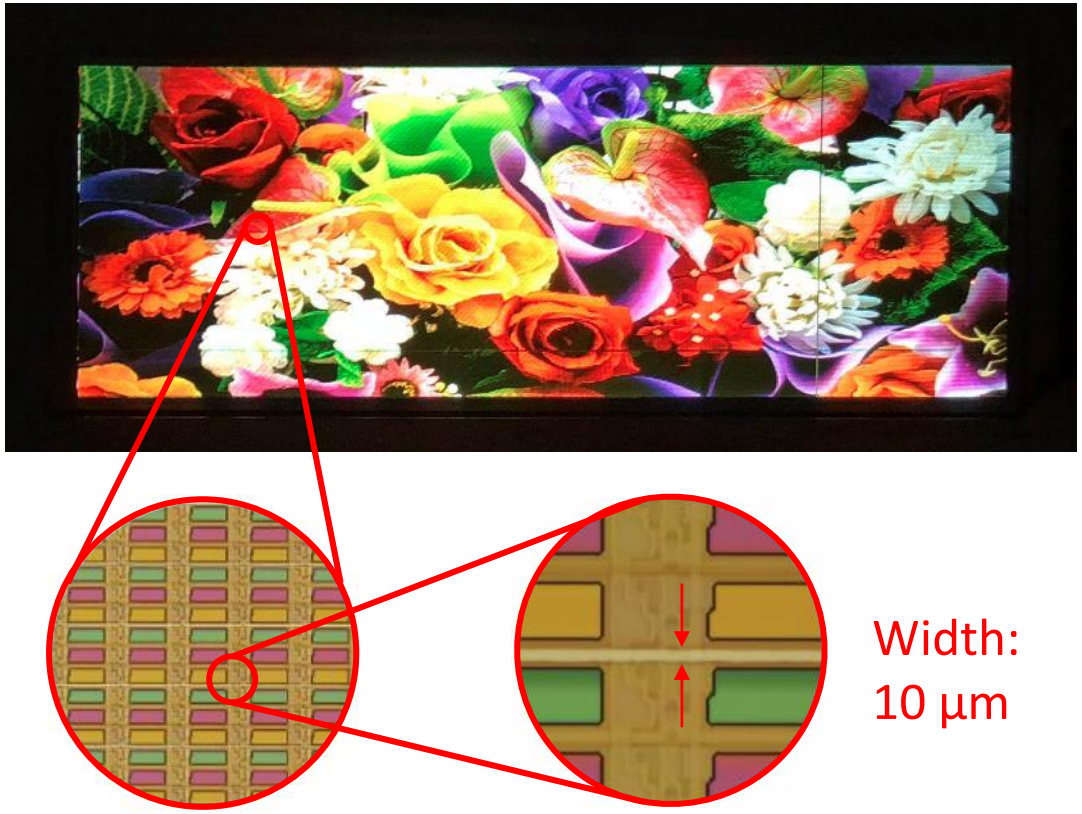


ConducTorr™ film with 25 µm lines (UV patterning)

