Thesis title:

Hollow Nanostructures of Copper and Cerium Based Multifunctional Oxides

ABSTRACT

Hollow nanomaterials are an important class of nanostructures, having characteristics of low mass density, large surface areas, high porosity, fast ion and mass transport and good strain accommodation. These properties make hollow nanostructures highly important for application such as electrode materials for energy devices, catalysis, photocatalysis, sensing, drug delivery etc. Cooper and cerium based metal oxides and their doped nanostructures are widely investigated nanomaterials for the above mentioned applications. The work presented in the thesis deals with the synthesis of hollow nanostructures of CuO, CeO_2, $Cu_{1-x}Ce_xO$ and $Ce_{1-x}Cu_xO_2$ ($0 \leq x \leq 0.2$). Hollow nanostructures of CuO can be formed at low temperatures and ambient pressure by applying the soft templating effect provided by the confinement of droplets in miniemulsion systems. Hollow nanostructures of CeO_2 can also be synthesized in inverse miniemulsions at room temperature. The synthesized hollow nanostructures show enhanced gas sensing, catalytic, magnetic and optical properties as compared to their solid counterparts. The results obtained from various synthesis procedures and applications are summarized in 6 chapters. Few of the major outcomes of the work are:

(1) Metal-ion surfactant interaction plays an important role in stabilization of hollow nanostructures of CuO, where growth can be explained by a mechanism involving both diffusional and reaction control.

(2) Evolution in the morphologies from hollow to solid type nanostructures is observed for CeO_2 nanostructures with increasing precursor and Cu^{2+} dopant concentrations.

(3) Large increase in the catalytic activity of CuO hollow nanostructures for p-nitrophenol reduction is attributed to the increased surface area possibly causing a change in order of the reaction.

(4) Tunable selectivity in the gas sensing response is observed in CuO hollow nanostructures with Ce^{3+} doping.

Two appendices are also given in the thesis, which clearly shows that the synthesis protocol can be extended to many more multifunctional oxides such as $BaTiO_3$ and $YCrO_3$.

Keywords: Hollow, nanostructures, metal oxides, magnetism, gas sensing, catalysis.

Part of the thesis has been published as Journal articles (see list of publications).