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Blue-red electroluminescence from hybrid Eu:phosphors/ZnO-nanowires/p-GaN LED

B. Viana, T. Pauporte, O. Lupan, L. Devis, T. Gacoin

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Abstract

Nanowire (NW) based light emitting diodes (LEDs) have drawn great research interest due to many advantages compared to thin film based devices. Marked improved performances are expected from nanostructured active layers for light emission. Semiconducting oxide nanowires can act as direct waveguides and favor emitted light extraction without use of lens and reflectors in LEDs. Moreover, the use of ZnO wires avoids the presence of grain boundaries and then the emission efficiency is boosted by the absence of non-radiative recombinations at the joint defects. In this context, europium (Eu):Chelate/ZnO:Mg-nanowires/p-GaN light-emitting-diode (LED) structures have been fabricated showing near-UV/violet electroluminescence and red emission from trivalent europium. Fabricated LED structures exhibit UV-blue light at about 380 nm coming from the n-(ZnO:Mg)/p-GaN and a sharp red emission at ~611 nm related to the intra-4f transition of Eu ions. It is found that in the case of the ZnO:Mg, the emission wavelength is slightly shifted to smaller wavelength to be well adapted to the trivalent europium excitation band. Radiative energy transfer is achieved through strong overlap between the emission wavelength from n-(ZnO:Mg)/p- GaN heterojunction and chelate ligand intensive absorption band. Indeed the Eu:chelate/(ZnO:Mg)-nanowires/p-GaN structure appears well adapted to UV/blue and red dual emission. Our results shows that the design of LEDs based on the chelate ligands are important issue to enhance the performance of electroluminescence devices based on ZnO nanowire arrays/p-GaN heterojunction and rare-earth metal complexes.