High Resolution patterning demonstrated down to 6.5 µm features

ConducTorr™ Demonstrated in 5.2” Mobile AMOLED

5.2” AMOLED display fabricated using ConducTorr™ Electrode

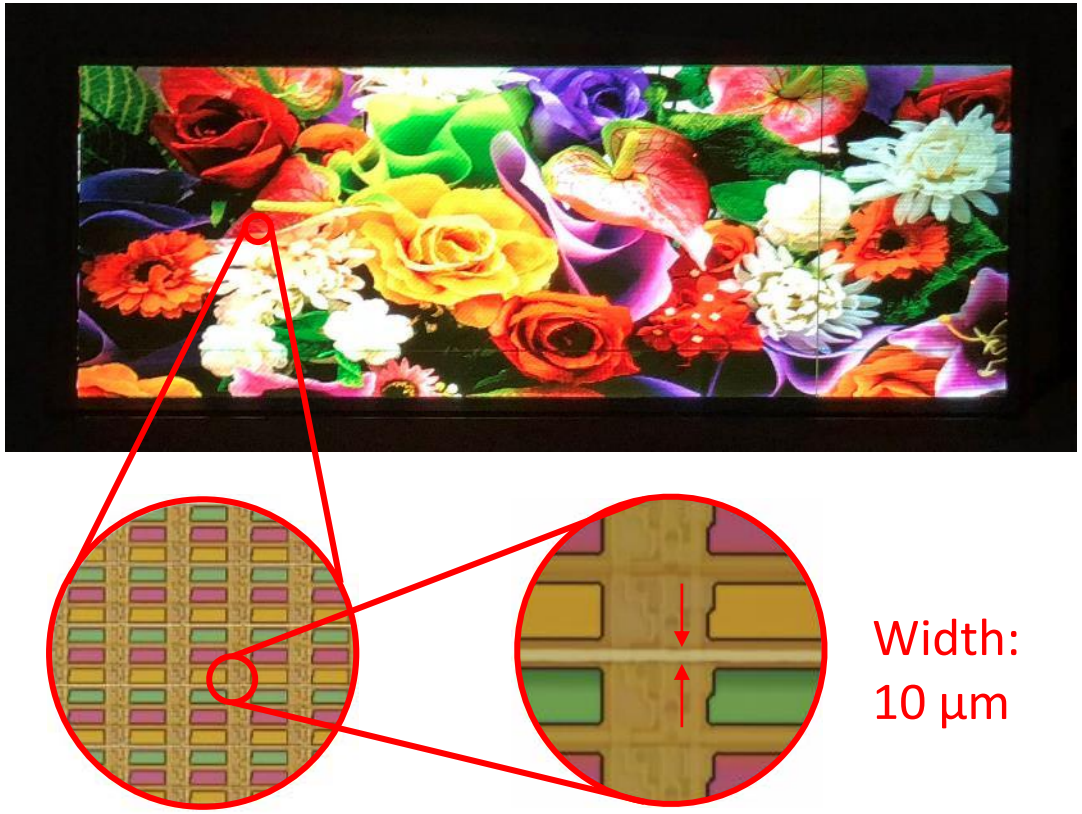


- 15 nm cathode + 600 nm ConducTorr™ Electrode

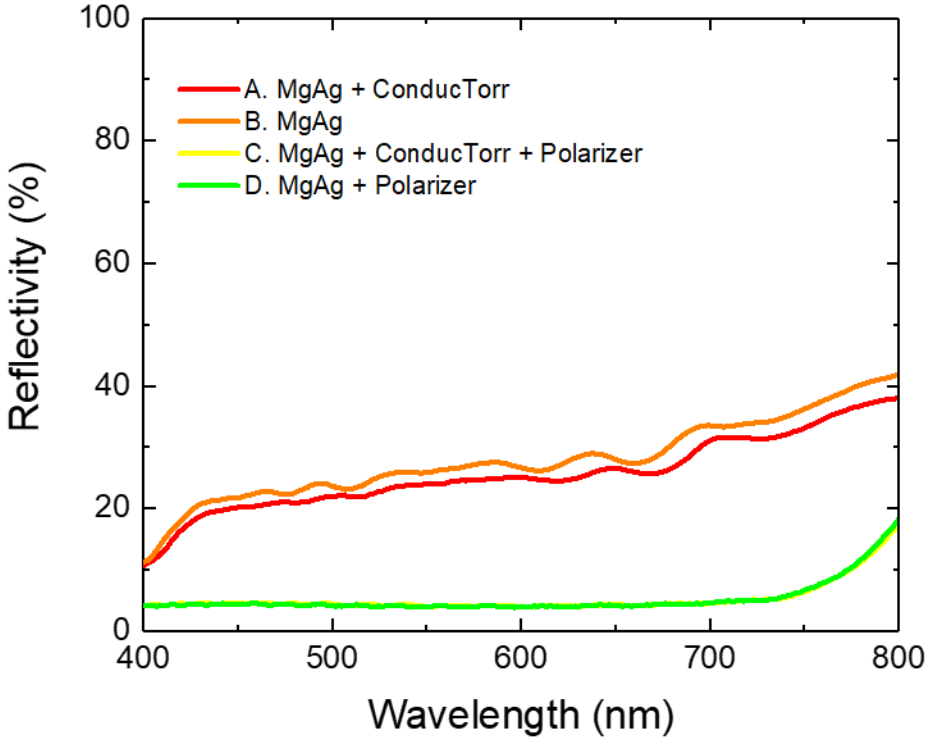
- 5.2” diagonal AMOLED panel
- Vacuum process using existing AMOLED tools and mask set
- No ConducTorr™ related defects
- 120 ppi (37” @ 4K equivalent)
- 10 µm auxiliary electrode width
- 1 Ω/□ cathode sheet resistance

