World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:10, No:07, 2016

Optical Characterization of Transition Metal Ion Doped ZnO Microspheres Synthesized via Laser Ablation in Air

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Abstract : ZnO is a semiconducting material with a direct wide band gap of 3.37 eV and a large exciton binding energy of 60 meV at room temperature. Microspheres with high sphericity and symmetry exhibit unique functionalities which makes them excellent omnidirectional optical resonators. Hence there is an advent interest in fabrication of single crystalline semiconductor microspheres especially magnetic ZnO microspheres, as ZnO is a promising material for semiconductor device applications. Also, ZnO is non-toxic and biocompatible, implying it is a potential material for biomedical applications. Room temperature Photoluminescence (PL) spectra of the fabricated ZnO microspheres were measured, at an excitation wavelength of 325 nm. The ultraviolet (UV) luminescence observed is attributed to the room-temperature free exciton related near-band-edge (NBE) emission in ZnO. Besides the NBE luminescence, weak and broad visible luminescence (~560nm) was also observed. This broad emission band in the visible range is associated with oxygen vacancies related to structural defects. In transition metal (TM) ion-doped ZnO, 3d levels emissions of TM ions will modify the inherent characteristic emissions of ZnO. A micron-sized ZnO crystal has generally a wurtzite structure with a natural hexagonal cross section, which will serve as a WGM (whispering gallery mode) lasing micro cavity due to its high refractive index (~2.2). But hexagonal cavities suffers more optical loss at their corners in comparison to spherical structures; hence spheres may be a better candidate to achieve effective light confinement. In our study, highly smooth spherical shaped micro particles with different diameters ranging from ~4 to 6 μm were grown on different substrates. SEM (Scanning Electron Microscopy) and AFM (Atomic Force Microscopy) images show the presence of uniform smooth surfaced spheres. Raman scattering measurements from the fabricated samples at 488 nm light excitation provide convincing supports for the wurtzite structure of the prepared ZnO microspheres. WGM lasing studies from TM-doped ZnO microparticles are in progress.

Keywords : laser ablation, microcavity, photoluminescence, ZnO microsphere
Conference Title : ICNOP 2016 : International Conference on Nanotechnology, Optoelectronics and Photonics
Conference Location : Stockholm, Sweden
Conference Dates : July 11-12, 2016