Optical modeling of the effect of the finite pixel boundary on the light emission characteristics in top-emitting organic light-emitting diodes

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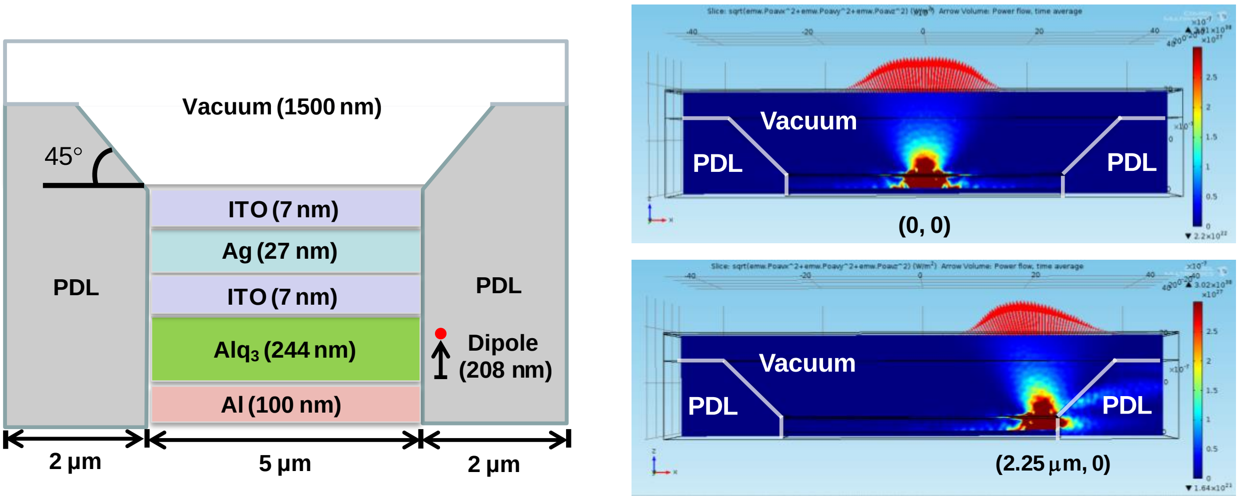
Top-emitting organic light-emitting diodes (OLEDs) have been investigated as an effective approach to enhance the brightness and the resolution of active matrix OLED displays [1]. It is essential to optimize the optical performance of top-emitting OLEDs based on the appropriate optical modeling. However, there has been no previous study to consider the finite pixel boundary in the optical modeling. In this paper, we numerically investigate the effect of the finite pixel boundary on the optical characteristics of top-emitting OLEDs.

Figure 1(a) shows a device structure of a top-emitting OLED, which is composed of a reflective bottom anode, an organic emission layer, and a semi-transparent top cathode in the vertical direction. The pixel domain is assumed to have a 5 μm × 5 μm square, which is surrounded by a pixel defining layer (PDL) in the lateral direction. All the simulations are performed based on the finite element method [2] and the emitter is modeled as a Hertz electrical point dipole with the wavelength of $\lambda = 520$ nm.

Figure 1(b) shows the calculated time-average optical power flow in the cross section of the center line when the emitter is located at the center (0, 0) and the edge (2.25 μm, 0) of the square pixel, respectively. The red arrows represent the magnitude and the direction of the optical power flow extracted into the air. As the position of the dipole emitter moves close to the pixel boundary, the angular emission profile is changed from a symmetric to an asymmetric pattern, which results from the optical reflections from the pixel boundary in the horizontal direction.



(a) (b)

Fig. 1. (a) Cross-sectional view of the top-emitting OLED along with the corresponding layer thickness. (b) Calculated time-average optical power in the cross section of the center line when the emitter is located at the center (0, 0) and the edge (2.25 μm, 0) of the square pixel.

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References

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