ConducTorr™ Demonstrated in 5.2” Mobile AMOLED

5.2” AMOLED display fabricated using ConducTorr™ Electrode



- 15 nm cathode + 600 nm ConducTorr™ Electrode

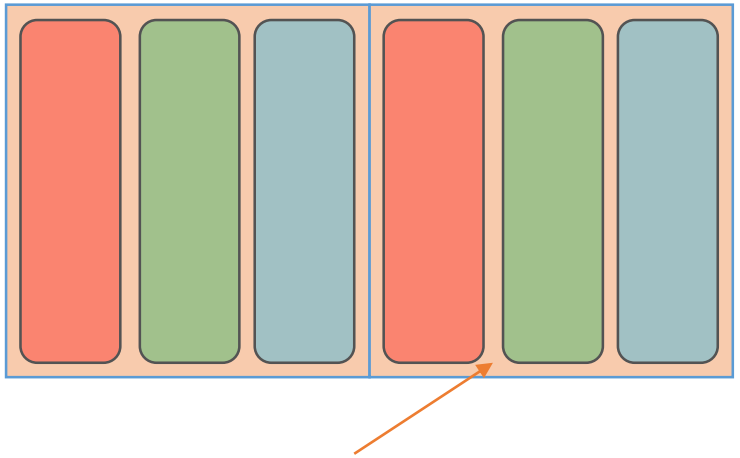


No negative impact on panel reflectivity with ConducTorr™ Electrode

ConducTorr™ Electrode for Transparent OLEDs

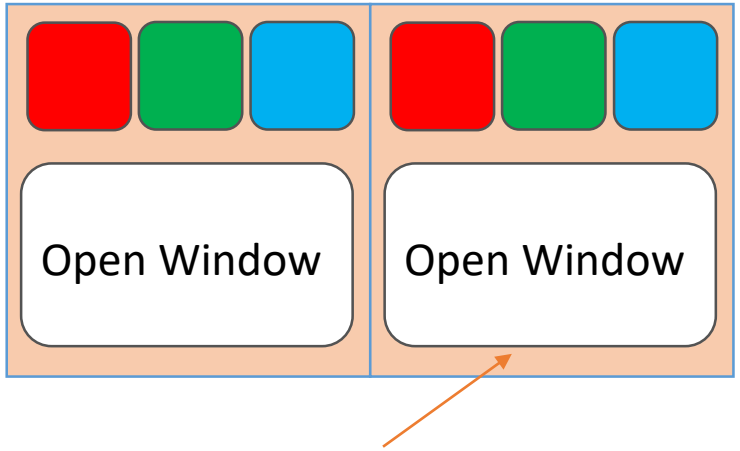
Transparent pixel vs transparent window

Transparent Pixel



