

Hybrid LED Developed by Si-Quantum-Dot/Polymer with Blue Emission: High Current Density and Optical Power Density

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A light-emitting diode (LED) composed of organic polymer and inorganic materials is called hybrid LED (HLED). The HLED is expected as a next-generation luminescent device, because easy solution process of polymer and stability of inorganic material are accomplished at the same time. Quantum dot (QD) enables us to tune the luminescence wavelength from UV to near IR region by the QD size. Here, we show a HLED composed of Si-QDs and polymer, giving blue electroluminescence.

We have synthesized luminescent Si-QDs showing RGB colors¹ or white light continuum² using pulsed laser ablation (PLA). In the present study, the PLA of Si was conducted in solution, and the Si-QDs product was used as emissive material in HLED. The size distribution of Si-QDs dispersed in a solution was measured by dynamic light scattering. The concentration was analyzed by an inductively coupled plasma optical emission spectrometer.

The fabricated HLED has flat hetero structure and consists of ITO anode, PEDOT:PSS (hole injection layer), PolyTPD (a hole transport layer), Si-QDs (emissive layer), Alq3 (electron transport layer), and Al cathode. By applying the voltage to the device, we obtained the electroluminescence spectrum of the Si-QDs at around 400 nm. The device performance was optimized by changing annealing condition, film thickness, and Si-QDs concentration. As a result, the output optical power density was about 350 times higher than that of a reported Si-QD/polymer HLED³. In addition, the maximum current density at 6 V was 170 mA/cm², whose value was 175 times larger than the reported data³. Such a high optical power and current density were established by optimizing the film preparations with solution processes.

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