Photoluminescence and Magnetic Photoluminescence Studies of Cobalt Doped ZnO Nanorods

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Objectives: The main objectives of this study are : 1) to understand the role of metallic dopants in mediating the optical properties of ZnO nanorods, 2) to understand the defect distribution in ZnO nanorods with various levels of doping and 3) to explain the luminescence spectra of Cobalt Doped ZnO nanorods using photoluminescence (PL) and magnetic Photoluminescence (Magnetic PL)

Methods: Cobalt doped ZnO nanorods were prepared by a chemical bath deposition process describes in previous studies. In this study we fabricated five samples with cobalt doping ranging in atomic percentage from 5 % to 25%. PL intensity was measured in these samples from 4K to 300K. In addition, we also investigated the changes in PL intensity at 4K for magnetic field ranging from 0 to 7 Tesla.

Results: The major results of this study can be summarized as follows: 1) The PL intensity of the Co defect (about 440 nm) was measured for each sample. The activation energy of the defect peak gradually decreased with increasing cobalt concentration (From 59.75 meV – 32.28 meV). 2) For the oxygen related defect peak around 550 nm, activation energy increases with cobalt concentration (30.61 meV - 66.49 meV). In Magnetic PL studies of 10% and 25 % Cobalt doped ZnO samples; we observe an increase in PL intensity with higher magnetic field.

Conclusion: Decrease in activation energy with cobalt concentration may be due to defect mediated radiative recombination via energy levels in the forbidden energy gap, which act as traps. Increase in magnetic PL at higher magnetic field in heavily doped ZnO samples may be an indication of the magnetic field assisted transport processes in cobalt doped ZnO.