ABSTRACT

The new scientific technologies are the result of human dreams and imagination. The emergence of nanotechnology, a 21^{st} century frontier is the outcome of such dreams. Nanotechnology is any technology at the atomic, molecular or macromolecular levels, whose dimensions are between 1 and 100 nm. It is believed to bring the next industrial revolution for exponential growth. The world of nanotechnology has an enormous impact on human life by providing society with great benefits. Over the past few decades, it has received more attention than ever worldwide for the design and development of nanomaterials and nanodevices used in many sectors like electronics, optics, medicine, plastics, energy, environment and aerospace. Multidisciplinary teams work together on the synthesis and processing of a diverse range of nanomaterials with unique physical and chemical properties of nanomaterials, which bridge between bulk materials and atomic or molecular structures. The control over size, shape and morphology of such materials always remains an ultimate challenge for the researchers. In the literature, two well-known approaches (top-down and bottom-up) have been utilized for the fabrication of desired nanostructures while the second one is preferred, as is the case for this study. Among various nanomaterials, metal oxides and sulphides have the most versatile applications due to their unique properties.

This thesis work mainly focused on the morphology engineering of zinc oxide (ZnO) and cadmium sulphide (CdS) nanostructures using coordination polymers (CPs), having a general formula $\{[M_2(bpxa)_2(adc)_2].yH_2O\}_n$ (where M(II) = Zn(II) or Cd(II); bpxa = N,N'-bis(pyridylmethyl)alkyl amine, alkyl = methyl, ethyl, tert-butyl; adc = acetylene dicarboxylate; y = 0 or 2), as precursors under various fabrication conditions (temperature, pH, time, solvent, post-synthetic annealing, and doping with divalent metal ion). Both hydrothermal and direct calcination fabrication methods utilized for these nanostructures are versatile, reproducible, scalable, efficient, eco-friendly, and surfactant-less. Compared to the traditional use of respective metal salts, such as zinc or cadmium acetate/nitrate, these CPs act as sacrificial templates providing a control over desired morphologies of the nanostructures. Furthermore, the tridentate bis(pyridyl) ligand in the CPs has a profound effect on the formation of these nanostructures. All ZnO and CdS nanostructures were characterized by powder X-ray diffraction (PXRD), field-emission scanning electron microscopy (FESEM), high resolution transmission electron microscopy (HRTEM), atomic force microscopy (AFM), and Raman and UV-VIS spectroscopy. Based on the critical and systematic evaluation (morphology and aspect ratio), and time-dependent study, of six different nanostructures (two of them are rare), their formation and morphology transition (e.g., 3D nanoflowers to 1D nanorods) can be understood. For showcasing their photocatalytic property, relevant examples will be discussed with an emphasis on: (a) the selective and optimum degradation of Congo red among four common dyes by ZnO nanoflowers at pH = 8, and (b) the correlation between morphology and rate of degradation of methylene blue by both ZnO and CdS nanostructures.