CEM as Auxiliary Electrode

Transparent Window

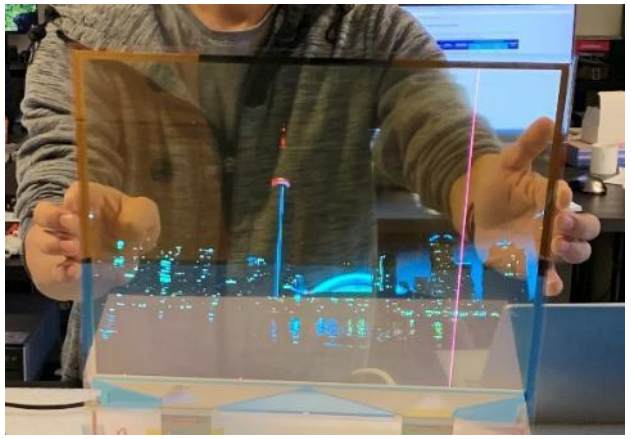


CEM as Patterned Cathode

ConducTorr™ solution can be applied to both transparent OLED architectures

ConducTorr™ Demonstrated in 17” Transparent AMOLED

17” Transparent AMOLED display fabricated using ConducTorr™ Electrode



Improved See-through Image Quality with ConducTorr™

Eliminates image blurring of see-through image for transparent AMOLED

