Abstract

The synthesis and study of nanomaterials have become a major rising area of research over the past few years. Semiconducting nanoparticles play a vital role in several latest technologies, which give rise to their potential applications in the fields of field emitters, photo detectors, nano lasers, light emitting diodes, chemical sensors, photo-electrodes and supercapacitors etc. One of the most popular topics of nanostructured materials is the transition metal ions/ rare earth ions doped ZnO nanoparticles. The synthesis process is a key factor for the doped ZnO nanoparticles considering the factors of quantum size effect and the position of dopant ions within the nanostructred ZnO. It is to be noted that several interesting phenomena like high luminescence quantum efficiency, shift and broadening of spectrum have been observed.

Influence of synthesis route on the morphology of the grain and there by modulation of different properties like optical, magnetic and dielectric of the undoped and doped semiconducting ZnO nanoparticles have been investigated in this research work. X-ray diffraction study exhibits that all the samples are polycrystalline in phase with hexagonal structure (wurtzite). FESEM analysis shows that all the nanomaterials are rod like structure. UV-Vis measurement reveals the remarkable control over the charge density of semiconducting host nanomaterial with the occupancy of dopant ions within the ZnO lattice structure. In photoluminescence spectra, sharp peaks have been observed in the UV region but no convincing peak has been detected in visible region. The synthesis mechanism dependent morphology and morphology oriented properties of all samples are the characteristic aspects of our research work. Till now this has not been used considerably by anyone else to modulate the dielectric properties. The dielectric property depending upon frequency as well as temperature of all samples has been investigated minutely. The well known, hydrothermal synthesis mechanism leverages the growth process of the nanomaterials favoring the rod like morphology and the co-precipitation synthesis method allows the growth mechanism of the nanoparticles mostly towards spherical in nature and the dopant influences the charge density, the defect density and the nature of defects within the structure of ZnO nanomaterials which have been suggested by the dielectric measurement. All the observation of semiconducting ZnO nanomaterials make it more productive for convenient applications in various magneto-dielectric appliances.

Different theoretical models introduced by various research groups have been presented in our work.

Soumyaditya Sutradhar
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Dr. Soumyaditya Sutradhar
Assistant Professor
Department of Physics
Jadavpur University

Tanumoy Debnath

Prof. Sukhen Das
Department of Physics,
Jadavpur University
Kolkata-700032
16/03/2022

Organization of the thesis

Chapter 1 gives an introduction and a brief literature review of the thesis. The novelty of our research work and the objective of the thesis are also provided in this chapter. All together, the doped ZnO systems are very much influential for leading electronic, optoelectronic, spintronic and quantum device fabrications.

Chapter 2 describes different preparation and characterization techniques used in this thesis. For the synthesis of undoped and doped ZnO nanoparticles, co-precipitation and hydrothermal synthesis method have been used. Mainly XRD and FESEM instrument have been used to characterize the synthesized nanoparticles and to study various properties of the nanomaterials, UV-VIS and PL spectroscopy, SQUID magnetometer and Dielectric measurement instrument have been used.

Chapter 3 discusses the optical, magnetic and dielectric properties of undoped and yttrium doped ZnO nanorods. Here, the structural parameters have been extracted from the XRD patterns. The synthesized nanoparticles are rodlike in nature. The optical property study shows that the doping may enhances the oxygen vacancies and intrinsic defects. So, these nanomaterials are suitable in various device applications.

Chapter 4 describes the dielectric property study of undoped and chromium doped ZnO nanorods. The increase in band gap with the decrease in particles size which has been observed for all the rodlike samples is called quantum confinement. Also, the high value of dielectric constant makes it useful in charge storage devices.

Chapter 5 addresses the structural and ferromagnetic properties of chromium doped ZnO nanoparticles. Here, the synthesis mechanism is considered to be favorable to produce lattice strain within the structure of the lattice to regulate the optical and magnetic properties. The oxygen vacancy defect plays the crucial role to increase the ferromagnetic ordering within the specimens.

Chapter 6 gives the structural, morphological and charge transport properties study of chromium doped ZnO nanomaterials. Here, synthesis mechanism dependent properties have been studied. The structural parameters of Cr-doped ZnO nanomaterial synthesized by co-precipitation and hydrothermal method have been calculated from Rietveld analysis. The dielectric constant of hydrothermally synthesized rod like nanomaterials is complementary to that of the spherical nanoparticles synthesized by co-precipitation method.

Chapter 7 addresses the reprint of the published papers.

Tanumoy Debnath

Dr. Somyaditya Sutradhar
Assistant Professor
Department of Physics
Jadavpur University
Kolkata-700032
16/03/2022

Prof. Sukhen Das
Department of Physics,
Jadavpur University
Kolkata-700032
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