Large-scale patterned quantum dots as color conversion layer for organic light emitting diode by inkjet printing

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Abstract

In this work, we fabricated 6.6-inch QD display panel by inkjet printing technology, being cooperated with active matrix organic light emitting diodes (AMOLEDs). Here 3-stack blue OLEDs (BOLEDs) with top-emission structure acted as backlight and red QD layer acted as converted materials, which exhibited high quantum efficiency, high luminance, high color purity and improved wide viewing angle of output emission. We believe that inkjet-printed QD display with AMOLEDs would be promising candidate for the next generation display and lighting in the near future.

1. Introduction

Recently, quantum dots (QDs) have shown great potential for next generation displays owing to their solution process, color tunability, narrow emission, and high luminescence efficiency[1-3] . Since the excellent physical and optical properties of QDs, QDs can not only act as self-emitting layers in electroluminescence device quantum dot light-emitting diodes (QLEDs), but also can be color converted layer for liquid crystal display (LCD) or LED due to the photoluminescence of QDs[3-5] . So far, most of the application of QDs in display device are QD-enhanced film (QDEF) equipped in backlight, offers an alternative approach to extend the color gamut and improve the optical efficiency of the LCDs [4-6]. For LCDs using conventional phosphors as down-converters, the color gamut is ~72% of the National Television Systems Committee (NTSC) standard. [12] In comparison with phosphors, QDs are semiconductor particles with nanoscale in size, whose bandwidth of spectrum is narrower resulting in better color purity. Eunjoo Jang have reported that they used green- and red-light-emitting QDs as color converter and successfully fabricated a 46 inch LCD panel using white QD-LED backlight as the first time, which showed more than 100% color reproducibility compared to the NTSC standard in the Commission Internationale de l'Eclairage (CIE) 1931 color space [4]. Chen proposed a new backlight system using a blue LED to pump green perovskite polymer film and red quantum dots, which achieved 95.8%Rec. 2020 in CIE 1931 color space with commercial high-efficiency color filters [7].

3. Results and discussion

In our work, we realized colorful display by cooperating OLED with QD, in which blue OLED act as excited light pumping green and red QDs, QDs act as color conversion materials. The structure diagram is showed in Figure 1a and b. In comparison with the structure of withe OLED with RGB CF, this method is easier and exhibit better optical performances. Moreover, the patterned QDs layer were prepared by solution ink-jet printing process (Figure 1c and d), which was low-cost and could use nanomaterials completely. We also used special design to reduce the cross-talk between sub-pixel. Based on this structure, we prepared a colorful display panel with size of 6.6 inch successfully.

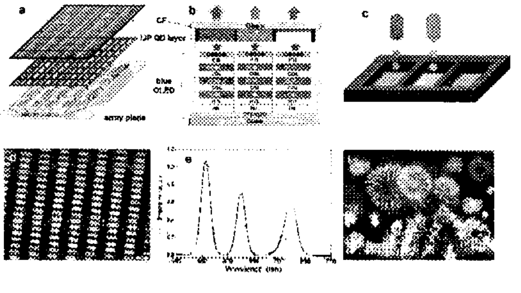

Figure 1a, 1b: The structure diagram of QD- OLED
Figure 1c: Inkjet printing process of QD in black bank
Figure 1d: Microscope image of colorful QDCF
Figure 1e: PL spectrumofwhitelightofQD-OLED
Figure1f:Photographof 6.6-inch QD-OLED display panel

Figure 1e and f show the photoluminance spectrum of white light the image of QD-OLED, respectively. These results express that the cooperation of QD and OLED can realize colorful display and QD can widen the color gamut and the view angle of OLED. This work would extend the application of QD in display technology in the future.

4. Acknowledgements

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5. References

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