The effect of synthesis pressure on properties of Eu-doped ZnO nanopowders prepared by microwave hydrothermal method.

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Nowadays, rare-earth doped II-VI semiconductors attract a lot of attention due to their wide potential applications in biology and medicine, including biological labels, biosensors or drug delivery systems. One of the most popular and suitable host material for doping is zinc oxide ZnO. This semiconductor has a wide band gap (3.37 eV) and high exciton binding energy (60 meV). Last but not least, ZnO is nontoxic and biocompatible material. Among rare earth, Eu^{3+} ions have been investigated especially in view of their strong, sharp emission lines in red region.

In this work, the effects of synthesis pressure on the morphologies, crystal structures and optical properties of Eu-doped ZnO were analyzed by Scanning Electron Microscopy (SEM), X-ray diffraction (XRD), cathodo- (CL) and photoluminescence (PL).

ZnO nanopowders doped with 5 mol % of Eu were prepared by a microwave hydrothermal method using $(NO_3)_2$ Zn · $6H_2O$ and $Eu(NO_3)_3$ · $5H_2O$. The solutions were alkalized with aqueous ammonia solution (25%, Carl Roth) to pH=10. Hydrothermal process was conducted at 20, 40, 60, 80 and 100 bar by 20 min. The samples were dried overnight. All Eu-doped ZnO nanopowders were prepared with the same procedure to study the pressure dependence on properties of obtained samples.

First of all, the results revealed improvement in crystal structure with increasing synthesis pressure. From XRD patterns, most of the diffraction peaks could be indexed to wurtzite type ZnO structure (according to JCPDS card no. 36-1451), so majority of Eu^{3+} ions were doped into ZnO lattice. However, diffraction peaks from impurities were detected in samples obtained at pressures: 20, 40 and 100 bar. This fact corresponds with the results of PL investigations. PL spectrum for λ_{exc}=466nm indicates that in case of samples obtained at 60 and 80 bar, trivalent europium ions are doped into ZnO and located at a symmetry site C_{3V}. In the remaining samples (obtained at pressures 20, 40 and 100 bar), Eu^{3+} ions have taken a lot of different crystallographic sites. In addition, the near band edge (NBE) in PL spectrum of ZnO is absent in the sample prepared at 20 bar, suggesting the lowest crystallographic quality. The SEM images of Eu-doped ZnO nanopowders indicate that samples prepared at different pressures vary in shape and size.