SYNTHESIS, CHARACTERIZATION AND PHOTOPHYSICAL STUDY OF LOW DIMENSIONAL INORGANIC/ORGANIC MATERIALS

Synopsis

BY

SADHAN SAMANTA

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Department of Chemistry & Chemical Technology
Vidyasagar University
Paschim Medinipur
West Bengal
Pin-721102

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Synopsis

My thesis entitled ***"SYNTHESIS, CHARACTERIZATION AND PHOTOPHYSICAL STUDY OF LOW DIMENSIONAL INORGANIC/ORGANIC MATERIALS"*** contains the work carried out in the Department of Chemistry and Chemical Technology, Vidyasagar University, Midnapore, Paschim Medinipur, W.B., PIN-721102, India under the supervision of Prof. Ajay Kumar Misra. This thesis comprises seven chapters.

Chapter I:

This chapter incorporates general introduction on low dimensional materials. This chapter discusses briefly the comparison between bulk and low dimensional materials, classification of low dimensional materials dimension wise and composition wise including nanoparticles and microparticles, various examples of nanoparticles and microparticles, their properties including optical, magnetic, electrical, thermal, mechanical and structural properties. Surface plasmon resonance (SPR) of metal nanoparticles, quantum size effect, Mie theory, luminescent properties, non-linear optical (NLO) properties are intricately discussed in the optical properties section. This chapter also depicts the applications of low dimensional materials in several fields including catalysis, sensor, medical, optical, electronics, information storage, energy, magnetic, thermal and waste water treatment fields.

Chapter II:

This chapter describes various methods for the synthesis of low dimensional materials, including both bottom-up and top-down approaches. Mechanism of particle formation in the bottom-up approach has been discussed. Four different stabilization processes viz. electrostatic stabilization, steric stabilization, electrosteric stabilization and stabilization by ligand or solvent are described in this chapter. This chapter also accounts the various methods for the synthesis of organic low dimensional materials.

Chapter III:

This chapter concisely discusses various characterization techniques of the synthesized low dimensional materials such as UV-Vis spectroscopy, Fluorescence spectroscopy, transmission electron microscopy (TEM), selected area electron diffraction (SAED), scanning electron microscopy (SEM), Optical, polarising and fluorescence microscopy, X-ray diffraction (XRD) spectroscopy, Fourier transform infrared spectroscopy (FTIR).

Chapter IV:

This chapter describes the synthesis of silver nanostructures of varying morphologies through a simple seed mediated growth approach. Seeds are prepared by reducing silver nitrate with sodium borohydride, and trisodium citrate is used as capping agent. This citrate capped seed sol is mixed to the growth solution containing ascorbic acid, sodium dodecyl sulphate (SDS) and sodium hydroxide. Colour of the growth solution changes from colourless to pink and the surface plasmon resonance (SPR) shows two distinct bands, indicating the formation of anisotropically grown silver nanostructures. Synthesized silver nanoparticles are characterized by UV-vis spectroscopy, transmission electron microscopy (TEM) & X-ray diffraction (XRD) techniques. Silver nanoseeds are spherical in shape with diameter ranges from 8-16 nm. On the other hand, a mixture of morphologies with shapes like triangular and hexagonal nanoplates, nanorods are obtained in the growth solution. XRD results suggest that the particles are crystalline in nature with face centered cubic (fcc) geometry.

Chapter V:

This chapter presents synthesis of silver nanodiscs and triangular nanoplates in aqueous PVP matrix, their photophysical study and simulation of UV-vis extinction spectra using DDA method. Circular silver nanodiscs and truncated triangular shaped silver nanoplates have been synthesized through a seeding growth approach in polyvinyl pyrrolidone (PVP) matrix at room

temperature. Seeds are prepared on reduction of silver nitrate ($AgNO_3$) by sodium borohydride ($NaBH_4$) and methyl cellulose (MC) is used as encapsulating matrix. Coloured silver sols are obtained as variable amounts of seeds are added to the growth solution containing silver nitrate, polyvinyl pyrrolidone (PVP) and ascorbic acid. Silver nanostructures are characterized using UV-vis spectroscopic and transmission electron microscopic (TEM) study. TEM studies reveal that particles are mostly circular disc and truncated triangular plate like as different amount of seeds are used in the growth solution. Simulation of UV-vis extinction spectra using discrete dipole approximation (DDA) method nicely explain the observed localized surface Plasmon resonance (LSPR) band of spherical and circular disc like silver nanoparticle.

Chapter VI:

This chapter describes synthesis of ZnO microcrystals with hexagonal morphologies via a fast and facile hydrothermal route using hexamethylene tetramine (HMTA) as reducing and hydroxylpropyl methyl cellulose (HPMC) as morphology directing agent. In the absence of HPMC, hexagonal rod shaped ZnO microcrystals are formed where as hexagonal bar and both end open hexagonal bar shaped structures are obtained in the presence of different amount of HPMC. Synthesized ZnO microstructures are characterized using XRD, SEM and fluorescence spectroscopic study. The strong asymmetric blue emission band from ZnO micro rod has been explained due to the presence of extended Zn_i states within the microcrystals. Photo catalytic activities of the microcrystals are investigated by monitoring the photochemical degradation of Methylene Blue. It has been observed that the catalytic efficiency of hexagonal both end open bar shaped ZnO microcrystals is higher than the other ZnO structures.

Chapter VII:

This chapter presents synthesis of N-doped carbon nanodots through a fast and facile microwave assisted synthesis method using polyethylene glycol (PEG-200) as carbon source and urea as nitrogen precursor. The prepared N-doped carbon nanodots exhibit bright blue emission under UV-light (365 nm) and excellent stability in aq. solution. Factors affecting the FL emission intensity have been analyzed and nanodots are prepared at optimized conditions. The prepared nanodots are characterized by UV-Vis absorption spectroscopy, Fluorescence emission spectroscopy and FT-IR study. We find that the synthesized N-doped carbon dots can be used as fluorescence turn-off sensors for Fe^{3+} ions.