Preface

This thesis summarizes the methods of preparation and optical properties of hybrid assemblies of Au NPs and cadmium selenide (CdSe) QDs. First chapter deals with the literature survey and theoretical aspects of plasmonics and discussions on optical excitations of metal (plasmons) and semiconducting QDs (excitons). Variation of energy levels of CdSe QDs and its optical properties i e. absorption and emission properties under strong confinement regime have been discussed with respect to effective mass approximation (EMA) model. This is followed by the discussion on optical properties of Au NPs and rods, describing absorption properties, based on Mie theory. Size and shape dependent variation of absorption properties. Theoretical discussions of collective effects in QDs assemblies and plasmonic interactions with the QDs assemblies i.e. plasmonic Dicke effect and metal nanoantenna interaction with CdSe QDs arrays is provided.

In the second chapter a discussion on experimental techniques used for the study is provided. It starts with a discussion on the synthesis methods for CdSe QDs and Au NPs/rods with different capping ligands. Different techniques of preparation of CdSe QDs assemblies and their hybrid with metallic nanoparticles has been discussed. Further discussion on optical microscopy techniques, confocal, near field scanning microscopy (NSOM), Brewster angle microscopy and electron microscopy techniques i. e transmission electron microscopy and scanning electron microscopy and thermogravimetry analysis of the samples is provided.

In the third chapter the details of the different self-assembly methods of preparation of hybrid assemblies of CdSe QDs and Au NPs /rods are given. The different strategies are used for different type of hybrids. In first method of Langmuir-Blodgett (LB) , effect of different capping agents, core size, and number ratios of Au NPs/rods to CdSe QDs, effect of anisotropy of Au NPs on the LB films of CdSe QDs assemblies is discussed. In another method of dip coating several control parameters like dip time, concentration of the solution and dip speed of transferring an aligned GNRs is given. Finally a combination of LB and dip coating methods is described for transferring aligned GNRs over a compact layer of CdSe QDs. At the end, a section is devoted to hit and trials of self-assemblies of hybrid of GNRs and CdSe QDs using LB method, the failures of which resulted in devising a method which uses a combination of LB and dip coating.

In fourth chapter effects of plasmons on the collective emission of CdSe QDs assemblies are investigated. A plasmonic tuning of photoluminescence from semiconducting QD assemblies using Au NP in different ratio and different packing density has been discussed. We have described how the emission from a closed pack assemblies, prepared with different packing densities depends on the packing density and extent of spectral overlap between QD photoluminescence and the metal nanoparticle absorbance. We have provided possible evidence for plasmon mediated coherent emission enhancement from some of these assemblies from the case of strong spectral overlap between CdSe QDs and Au nanoparticle.

In fifth chapter, we have demonstrated non local far field enhancement of PL in QDs assemblies induced by isolated and partially aligned GNRs nanoantenna located on such assemblies. It is shown that the emission is also anisotropic with the maxima being near such GNRs assembly which decays to finite, nonzero and significantly large values even away from the vicinity of any such assemblies. For this novel effect it is shown to have a clear spectral dependence. It is shown to be maximum when the longitudinal surface plasmon resonance absorption maxima is resonant with the CdSe QD photoluminescence maxima and the excitation wavelength and is always non-existent for the off resonant case. We have also shown that finite difference time domain simulations could model some of the observed near field effects but the far field effects could not be modelled in such simulations.