Light-emitting diode panels produce even brightness in large areas

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With low resistance and dramatically reduced short-circuiting, organic light-emitting diode panels uniformly brighten large areas, yielding high production with low power-efficiency loss.

In recent years, there has been increasing interest in using white organic light-emitting diodes (OLEDs) for lighting applications.¹⁻⁵ A principle reason for this is that OLEDs are highly efficient phosphorescent sources. In contrast to LEDs, which are high-intensity point sources, OLEDs provide an inherently diffuse light of high quality and with high color rendering index (CRI) that is naturally adapted to large-area lighting needs. In addition, OLED lighting panels can be transparent and flexible, which opens up exciting new lighting uses and design concepts.

For broad commercial success, however, key technical challenges related to the fabrication and optimization of large-area OLED light panels must be solved. First, using only standard transparent conductive oxide anodes with high sheet resistance, such as indium tin oxide (ITO), producing a large-area panel with uniform luminance is difficult. Second, in a large-area OLED light panel, Joule heating causes significant temperature elevation as the charge is transported from the electrode contacts to the emissive region. Careful panel design is, therefore, required to minimize panel temperature, especially at high-luminance operation. This is particularly important for maximizing panel life because organic materials typically degrade more quickly at elevated temperatures. Finally, the shorting defect is particularly problematic for large-area devices. An OLED device has films of organic material placed between parallel electrodes. As the organic layers are very thin (approximately a few hundred nanometers in thickness), excess rough surface features, asperities, or particles can cause the two electrodes to touch, creating a short circuit. When this happens, all the current flows through the shorted spot because of its much lower resistance, and, therefore, no current can flow through the organic layers to generate light. For large-area OLED lighting panels, such shorting defects can cause dysfunction in a significant portion of the area.

We introduced an effective method to reduce these shorts. In our design of the OLED lighting backplane, we divided the large lighting area into several individual pixels united by a metal grid, and then connected each pixel to one short-reduction layer (SRL, composed of ITO) in a series (see Figure 1). When there is a shorting defect in one lighting pixel, the current passing through the defective pixel can be substantially limited at

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To summarize, we demonstrated a novel design for large-area OLED lighting panels that feature low electrode resistance and complete short reduction. At the same time, these panels produce uniformly high brightness and product yield with low power-efficiency loss. In the near future, we plan to develop large-area flexible OLED lighting with an eye-catching luminaire design.

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