Dedicated to

My

Parents and Teachers
PREFACE

Metal nanoparticles play a central role in the emerging technological revolution that is pushing optics past the diffraction limit and fully into the nanometer size regime. The field of metallic nanostructures is now more popularly called plasmonics, since the major manifestation produced by optical excitations is the collective oscillation of electrons, which are localized along the interface. Among the various metal nanoparticles, gold nanoparticles are of particular interest due to their unique and tunable surface plasmon resonance over the visible and near-infrared region. The optical properties of gold nanoparticles hold considerable promise for applications in catalysis, electronics, optics, optoelectronics, surface enhanced Raman scattering (SERS), optical data storage and biological and chemical sensing. This thesis deals with the colloidal synthesis of gold nanoparticles of different shapes and sizes. Investigations made on the influence of size and shape of gold nanoparticles on its plasmonic behaviour is discussed in detail. In addition, attempts have also been made to understand the surface enhanced Raman scattering, nonlinear optical and biological activities of these nanoparticles.

The first chapter gives an introduction to nanotechnology, nanomaterials, surface plasmons in metal nanoparticles, gold nanoparticles and its applications. A brief review of earlier studies made on Au nanoparticles is also provided. The second chapter discusses the various diagnostic techniques used in the analysis of the samples. UV-visible absorption spectroscopy, photoluminescence spectroscopy, Fourier transform infrared spectroscopy, surface enhanced Raman spectroscopy, nonlinear optical transmittance measurement using Z-scan technique, high-resolution transmission electron microscopy and X-ray diffraction technique were used for the characterization of the samples.
Third chapter discusses the synthesis of borohydride reduced Au nanoparticles with polyethylene glycol (PEG) as the stabilizing agent. The action of PEG as a stabilizer and reducing agent is found evident in the study and the effect of pH on the plasmonic behaviour is discussed in detail. The samples are found to be suitable as SERS substrates for 2-aminothiophenol (2-ATP) and crystal violet (CV) as probing molecules. The SERS activity and the nonlinear optical properties are found to be sensitive to size of the particles formed.

Investigations made on the seed-mediated synthesis of rod shaped Au nanoparticles form the fourth chapter. The influence of concentrations of silver ions, seed, ascorbic acid and pH of the growth solution on the aspect ratio of the Au nanorods is discussed in detail. Au nanorods obtained in this study were tested for Raman activity using 2-aminothiophenol (2-ATP) and crystal violet (CV) as probing molecules and the influence of aspect ratio on the enhancement factor was investigated. The results indicate that the nanorods obtained under optimum growth conditions are highly Raman active and can be used as SERS substrates. Investigations on the dependence of nonlinear absorption in relation to the aspect ratio of Au nanorods using open aperture Z scan is also discussed in detail.

In the fifth chapter the green synthesis of Au nanoparticles using Cinnamomum zeylanicum and Vitis californica leaf broth is discussed. The properties of the gold nanoparticles formed are found to be highly sensitive to the concentration of the extract. At lower concentrations of the extract, formation of triangular shaped Au particles is found to dominate, while at higher concentrations almost spherical particles are observed. The influence of morphology of the samples on the SERS activity is discussed in detail. Attempts were also made to understand the photoluminescence, antibacterial and antifungal properties of these samples and are also discussed.

The sixth chapter deals with the synthesis and characterization of bimetallic Au-Ag nanoparticles. The variation in surface plasmon resonance with different Ag concentrations is discussed in detail. The seventh chapter gives the summary of the present work.
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