Full-Color and White Electroluminescent Quantum Dot-light-Emitting Diodes

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Most effort on quantum dot-light-emitting diode (QLED) fabrication has been dedicated to electroluminescence (EL) performance improvement of monochromatic device. However, from a standpoint of practical application of QLEDs to general illumination and display, multicolored white EL should be pursued. Kim *et al.* demonstrated the fabrication of a full-color white QLED as a display device, where red, green, and blue II–VI QD emitting layers (EMLs) were sequentially patterned by a solvent-free transfer printing [1]. A more convenient approach for the realization of white EL is to form the EML mixed with multicolored QDs. Very recently, adopting the same approach of mixed II–VI QD EML (1–2 monolayer) as above, Bae *et al.* reported better-performance trichromatic (red, green, blue) and tetrachromatic (red, yellow, cyan, blue) white QLEDs integrated with ZnO nanoparticle (NP) electron transport layer (ETL). The resulting QLEDs showed peak external quantum efficiency (EQE) of 0.9–1.3% and peak luminances of 5340–6400 cd/m^2, depending on the type of device [2].

Herein, we explore the solution-processed fabrication of two types of multicolored, multilayered hybrid QLEDs having a hole transport layer (HTL) of poly(9-vinlycarbazole) (PVK) and an ETL of ZnO NPs. The first device consists of high-color purity CdZnS/ZnS blue (B), CdZnSeS/ZnS green (G), and CdSeS/ZnS red (R) QDs with RGB QD-mixed multilayer EML (Figure 1a). As shown in Figure 1b, three primary colored EL spectra are successfully obtained. This full-color QLED exhibits record-high values of 23352 cd/m^2 in peak luminance, 21.8 cd/A in current efficiency, and 10.9% in EQE. The second device is constructed with CdZnS/ZnS B and Cu-In-S (CIS)/ZnS yellow (Y) QDs having a bilayer scheme of a CIS/ZnS // CdZnS/ZnS sequence (Figure 1c). As shown in Figure 1d of voltage-dependent EL spectral evolution, a satisfactory bicolored white EL is attainable, specifically showing the peak EL values of 786 cd/m^2 in luminance, 1.4 cd/A in current efficiency, and 0.6 % in EQE. Detailed EL performances of two types of QLEDs in regard to display *versus* lighting application will be presented.

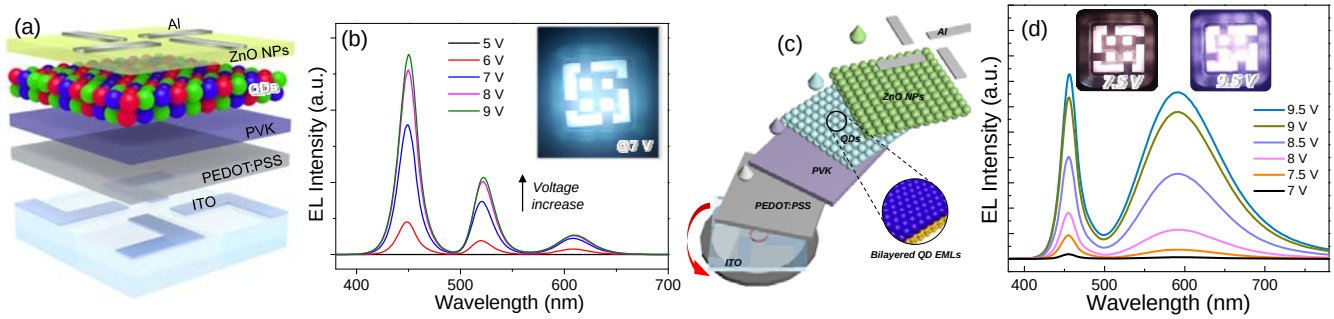

Fig. 1. (a) Device schematic and (b) voltage-dependent EL spectral evolutions of full-color QLED with RGB QD-mixed EML. (c) Device schematic and (d) voltage-dependent EL spectral evolutions of white QLED with Y/B QD-bilayered EML.

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References

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