Without ConducTorr™

Image viewed through transparent panel

With ConducTorr™

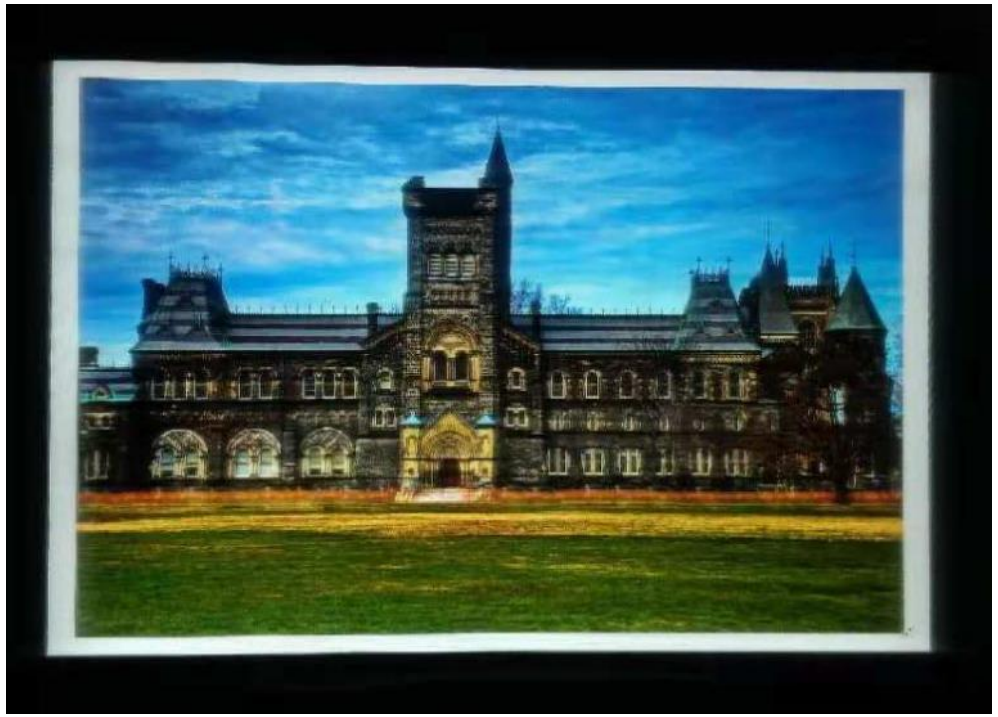


Image viewed through transparent panel

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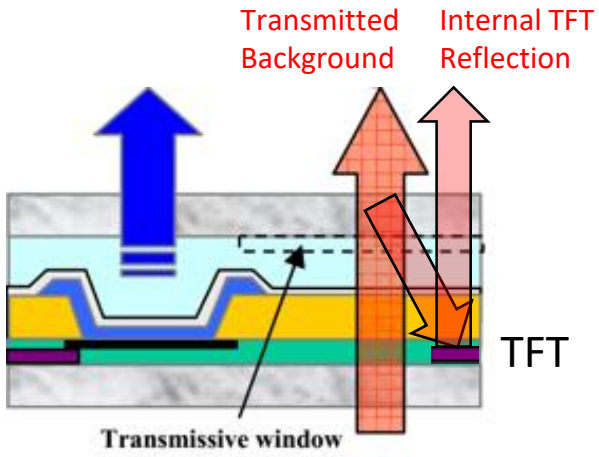
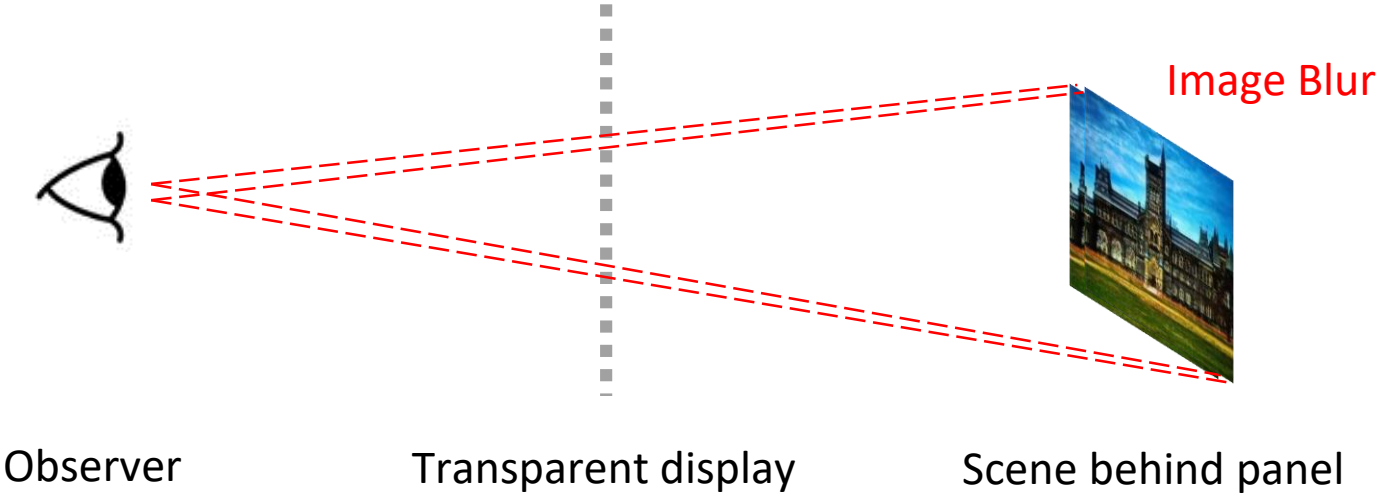
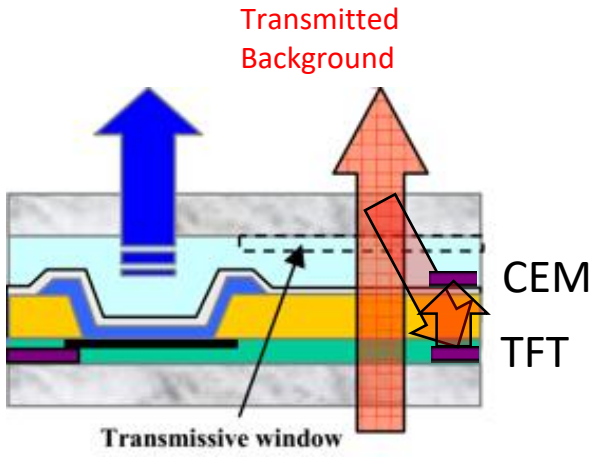
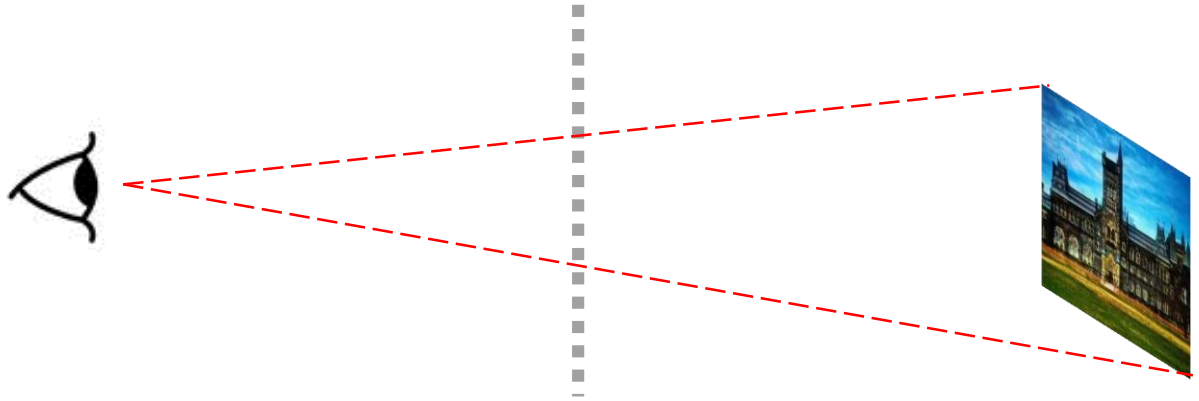
Without ConducTorr™





