Inkjet-printed Quantum Dot and Polymer Composites for AC-driven Electroluminescent Devices

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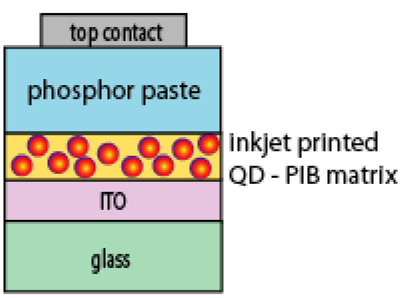
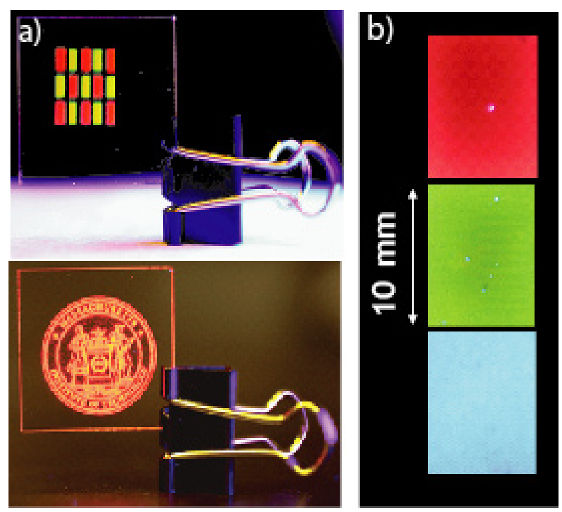
We introduce a technique for the reliable deposition of intricate, multicolored patterns using a quantum dot (QD) and polymer composite and demonstrate its application for robust AC-driven displays with high brightness and saturated colors. The AC electroluminescent (AC EL) devices are a well-established technology [1]. Their relatively simple fabrication and long operating lifetimes make them desirable for large-area displays; however, a major challenge with AC EL remains finding efficient and stable red phosphors for multicolored displays. Colloidally synthesized QDs are robust, solution-processable lumophores offering tunable and narrowband photoluminescence across the visible spectrum [2]. By integrating QDs into an AC EL device, we demonstrate patterning of saturated red, green, and blue pixels that operate at video brightness.

The concept behind the device operation is optical downconversion: red and green QDs absorb blue electroluminescence from phosphor grains and then emit at longer wavelengths. The device, pictured schematically in Figure 1, is fabricated with a layer-by-layer approach that is compatible with flexible substrates. A QD and polyisobutylene (PIB) solution is printed on conductive indium tin oxide (ITO) using a Hewlett Packard Thermal Inkjet Pico-fluidic dispensing system (TIPs). Figure 2a shows examples of the intricate and multicolored patterns possible. The electroluminescent phosphor paste (ZnS:Cu powder in a transparent binder from Osram-Sylvania) is deposited uniformly over the sample using a disposable mask and doctor-blading to define the device area. Top contacts are made with conductive tape from 3M. This basic device structure is assembled and tested entirely under atmospheric conditions.

When an AC voltage waveform is applied across the device, we measure spectrally pure QD emission in the red and green and ~100 Cd/m^2 brightness. Photographs of the red, green, and blue pixels of a working, AC-driven device appear in Figure 2b. The Commission International d'Eclairage (CIE) coordinates of the pixels device define a color triangle that is comparable to the International Telecommunication Union HDTV standard.



▲ Figure 1: Schematic showing basic device structure.



▲ Figure 2: Photographs of a) photoluminescence of QD-PIB composites inkjet-printed on 1 in. x 1 in. indium tin oxide coated glass slides and b) emission from blue, green, and red pixels of completed devices driven at 70 V_{rms} and 50 kHz.

References

[1] Y.A. Ono, *Electroluminescent Displays*. Singapore: World Scientific, 2000.

[2] C.B. Murray, D.J. Norris, and M.G. Bawendi, "Synthesis and characterization of nearly monodispersed CdE (E= S, Se, Te) semiconductor nanocrystallites," *Journal of the American Chemical Society*, vol. 115, pp. 8706-8715, 1993.