Organic Light-Emitting Diode Display Panel Integration Using Graphene Pixel Electrodes

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In recent years, significant advances of organic light-emitting diodes (OLEDs) have been made in the active-matrix OLED displays, and OLED has been one of the biggest market leaders in mobile. Furthermore, OLED is expanding its application to large-size display such as both 55-inches and bigger size TVs in the market and the market of the flexible OLED displays as a new trend has been studied and developed. Graphene films are promising for transparent electrode of OLED displays; the superior features of optical transparency and mechanical flexibility give a possibility of alternative to conventional electrode materials [1-4]. However, the limitations of large area graphene with process compatibility has blocked the way of graphene film application in OLED displays [3].

In this work, we have examined the technical issues for the panel integration and fabricated the OLED display panel with graphene pixel electrodes. As a preliminary to the integration, optical and electrical issues have been addressed in the previous our report [3-4]. In the optical part, the efficiencies, emission distributions and emission spectra of OLEDs with the graphene electrode showed a weaker dependency on the thickness of the organic layers than OLED with the conventional ITO electrode. Because the graphene electrode OLED can offer spectral stability over a wide angle range, graphene emerges as a useful choice in large area OLED in which color uniformity is a concern. As for the electrical issue, interfacial engineering of the graphene electrode such as plasma treatment and insertion of additional layer was needed for better hole injection. As for the last issue to overcome the processability, we have established graphene film patterning process, which do not cause the occurrence of surface defects which affect OLED operation. The OLED with the patterned graphene electrode exhibited comparable performance to the OLED with pristine graphene electrode as shown figure 1.

To investigate the processability of graphene film as OLED display pixel electrodes, we have fabricated the integration substrate with the pixel array of 155 x 60. Each pixel contains the addressing metal line under the planarization layer. The graphene pixel electrodes could be connected to external OLED driver, through trenched via holes, the contact pad and the addressing metal line. The graphene film was synthesized by rapid thermal chemical vapor deposition on rolled copper, and transferred on the planarization layer. Thereafter, the graphene film was patterned into pixel electrodes with size of 170 x 300 μm^2. Hole transporting layer, emitting layer, electron transporting layer and metal cathode were deposited on OLED display area, sequentially. After the glass encapsulation, we have demonstrated the integrated OLED display panel with the active area of 26 x 26 mm^2 as shown figure 2 and 3.

Despite of extensive attention to graphene by researchers in both industry and academia, there exist many hurdles to overcome to make graphene applicable in OLED display. To this end, we have successfully fabricated the OLED display panel using graphene pixel electrodes and probed the applicability of graphene to OLED displays.

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References

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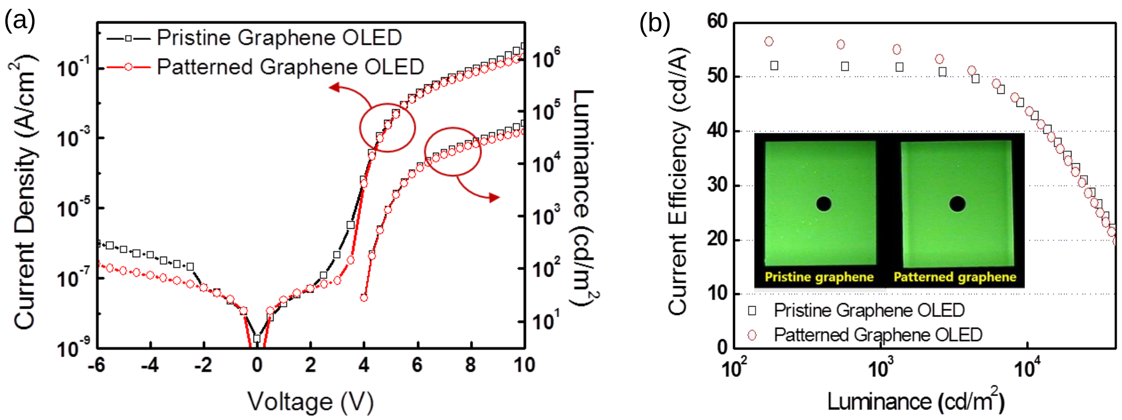

Figure 1. (a) IVL characteristics and (b) current efficiency of the graphene electrode OLEDs before and after patterning process.

Figure 2. The demonstration of OLED display with graphene pixel electrodes

Figure 3. The close-up image: graphene pixel electrodes of integrated graphene OLED display panel