With ConducTorr™





ConducTorr™ Demonstrated in 17” Transparent AMOLED

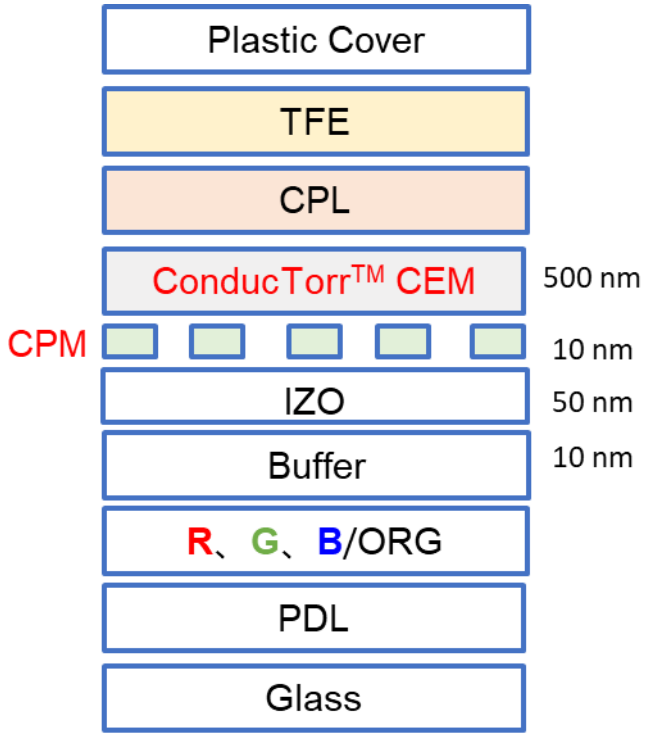
17” Transparent OLED display fabricated using ConducTorr™ Electrode

- > 65% Transparency at Panel Level
- < 1 Ω/□ Sheet Resistance (15% fill factor)
- Eliminates see-through image blue

Live demo of 17” panel at SID 2019:

