Enhanced efficiency of p-GaN/n-ZnO light-emitting diodes by using NiO and ZnSe interlayers

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We report the results from numerical simulations of p-GaN/n-ZnO light-emitting diodes (LEDs) with different architectures. p-GaN/n-ZnO, p-GaN/p-NiO/n-ZnO, and p-GaN/p-NiO/n-ZnSe/n-ZnO LED structures have been examinated using one-dimensional (1D) Schrödinger-Poisson solver simulator. We found that the presence of an additional p-NiO and n-ZnSe interlayers makes a profound impact on LED device performances such as luminance and efficiencies. Compared to p-GaN/n-ZnO LED devices the efficiencies of p-GaN/p-NiO/n-ZnSe/n-ZnO LEDs are overwhelmingly higher, specifically showing higher values of peak current efficiency of 12 cd/A, internal quantum efficiency of 82.2%, and external quantum efficiency of 16.4 %. We believe that such a comprehensive scheme in designing LED device architecture with wide-bandgap interlayers provides a reasonable guideline for practical realization of environment-friendly, high performance LEDs in the future.

Keywords— electroluminescence device, internal quantum efficiency, gallium nitride, zinc oxide, nickel oxide, zinc selenide.

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