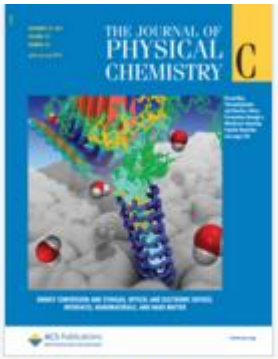

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Controlled Mixed Violet–Blue–Red Electroluminescence from Eu:Nano-Phosphors/ZnO-Nanowires/p-GaN Light-Emitting Diodes

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Abstract

Europium (Eu):Y2O3-nanoparticles/Mg:ZnO-nanowires/p-GaN and (Eu):chelate-based light-emitting diode (LED) structures have been fabricated, showing controlled mixed near-UV, violet, and red electroluminescence from trivalent europium. The magnesium (Mg)-doped ZnO (Mg:ZnO)-nanowires/p-GaN heterojunction were integrated into the LED structure and were covered on the top with the nanoparticle of yttrium oxide doped with trivalent europium ions (Eu3+:Y2O3) or by Eu:chelate. Samples exhibit mixed UV/blue light at ~384 nm coming from the Mg:ZnO structure and a sharp red emission at ~611 nm related to the intra4f transition of Eu ions. It is found that with Mg doping of ZnO, the emission wavelength of LEDs in the near-ultraviolet region is shifted to a smaller wavelength, thus being better adapted to the trivalent europium excitation band. Radiative energy transfer is achieved through the strong overlap between the emission wavelength from n-(Mg:ZnO)/p-GaN heterojunction and 7F0-5L6 absorption of Eu3+ ions in the case of Eu:Y2O3 or of the (Eu):chelate intensive absorption bands. Indeed, the (Eu):chelate/(Mg:ZnO)-nanowires/p-GaN structure appears to be more adapted to UV/blue and red dual emission than Eu:Y2O3, for which low absorption prevents efficient emission. Our results demonstrate that the designs of nano-LED structures and of the chelate ligands are crucial to enhance the performance of electroluminescence devices based on ZnO nanowire arrays and rare-earth metal complexes.