Abstract

The thesis describes some simple and facile synthesis of water soluble stable nanomaterials for optical spectroscopy-based studies such as sensing, localized surface plasmon resonance (LSPR) tuning. This also provides an understanding of the role of capping agents toward optical properties and sensing applications of nanocrystals (NCs). Here, a simple one-pot hydrothermal synthesis of 3-mercaptopropionic acid (MPA)-capped, water-soluble CdS quantum dots (QDs) with highly tunable optical properties has been carried out avoiding additional sulfur precursor. MPA played a dual role, both as source of sulfur and a stabilizer. The observed broad and large Stokes shifted photoluminescence (PL) of QDs arises from the trap states. Coordination of Co^{2+} or Ni^{2+} with MPA-capped CdS QDs (MPA-CdS QDs) through the carboxyl group of MPA provides a turn-off PL-based assay for sensitive detection of these metal ions without any interference from other commonly coexisting metals. Again, the lower stability of the Co(II)-MPA complex than the Ni(II)-MPA complex enables disodium ethylenediaminetetraacetic acid (EDTA)-induced, time dependent turn-on PL-based protocol to distinguish Co^{2+} from Ni^{2+}. An exploration of the importance of the structural effect of mercapto acids as capping agents on the PL properties as well as metal ion sensing selectivity of QDs have been attempted. The side chain alkyl group of mercapto acids as capping agent facilitates the selective detection of metal ions *via* exclusive surface adsorption of QDs by metals and this is evident from selective sensing of Ag (I) by thiolactic acid (TLA)-capped CdTe QDs and Cu (II) by TLA-capped CdS QDs. The pendant methyl group of TLA effectively impedes the secondary coordination of carboxyl oxygen with the surrounding metal ions, which results in high PL intensity of QDs and also exclusive surface adsorption of QDs by metal renders sensing selectivity. Herein for the first time, the synthesis of silver nanoparticles (Ag NPs) *via* complete photo-degradation of water soluble azo-food-colorants has been successfully carried out, which can also be an eco-friendly way for environmental remediation of toxic dye stuffs. Use of substantially low concentration (50 μM) of cetyltrimethylammonium bromide (CTAB) as a stabilizer, leads to much less surface coverage of Ag NPs and facilitates the detection of ions or small molecules through the interaction between the metal surface

and additives. Ag NP provides a turn-on fluorescence-based assay for selective dual detection of either S^{2-} or CN^{-} just by masking one of them in their mixture. A new and simple method has been developed for reversible LSPR tuning with the dilute CTAB-stabilized Ag NPs through cyclodextrin (CDx)-induced formation and subsequent surfactant-induced dispersion of nano-aggregates, without insertion of any self-assembling molecule within the aggregates.

Keywords: quantum dots, mercapto acids, dual role, optical properties, photoluminescence, sensing, metal ions, secondary coordination, structural effect of mercapto acids, exclusive surface adsorption, nanomaterials, photo-degradation, azo-food-colorants, eco-friendly, environmental remediation, dual sensing, anions, small molecules, reversible LSPR tuning, self-aggregation, cyclodextrins, surfactants.