

Diffuse Lighting with Organic LEDs

2022 U.S. DOE Solid State Lighting Workshop



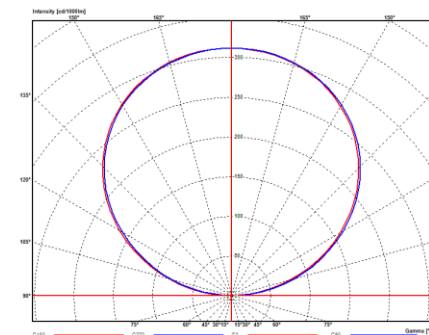
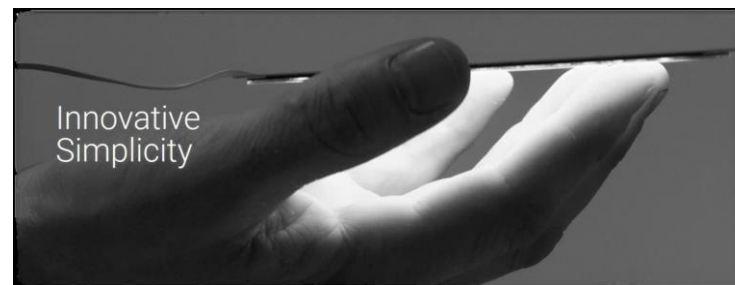
Presented by:
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OLED Strengths and Opportunities

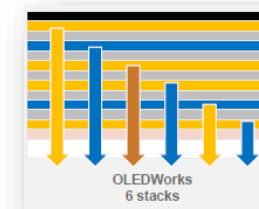
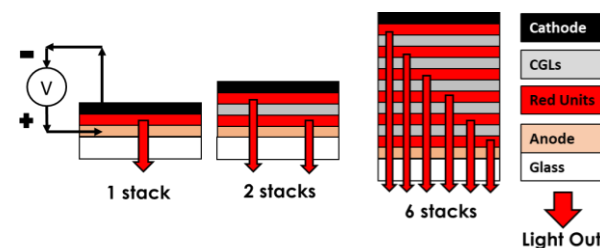
OLED Differentiators:

- Diffuse, surface area light source by nature
- Thin & flexible – active layers are < 1 micron thick
- Can easily be stacked to produce higher brightness and longer lifetime with any color
- Can reduce system costs – no need for heat sinks, optics, light guides or diffusers
- Segmentation possible with extremely high uniformity and contrast

Segmentation and dimming enables 3D dynamic visual effects with a thin 2D surface



Lambertian distribution



OLED Opportunities:

- Get the word out – continue education efforts
- Get the light out – best products still trap 40-50% of photons
- Get the costs out – higher volume products, enabled by lower cost manufacturing processes with higher throughput

OLED Technology Trends

DISPLAYS

Mobile displays



Flip/foldable

OLED TVs / Monitors

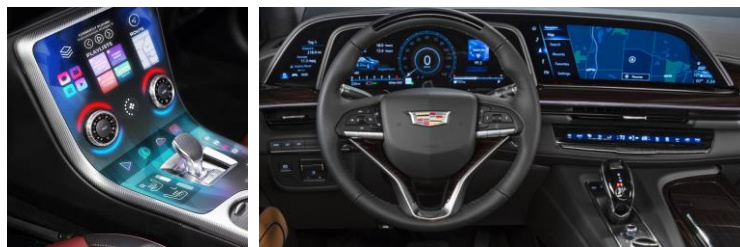
Curved / Rollable



OLED Micro-displays

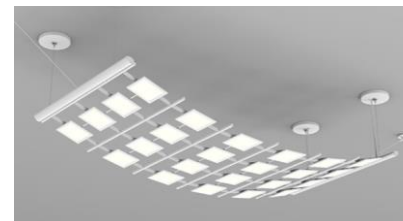


Automotive curved OLED displays



Trends toward flexibility, high resolution, high brightness, high dynamic range

General Lighting



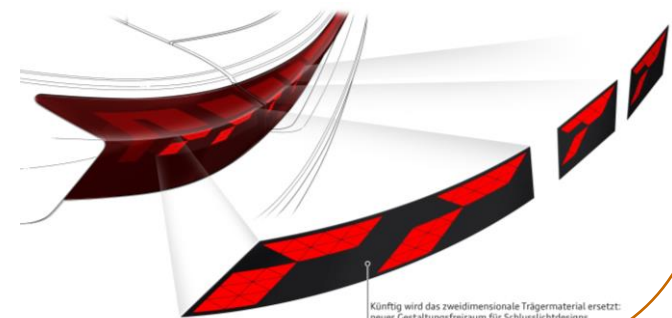
Trends toward flexibility, high brightness, digital segmentation, tunability, custom shapes/logos

LIGHTING

Automotive Lighting



DISTRIBUTED DOME LIGHTING



Künftig wird das zweidimensionale Trägermaterial ersetzt: neuer Gestaltungsfreiraum für Schlüssellichtdesigns, welche der Fahrzeugkontur folgen

OLED Applications Automotive Lighting



CES 2022 OLEDWorks RCL Demonstrator



Audi A6 e-tron concept car with OLEDWorks' red OLED taillights



OLED technology allows designers to explore unique appearances that set the vehicle apart from all others.

