ABSTRACT

In this thesis, we describe our research on the *experimental fabrication* of various ZnO nanostructures namely, 1-D nanorods, nanotubes, nanobelts and nanopencils, 2-D nanosheets, spherical and octahedral nanostructures and quantum dots using a wet chemical and electrochemical fabrication process followed rigorous *structural and optical characterization*. We studied the effect of tailoring process conditions/ parameters of fabrication in realizing nanostructures of varying shape, size and morphology to understand the growth mechanism and to investigate the governing structure-property relationship for accurate prediction of the achievable optical characteristics. Crystallinity and purity of the fabricated structures were checked using XRD. FESEM and TEM were used for further microstructure and crystallinity study. The effect of varying the associated process parameters was studied systematically to determine the relevance of growth mechanisms of various nanostructures which is discussed here in details. The fabricated 1-D nanostructures exhibit violet PL due to the existence of defects in the chemically grown nanocrystals except nanobelts, which exhibit UV PL due to direct band-to-band transition. In the 2-D ZnO nanostructures, directional growth was observed for hexamine assisted growth. But the structures are not environment friendly as they are disrupted in presence of moisture. Benzene, in this regard, was found to be very effective. ZnO nanosheets grown with benzene show better crystallinity and less defect states; however, the PL spectrum is very similar as that of the hexamine assisted grown samples. In 3-D structures, rarely observed octahedral ZnO nanostructures were fabricated without any surfactant that exhibits strong singular violet PL being a very rare finding. Spherical ZnO was fabricated by a two-electrode based electrochemical process. The microstructure depends on the concentration of the electrolyte solution and growth duration. We also fabricated ZnO monopods and bipods, which exhibit visible PL. The shift of PL peak occurs due to strain in the thin film. Finally, we realized ZnO quantum dots which exhibited size dependent optical properties. By varying the alkaline precursor concentration, the dot size was tailored to achieve tunability of PL emission. Thus, our investigation will be extremely useful for research and device application in optoelectronics, nanophotonics and Spintronics.

Keywords: Zinc oxide; nanostructures; wet-chemical method, electrochemical method, photoluminescence, defect emission.