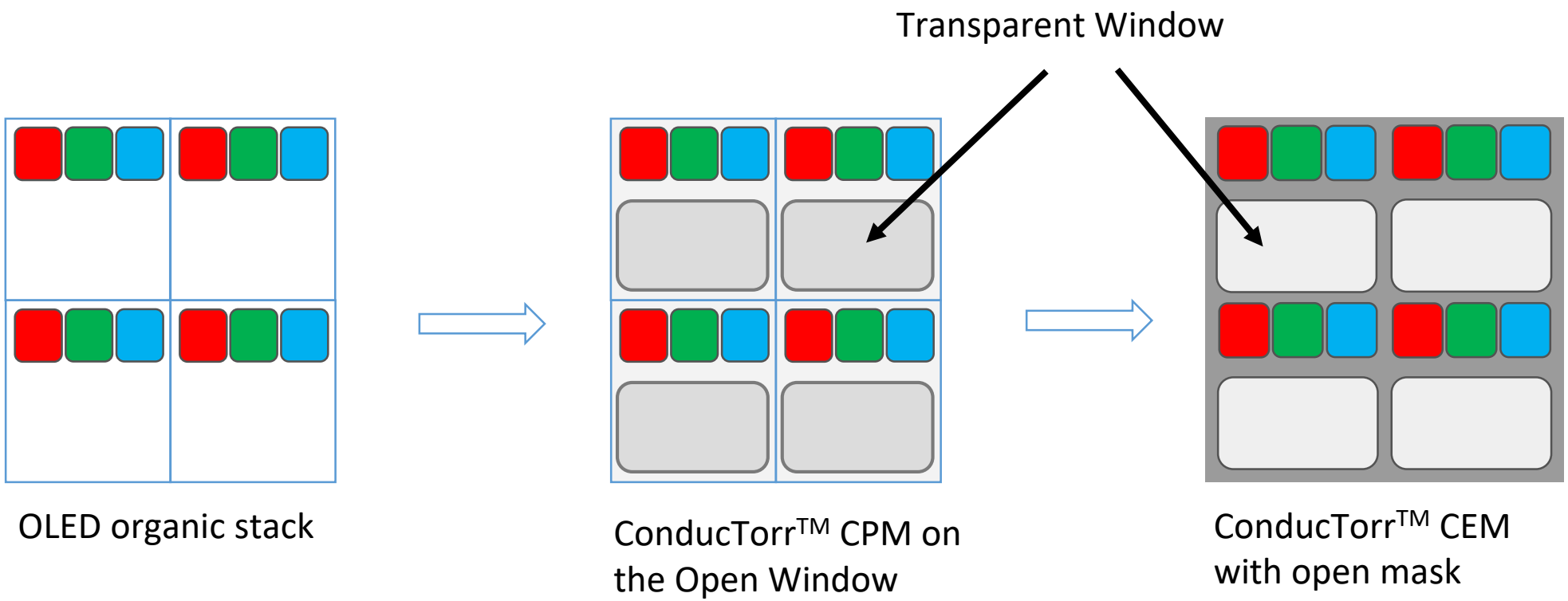
60.5 17-inch Transparent AMOLED Display
With Self-Assembled Auxiliary Electrode

Email to schedule private demo at SID 2019



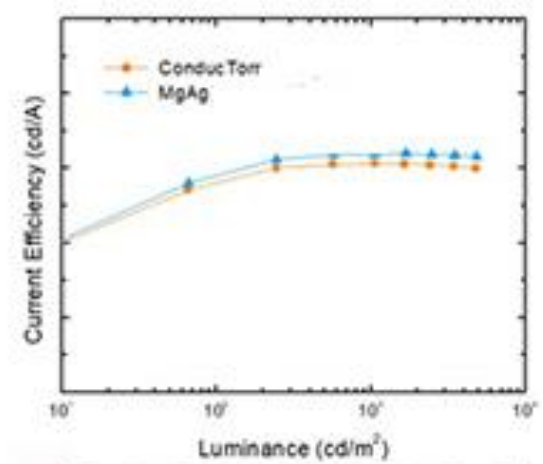
ConducTorr™ CEM as Cathode in Transparent OLED

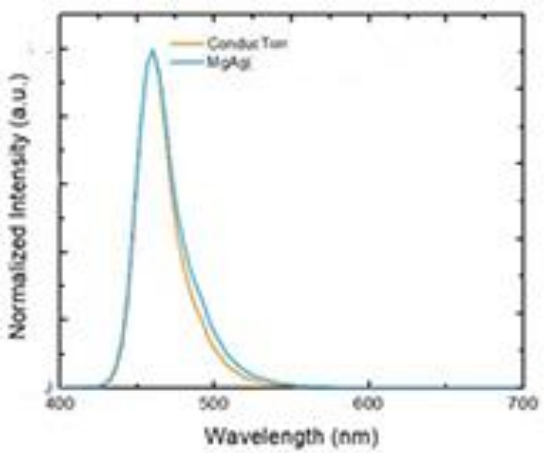
Fabrication process using ConducTorr™ to pattern transparent window

