Abstract

The thesis principally engrosses the syntheses of different composite and faceted nanomaterials for their useful applications in spectroscopy, catalysis and plasmonic photocatalysis. In the first chapter, a brief discussion on size, shape and facet dependent synthesis of nanomaterials with an overview of current research area associated with their applications in the advanced field has been presented. The second chapter describes the synthesis of morphologically different Cu_2O nanoparticles with different hydrolyzing agents, complexing agent and reducing agents. Then morphology and composition change of the as synthesized Cu_2O particles have been envisaged by using different etching agents such as NaOH, triethylamine (TEA) and oxalic acid. Among them only oxalic acid causes facet selective etching of Cu_2O. Finally the differences in the rate of photocatalytic reactivity have been interpreted considering the exposed facet and surface area. Third chapter involves precursor salt assisted synthesis and reshaping of two different polyoxometalates [$(NH_4)_2Cu(MoO_4)_2$ (ACM) and $Cu_3(MoO_4)_2(OH)_2$ (CMOH)] of varied shapes. Then their facet dependent photocatalytic activity has been studied for dye degradation under visible light irradiation and the importance of high-index facets over low-index facets has also been documented. In fourth chapter, a redox transformation approach for obtaining hierarchical Au-CuO nanocomposites has been presented. There the as-obtained Au-CuO nanoflowers, owing to the hierarchical assembled structure, show higher SERS activity with 4-aminothiophenol while compared with the individual components (Au or Cu_2O or CuO). Additionally the derived Au–CuO nanocomposite becomes a potent catalyst that exhibits demonstrable clock reaction with methylene blue and ascorbic acid in solution. Chapter five describes the size and shape controlled synthesis of CuO-MnO_2 composite nanomaterials from time dependent redox transformation reaction between Cu_2O and $KMnO_4$. Here, all the nanocomposites exhibit high surface area due to porous structure and hence become effective catalyst for nitroarene reduction. The last chapter embodies the syntheses of three different semiconductor-based composite nanomaterials (Cu-ZnO, Cu-Cu_2O-ZnO, and Cu_2O-ZnO) with n-p hetero-junction and metal semiconductor junction by varying complexing agents from the same experimental condition. Visible light driven photocatalytic activity of all the composite nanomaterials has been investigated for a mechanistic interpretation. Interestingly, the ternary nanocomposite, Cu-Cu_2O-ZnO exhibits higher photocatalytic activity than the other two binary nanocomposites due to the extended light absorption, effective transfer of photogenerated carriers and presence of strong SPR effect.

Keywords: Faceted nanomaterials, Nanocomposites, Redox transformation, Reshaping, Etching, Catalyst, SERS, Photocatalysis, Plasmonic photocatalysis