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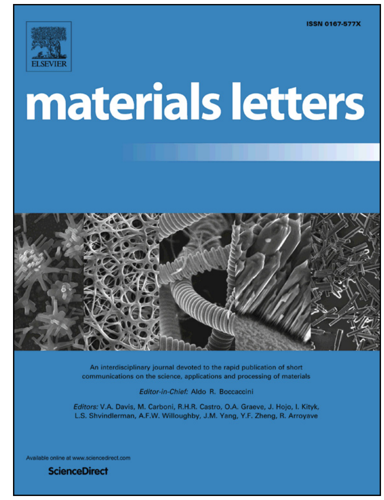

Quantum confinement effect and size-dependent photoluminescence in Laser ablated ultra-thin GZO films

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Quantum confinement effect and size-dependent photoluminescence in Laser ablated ultra-thin GZO films

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Abstract:

The structural, morphological, and optical characteristics of GZO ultra-thin films were investigated using XRD (X-ray diffraction), FE-SEM (field emission electron microscopy), in-situ EDS (Energy Dispersive X-ray) spectroscopy, UV-VIS-IR spectroscopy and photoluminescence spectroscopy (PL) respectively. Morphological analysis reveals the noodle, seed and particle like structure of GZO for GaN, sapphire and Si substrates respectively with average grain size ranging from 5 to 20nm. An effective mass model (EM-Model) for particle in a cylindrical wave function of e-h pair was correlated with experimental results. The reduction in FWHM value (from 31nm to 13nm) of NBE (near-band-edge) emission peak and enhanced NBE intensity have been achieved with small grain size. Blue shift in optical band gap is explained in term of grain radius by EM-model. Improved optical and structural properties were found in relation with quantum confinement effect. The current study states that grain size plays vital role in order to tailor optical properties of GZO thin films.

Keywords: Thin films, Luminescence, Laser Processing, Semiconductor, Epitaxial growth.

Introduction:

Zinc Oxide (ZnO) having wide and direct band gap (3.37eV) with comparatively large exciton binding energy (60meV) is regarded as one of the best candidate for replacing the rare earth transparent conductive oxides and other functional semiconductors [1]. ZnO based nanowires (NWs) [2] and nanorods (NRs) [3] have attracted much interest due to their unique electrical and optoelectronic properties in the field of modern device fabrication technology. Some recent studies show the obvious milestone in developing precisely controllable size and shape of ZnO nanoparticles (NPs) and NRs having excellent electrical and optical properties [4].

Beside these, the favorable doping elements in ZnO matrix is a hot issue in order to attain desired electronic and optoelectronic properties. Rare earth metals always produce deep alteration of spin dependent phenomena in ZnO NWs and NRs, this helps to establish a system with unique and enhanced functionality, such as sensitive