- RCL (Rear Combination Lamp)
- CHMSL (Center High Mounted Stop Light)
- Turn Signal, Indicator Lighting
- Dome Lighting
- Emblem or Logo Branded Lighting
- Exterior/Interior Light Signatures

Present:

Deep Red Panels with ~10 Segments/Panel

Future:

Higher Brightness, More Colors (Amber, White)

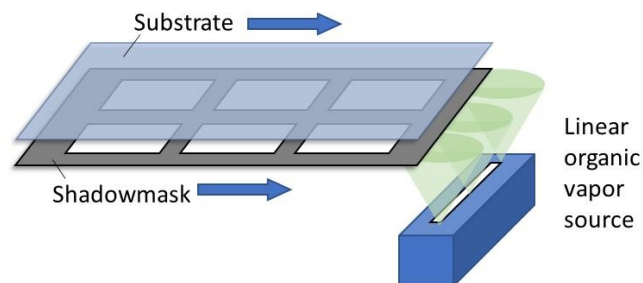
Bendable and Rigid Panels

More Segments per Panel

OLED Panel Manufacturing

Vacuum Thermal Evaporation (VTE)

VTE systems are proven in OLED production and meet performance requirements for high product yield

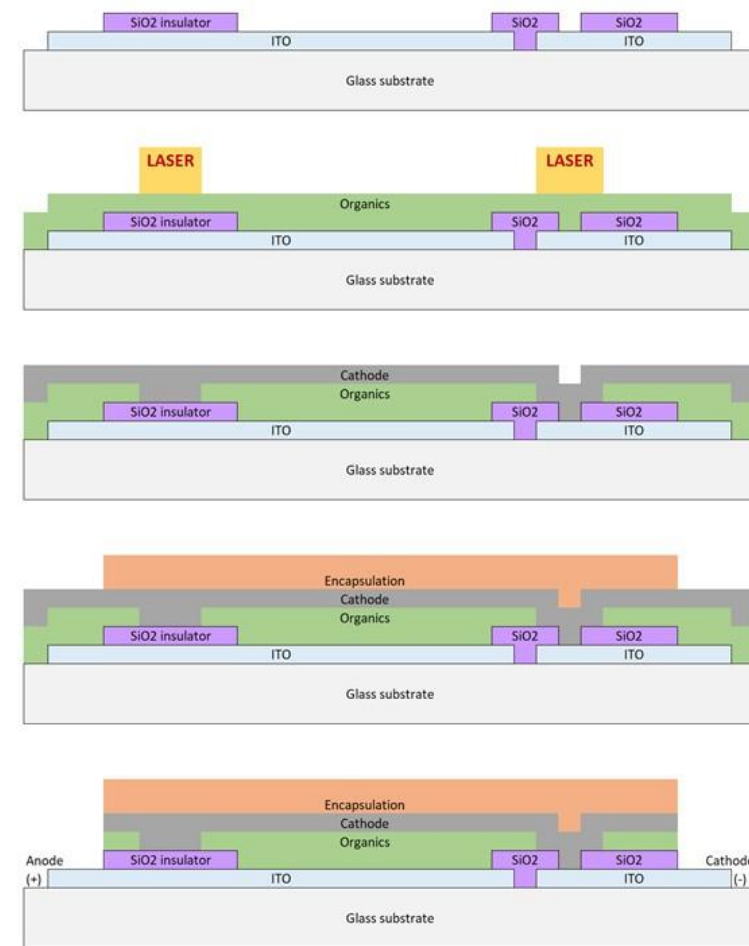


Still some challenges with VTE:

- Higher throughput accomplished by increasing deposition rates – some organic materials may hit thermal limitations
- Mixing of multi-component layers requires multiple sources – control of homogeneity throughout layer can be a challenge
- Difficult to change configuration of in-line system for various OLED stacks
- Shadowmasks require regular cleaning and are difficult for R2R
 - Successfully demonstrated mask-free patterning by UV laser removal of organics inside VTE system

Other techniques not proven yet:

