

Synergistic opportunities between OLED lighting and displays



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UNIVERSAL DISPLAY CORPORATION



UDC: Who we are

>Twenty Years of Research & Development

UNIVERSAL DISPLAY CORPORATION™



Technology Licensing

- 5,000+ issued and pending patents worldwide
- Composition of matter, and Device & Architecture patents
- Fundamental PHOLED patents issued in China, Europe, India, Japan, Korea, Taiwan, and US



PHOLED Materials Supply

- Red, green and yellow PHOLED emitters and host systems
- Produced by PPG Industries
- Device-qualified and sold by UDC
- In commercial use since 2003



Technology Innovation

- Phosphorescence
- OLED architectures
- OVJP and OVJP Corp
- Organic electronics
- Adesis – our CRO



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UNIVERSAL DISPLAY CORPORATION



Our Team – Building for growth



- ~300 employees, > 150 scientists, engineers and technicians
- Headquartered in Ewing, NJ with subsidiaries and branch offices in Korea, Hong Kong, Ireland, Japan, China and Taiwan
 - **Research & Development**
 - Includes Contract Research Organization (CRO) Adesis
 - **PHOLED Material Business**
 - Chemical Manufacturing Management, Quality Control and Order Fulfillment - Supply chain management
 - **Universal Display – Ireland**
 - Order processing and customer support
 - **Universal Display in Asia**
 - Technical customer support
 - 2 Application Centers in Korea and Hong Kong
 - **UDC Ventures**
 - Venture fund for strategic investments





Growing list of OLED Applications



Phones, Tablets
(Samsung, Apple),



AR/VR
(Pimax)



Foldable displays
(Samsung, Royole)



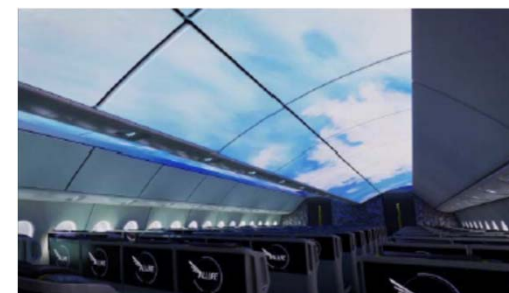
Wearables (Samsung, LG, Apple, Huawei)



Lighting (Acuity Brands, Audi and OLEDWorks)



Laptops (Dell, Lenovo)



Automotive and aircraft displays
(LG, Boeing)



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TV (LG)

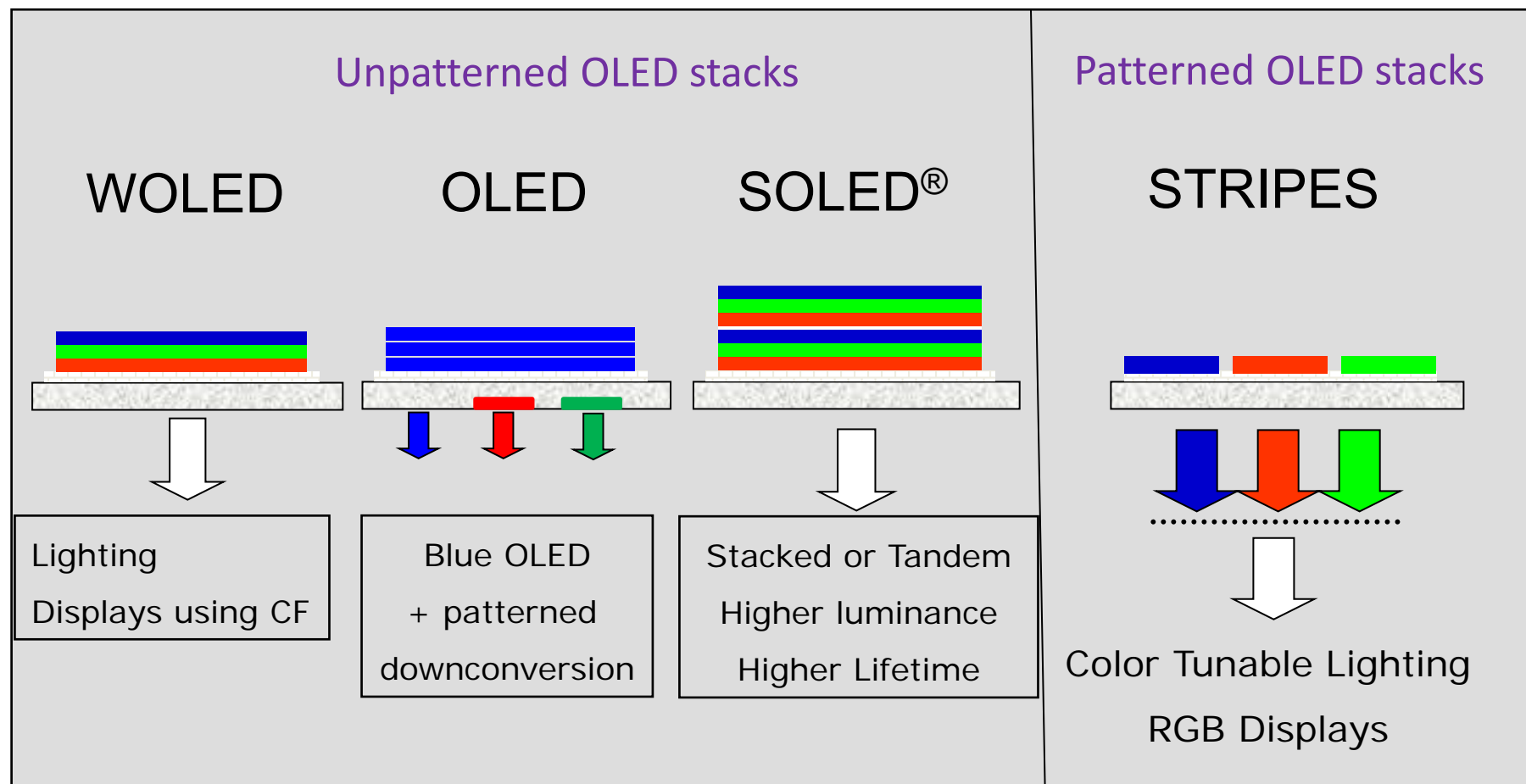


Comparison of OLED lighting and displays

Metric	Lighting	Displays
Emissive Materials	Small molecule, wide FWHM	Small molecule, narrow FWHM
Architecture	Stacked (usually) Commonly bottom emission	Side by side or stacked Mobile - TE TV - BE or TE
Luminance (cd/m ²)	3,000 similar output as fluorescent troffer	500 – 1,000 but polarizer and fill-factor increase >6x
Color Temp (K)	3,000 – 5,000	D65 = 6,500K
Organic deposition	Vacuum thermal evaporation dominant	Vacuum thermal evaporation dominant
Organic patterning	None, unless color tunable	High resolution for mobile (FMM) None or low resolution for TV (OVJP/IJP)
Substrate	Few restrictions	Need TFT backplane
Encapsulation	Yes < 10 ⁻⁶ g/m ² /day	Yes < 10 ⁻⁶ g/m ² /day
Reliability	residential/commercial/automobile 10K/25K/10K hours	Mobile/IT/TV (500 – 1,000 nits) 5K/10K/15K hours



General Designs for White PHOLEDs





*Lighting up the
global OLED
revolution with its
proprietary
phosphorescent
technology and
UniversalPHOLED®
materials*

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