Conclusions and future scope

Conclusions

Semiconductor nanoparticles are being studied by large number of groups for their various important properties and subsequent applications. Among these materials, II-VI semiconductors are forming a group of materials which are known for their interesting properties like luminescence, wide band gap and recently considered as DMS. The main reason why these materials are being studied extensively is that the quantum confinement effect can be observed easily in these materials.

In this work we have demonstrated simple chemical routes to synthesize zinc oxide nanoparticles. Chemical capping was used to control the size as well as to achieve the stability. Thioglycerol capped nanoparticles with various sizes ranging from 2.6 to 6.5 nm have been synthesized. Particles remained stable over a long period of time. EMA and TB models were used to calculate the particle size. Size distribution calculated showed that particles are fairly monodispersed. Characterizations like UV-Vis absorption, XRD, PL, TEM, FTIR, XPS were employed to investigate various properties of ZnO nanoparticles.

Doped zinc oxide nanoparticles using europium (rare earth) and cobalt (transition metal) have been synthesized using chemical routes. Europium doped ZnO nanoparticles were studied for their luminescence properties as the rare earth ions are considered to be the excellent luminescence centers when doped in any host materials. Doping percentages were varied from 0.3% up to 7%. Annealing was varied out to study its effect on the optical properties of Eu doped ZnO. Particles were studied using techniques like UV-Vis absorption, PL, XRD, FTIR and XAS. Luminescence due to Eu$^{3+}$ ions could be observed in annealed samples having high doping percentages (above 3%). EXAFS and XANES study showed that the particles have core-shell type of structure in which ZnO core is surrounded by Zn(OH)$_2$ shell. From fitting the EXAFS data with standard models it was concluded that europium ions have oxidation state of 3+ and they are present on the surface and not inside of the ZnO particles. An interesting thing was noticed in case of 0.3% Eu doped ZnO where after annealing some part of the Eu$^{3+}$ had converted to Eu$^{2+}$.

ZnO has been reported to be the possible material for DMS. We choose to investigate the Co doped ZnO nanoparticles. Cobalt doped ZnO nanoparticles were
synthesized using a chemical route. The particles were capped using olefamine. Doping percentage was varied from 1% to 5%. Co:ZnO nanoparticles were studied for the structural as well as their magnetic properties. XAS studies were employed to know whether Co is incorporated into ZnO lattice. Studies revealed that Co is indeed located at the site of Zn or it is substitutionally doped. But ferromagnetic properties could not be observed in the samples.

Due to growing interest for synthesizing materials with novel morphologies, we chose the topic of ZnO micro particles. The particles were synthesized using chemical route in autoclave at high temperature. Particles in the size range of 250 nm to 3 μm have been synthesized. The particles were found to be having cavity of the size of few hundred nanometers. The particles were characterized using different techniques like X-ray diffraction. Scanning electron microscopy, X-ray photoelectron spectroscopy, UV-Vis absorption spectroscopy etc. A growth model has been given for the ZnO microparticles with cavity based on the observations in scanning electron microscopy analysis.
Future scope

Rare earth doped II-VI semiconductor nanoparticles are considered to be important phosphor materials for the applications like flat panel displays, field emission displays etc due to the rare earth ions give rich emission lines in visible regions. Few of the rare earth ions have been studied in ZnO as a host material. But still many elements can be doped into ZnO and studied for their luminescence. One can study these materials in the application point of view. Effect of rare earth doping on the cathodo-luminescence as well as field emission properties of ZnO can be studied, which will help in designing the display devices. ZnO:Eu material studied in this work is one such material which can be considered for above said applications.

Diluted magnetic semiconductor and specially ZnO based DMS is still an important topic. Still it is not yet known whether ferromagnetism observed in case of TM doped ZnO originates from the doping or something else. One can study these materials extensively to know the exact answer of this problem.

In case of microparticles of ZnO, one has to study the effect of different morphologies on the various properties viz. optical, electrical etc. of ZnO. Then by using these properties size and shape dependant properties one can use the material in many applications. ZnO micro spheres with cavity, studied in this case can find the use in drug delivery as one can use the cavity for storage of the drug. Core shell particles can be synthesized using the ZnO microspheres on which shell of various metal, semiconductor nanoparticles can be grown and their properties can be studied.