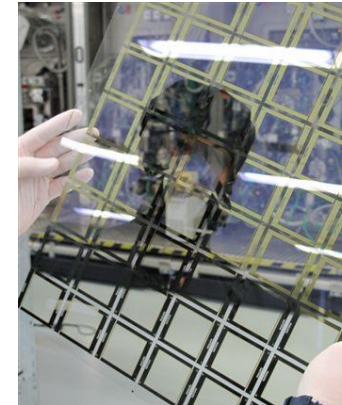
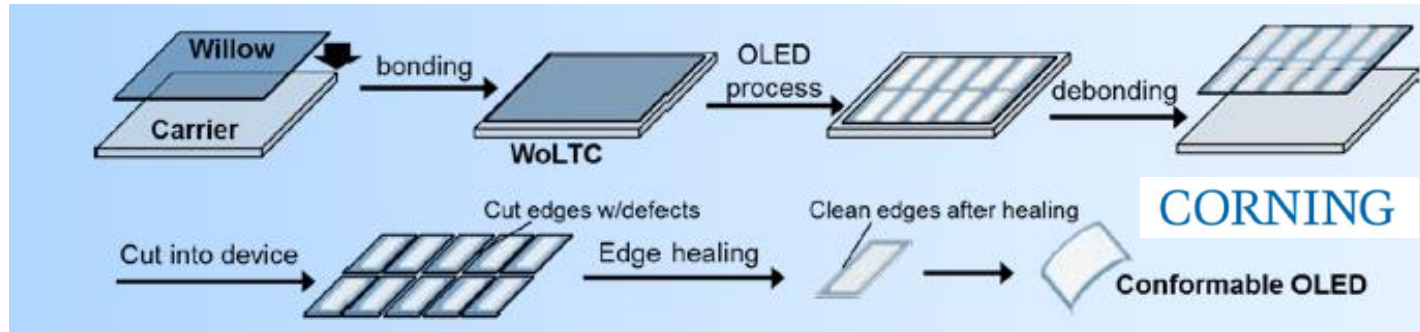
- Inkjet printing – not compatible with multi-stack OLEDs
- Vapor printing (OVPD, OVJP) – performance, cost, compatibility with R2R processing?
- Roll-to-roll OLED manufacturing in general



DE-EE0008211: Mask Free OLED Fabrication Method

Flexible OLED Manufacturing

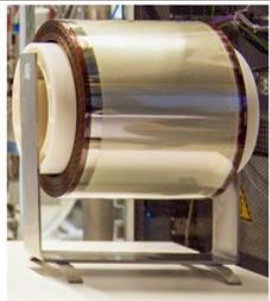
Current: Rigid OLED panels manufactured like flat panel displays (FPDs); Flexible OLED manufacturing using existing rigid glass infrastructure



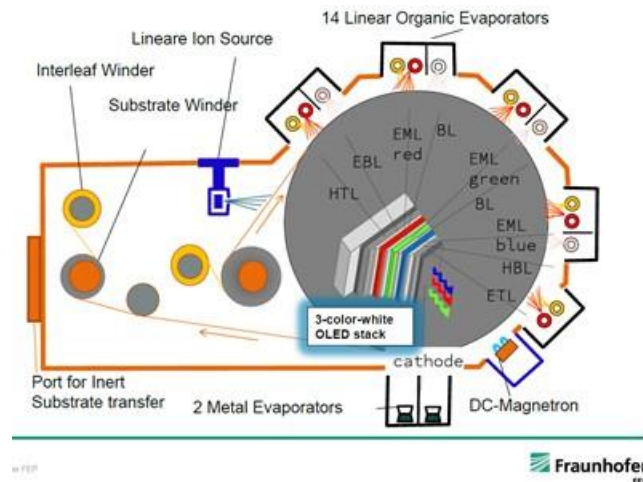
Sunic G5 rigid OLED VTE System

Future: Roll-to-roll (R2R) manufacturing of flexible OLEDs for lower cost

ITO-Coated Willow Glass



Width - 330 mm
Length - 100 m



FEP / Von Ardenne R2R VTE System

Development needs:

- Material handling
- Patterning of organics/metals
- Robust all-vacuum encapsulation technology
- Backend processing – automation, inspection

Priorities for R&D

- Lower cost OLED manufacturing solutions
 - Technologies compatible with future R2R manufacturing
 - Lower cost, higher throughput encapsulation technology
- Continue to work on improving OLED light extraction efficiency – enables fewer stacks for lower organic materials cost
- Flexible OLED panel integration - robust mechanical, electrical, thermal connections
- Segmented OLEDs – lower cost drivers and electrical components
- Study how OLEDs can better complement LEDs to achieve lighting goals for improved energy efficiency and non-energy benefits (health, wellness, etc.)
 - LAE - OLEDs are an ideal light source for applications requiring localized low-glare and high-quality light, where light source is in view – feature the beauty of OLED light
 - Consider more hybrid LED-OLED lighting systems, including integrated drivers & power delivery
 - Synergies in segmentation, tunability, and other features

