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Temperature-dependence on the structural, optical, andparamagnetic properties of ZnO nanostructures

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Abstract

Violet-blue emitting ZnO nanostructures were synthesized by a microwave-assisted hydrothermal method followed by post-synthesis annealing at different temperatures. Scanning electron microscope analysis revealed a morphological transformation upon increasing annealing temperature from well-defined "flower-like" structure composed of ZnO multi-nanorods to randomly oriented worm-like ZnO nanostructures. Raman analysis showed that the E_2 (high) mode became sharper and stronger while the intensity of the phonon peak at 580 cm(sup-1) was gradually enhanced with the increase of annealing temperature. X-ray diffraction and X-ray photoelectron spectroscopy (XPS) measurements showed that all ZnO samples possess a typical wurtzite structure with high crystallinity and no other impurity phases were observed. A decreasing trend in the photoluminescence (PL) intensity of a strong broad violet-blue emission from ZnO nanostructures with increasing annealing temperature was also observed. The electron spin resonance (ESR) signal was also found to gradually decrease with increasing annealing temperature indicating the decrease in the concentration of zinc interstitials (Zn_i) and/or zinc vacancies (V_{Zn}) defects in ZnO nanostructures. Moreover, a combination of results from the PL, XPS and ESR suggested that Zn related defects; especially V_{Zn} and Zn_i are the primary source of the paramagnetism observed in the ZnO nanostructures.