OLEDs heading for lighting, automotive, wearables

Yoelit Hiebert - December 27, 2018

Organic LED (OLED) are now commonly used for television and phone screens, but OLEDs promise to be the next big thing in solid state lighting technology and might become useful in other applications as well. Inorganic LEDs still tend to make more economic and technological sense for many applications, but OLEDs have some interesting properties that inorganic LEDs lack, and new production techniques promise to reduce the cost of making OLEDs enough that the two become more cost-competitive.

OLEDs emit light through the application of current to an electroluminescent layer made of small organic molecules or polymers, and can be manufactured as either rigid or flexible film sheets. OLEDs are ideal for applications that require evenly distributed light, such as digital displays for screens and smartphones. The figure below shows typical OLED construction - in addition to electron and hole transport layers, there are layers for emission of red, green, and blue light.

![OLED architecture](image)

When a voltage is applied such that the anode is positive with respect to the cathode, electrons flow through the OLED. Electrostatic force within the OLED brings the electrons and holes toward each other and as each electron combines with a hole, light is emitted.

OLED efficacy significantly trails that of inorganic LEDs, with figures of 60-90 lumens/watt reported for volume production. Various commercially available LED light bulbs range from about 100 lumens/watt to well over 200 lumens/watt. As is the case for inorganic LEDs, there's a trade-off between efficacy and color rendering. OLED lumen degradation occurs both as a function of operating current (similar to inorganic LEDs) and also during storage (the culprits being oxygen and moisture ingress).
OLEDs are used extensively in the display market, in lieu of LCDs. While LCD displays have been available for over 20 years, OLEDs have only been available for about five. Both are flat panel display technologies that use a matrix of pixels addressed via a backplane. Both technologies include red, blue, and green sources within each pixel and both can be manufactured in a wide range of sizes. However, important differences exist.

Even though OLEDs require a more complicated circuit structure, LCDs require more optical layers. LCD displays require a backlight whereas OLED displays do not. And, as mentioned above, OLEDs have an advantage in terms of production using a flexible substrate. For these reasons, OLEDs are slowly making headway as the display technology of choice.

Power consumption is a bit more complicated. While LCD display power consumption depends on the backlight, OLED display power consumption depends on the screen content, so OLEDs do not necessarily have an advantage over LCDs.

Projections by DSCC indicate that OLED will overtake LCD technology for smartphones by 2022, mainly due to the advanced form factors, including foldable displays that are made possible using OLEDs.

Looking beyond display applications, recent innovations resulting from an EU-funded Horizon 2020 study promise to cut manufacturing costs by 90 percent, bringing these costs in line with inorganic LED lighting products. These innovations include the use of planarized flexible steel as a production substrate, transparent top contacts, and thin film encapsulation, making it possible for OLED production to no longer rely on glass substrates and encapsulation. While no products have yet been released using this new production technique, potential areas of application are anticipated to include general lighting, automotive lighting, and even wearables.

And recently, working together under the auspices of Europe's Lyteus initiative, the objective of which is to promote the commercialization of OLED technology, the Holst Centre in Holland and Fraunhofer FEP in Germany have reported an innovation in production methods that yielded what they are claiming is the world's longest OLED (15 meters). The demonstration makes possible "cut-to-fit" customization of OLED lighting for applications ranging from transportation to interior design. A major drawback of this technology is in the area of efficacy, about 15 lumens/watt, which is very low even for OLED technology.

Finally, in the general illumination space, Wegmans Food Markets announced earlier this year that in an effort to provide what it considers better quality lighting for customers and employees, it will be installing combination OLED/LED in suspended luminaires in select stores and at the company's headquarters in Rochester, NY. The OLED component of the hybrid fixtures will be made by OLEDWorks, the only OLED lighting manufacturer based in the U.S.

OLED-based lighting, already widely used in display products, is beginning to make inroads into other illumination markets. So far, production costs and efficacy are the main impediments to wider adoption but research is on-going that promises to eventually overcome these limitations. Expect to see OLED coming to a lighting product near you soon.

— Yoelit Hiebert has worked in the field of LED lighting for the past 10 years and has experience in both the manufacturing and end-user sides of the industry.

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