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Characterization of the structural and optical properties of ZnO nanostructures by X-ray diffraction

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Zinc Oxide (ZnO) has been extensively investigated due to its unique properties such as wide direct bandgap energy, large exciton binding energy, and thermal stability. These characteristics make ZnO nanostructures interesting for application in ultraviolet (UV) light emitters, optoelectronic devices, and chemical sensors. Various methods have been utilized to synthesize ZnO nanostructures, such as metal-organic chemical vapor deposition, sol-gel methods, and the low temperature hydrothermal method. The hydrothermal method has been widely used to grow ZnO nanostructures on ZnO-seeded substrate because of its advantages including low-cost, low-temperature, electronic compatible, and suitable for large area substrates. The properties of ZnO produced by the hydrothermal method are dependent upon preparation parameters such as growth temperature, precursor concentration, and growth time. In this work, the structural and optical properties of hydrothermally grown Zinc oxide (ZnO) nanostructures with aqueous solution molarity from 10 mM to 50 mM were studied by measurements of X-Ray Diffraction (XRD) and temperature-dependent photoluminescence (PL). The ZnO nanostructures exhibit weak emission in the Ultra Violet (UV) region and a strong and broad yellow-orange emission peak. With increasing solution molarities, the relative PL intensity ratio of the emission in the UV region to the emission in the visible region first increases and then decreases. It implies that too higher solution molarity leads to the disorder of ZnO structures. To verify the results, the measured X-ray diffraction curves are analyzed by a theoretical model and the ZnO structure size distribution were calculated. The analysis shows that the structure size uniformity of hydrothermally grown ZnO is improved with appropriately increased aqueous solution molarity, which is consistent with the experimental results from the PL spectra. Furthermore, the calculated results of the size broadening effect of the samples are verified from the Scanning Electron Microscope (SEM) images.

Biography

Ya-Fen Wu received MS degree in Department of Electrical Engineering from National Central University, Taiwan, and PhD degree in Department of Electronic Engineering from Chang Gung University, Taiwan, in 1990 and 2007, respectively. Currently, she is with the Department of Electronic Engineering of Ming Chi University of Technology, Taiwan, as Professor. Her main field of research includes compound semiconductor materials and opto-electrical devices.

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