Title of the Thesis: Synthesis of ZnO Nanorods by Microwave Irradiation of Precursor Solution and Study of their Process Parameters

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Session: April, 2017
Degree Name: M.Phil.
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Abstract

Zinc oxide (ZnO) nanorods in the form of hexagonal prismatic shape have been successfully synthesized by a simple one step microwave assisted irradiation process using a customized domestic microwave oven. The effects of different process parameters such as precursor reagents, synthesis time, precursor concentration, etc. have been studied. A domestic oven is customized for microwave irradiation during synthesis of ZnO nanorods and a position with high energy density is located within the microwave oven chamber to ensure efficient heating of the precursor. The morphological, structural and optical properties of the ZnO nanorods are studied using a scanning electron microscope, powder X-ray diffraction and UV-Vis spectroscopy. ZnO nanorods with the smallest diameter of about 300 nm has been synthesized when zinc nitrate precursor is used, but the average diameter of the ZnO nanorods increases with the precursor concentration and synthesis time. It is observed that depending on the concentration of the precursor diameter of the ZnO nanorods vary from 300 to 500 nm and the length varies in the range 1.8 – 3.5 μm. The average length of the ZnO nanorods increases with the precursor concentration up to an optimum value of 15 mM. There is also an increase in the average length (1.5 – 4.0 μm) associated with a comparatively slight increase in diameter, when synthesis time is not more than 20 min. Length to diameter ratio varies from 3.7 to 8.3 for various synthesis conditions. The best length to diameter ratio of the synthesized ZnO nanorods was obtained with an optimum concentration 15 mM and synthesis time 20 min using the customized system with basic precursor solution using the customized system. All samples have strong absorption in the UV region and the band gap values calculated from these absorption edge varies between 3.19 eV to 3.30 eV, very near to the standard value of 3.40 eV. XRD spectra confirms the hexagonal wurtzite structure of the ZnO nanorods and EDAX study confirms the purity of the nano-rods. The atomic percentage of Zn and O are almost near the standard stoichiometric ratio. The nanorods has a higher dielectric constant value at room temperature for lower frequency region, which decreases with increasing frequency and attain a low and constant value.