Abstract

The presentation principally engrosses the syntheses and characterizations of a variety of nanomaterials and their useful applications in catalysis and surface enhanced Raman spectroscopy (SERS). In first chapter, a brief discussion on nanomaterials with an overview of current research area associated with their applications in the advanced field has been presented. In the second chapter, gold nanoparticles with different (negative and positive) surface charge have been admitted for discriminating charged analytes through SERS studies as the case may be. The results have been well documented from electrostatic field originating from the nanoparticle surfaces and have been successfully interpreted with density functional theory. The third chapter describes a facile synthetic strategy of ferromagnetic nickel nanoparticles exploiting commercial cation exchange resin. XPS study authenticates the presence of a thin oxide layer over the nickel nanoparticles surface. Then enhanced SERS spectra from a chosen chelating ligand 1,10-phenanthroline over the nanoparticles were confirmed as a result of Ni(II)-1,10-phenanthroline complexation. The time-dependent surface complexation of the chemically anchored probe molecule 1,10-phenanthroline has been studied kinetically and finally the observation was verified with other chelating ligands also. In fourth chapter, a facile wet chemistry approach for surfactant assisted synthesis of prickly nickel nanowires through hydrazine reduction has been presented. To have a general conclusion, related reaction parameters have been varied and studied systematically. Finally nickel@gold bimetallic nanocomposites were fabricated in different time scale employing redox transmetalation of the prickly nickel wires with $HAuCl_4$. Catalytic and SERS activity of the as-synthesized materials have been investigated to put forward a mechanistic interpretation. Chapter five presents an ammonothermal methodology for hierarchical synthesis of β-$Ni(OH)_2$ nanostructures. Ammonia assisted shape transformation for the material has been achieved and reported here for the first time. The materials have been used in photocatalytic and SERS studies. Finally, in chapter six, a commercially available Raman reporter has been exploited for selective recognition of Cu(II) ion in aqueous solution. The recognition has been quantitatively assessed with

SERS studies and the selectivity as well as sensitivity of the method guarantees the analytical superiority of SERS.

***Keywords*:** Nanoparticles, SERS, Electrostatic Field, Chelate Effect, Redox Transmetalation, Catalysis, Shape Transformation and Recognition.