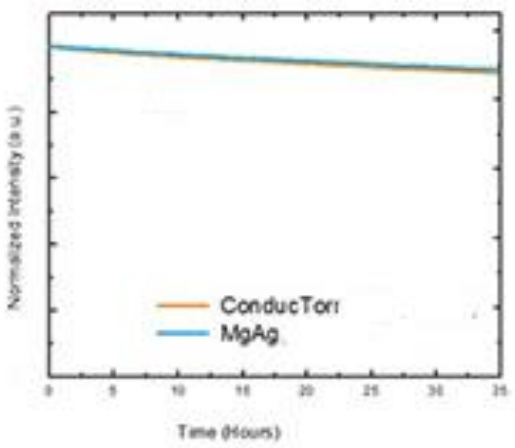


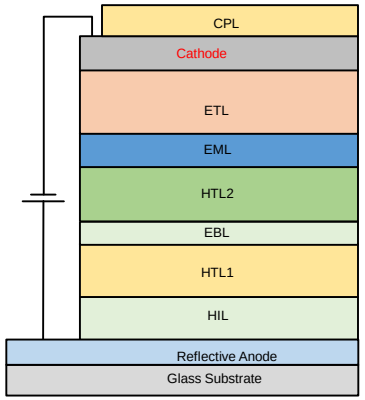
ConducTorr™ CEM as Cathode in Transparent OLED

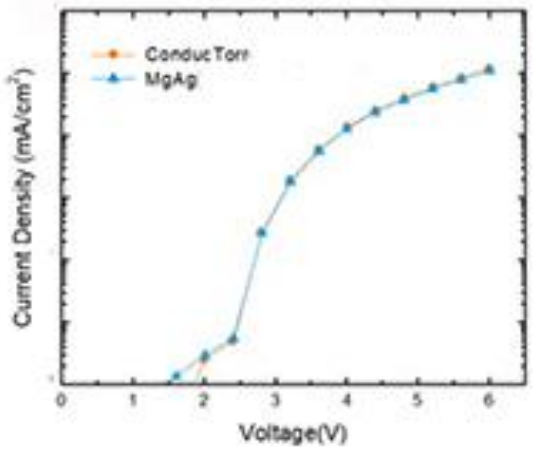
OLED device performance using ConducTorr™ CEM as cathode

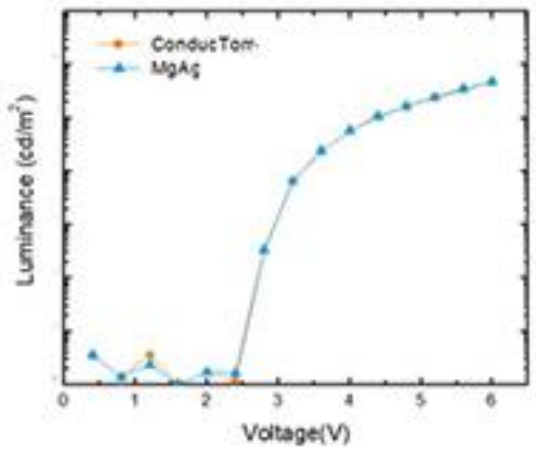












Comparable voltage, efficiency, CIE and lifetime for ConducTorr™ CEM vs MgAg (1:9) cathode

ConducTorr™ CEM as Cathode in Transparent OLED

Transparent OLED panels fabricated using ConducTorr™ CEM as cathode

Benefits of ConducTorr™ for Transparent OLEDs

Mass production ready solution to enable transparent OLED displays

- High Aperture Transparency of 99% (including NIR)
- High Electrode Transparency of > 85% (15% fill factor)
- High Panel Transparency of > 65% demonstrated
- High Conductivity of Rs < 1 Ω/□ (15% fill factor)
- Eliminates See-Through Image Blur from TFT
- Materials Ready for Mass Production in 2019

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Thank you

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