TT2-002

Electrically Driven Quantum Dot/wire/well Hybrid Light-emitting Diodes via GaN Nano-sized Pyramid Structure

고영호[1], 김제형[1], 김려화[1], 고석민[1], 권봉준[1], 김주성[2], 김 택[2], 조용훈[1]*

[1]Department of Physics and Graduate School of Nanoscience & Technology (WCU), Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea,
[2]Samsung Advanced Institute of Technology, Yongin, Korea

There have been numerous efforts to enhance the efficiency of light-emitting diodes (LEDs) by using low dimensional structures such as quantum dots (QDs), wire (QWRs), and wells (QWs). We demonstrate QD/QWR/QW hybrid structured LEDs by using nano-scaled pyramid structures of GaN with ~260 nm height. Photoluminescence (PL) showed three multi-peak spectra centered at around 535 nm, 600 nm, 665 nm for QWs, QWRs, and QDs, respectively. The QD emission survived at room temperature due to carrier localization, whereas the QW emission diminished from 10 K to 300 K. We confirmed that hybrid LEDs had zero-, one-, and two-dimensional behavior from a temperature-dependent time-resolved PL study. The radiative lifetime of the QDs was nearly constant over the temperature, while that of the QWs increased with increasing temperature, due to low dimensional behavior. Cathodoluminescence revealed spatial distributions of InGaN QDs, QWRs, and QWs on the vertices, edges, and sidewalls, respectively. We investigated the blue-shifted electroluminescence with increasing current due to the band-filling effect. The hybrid LEDs provided broad-band spectra with high internal quantum efficiency, and color-tunability for visible light-emitting sources.

Keywords: quantum dot, quantum wire, quantum well, light-emitting diodes