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Surface Modification of Co-Based Nanostructures to Develop Intrinsic Fluorescence and Catalytic Activity

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Abstract : Herein we report the molecular functionalization of promising transition metal oxide nanostructures, such as Co3O4 nanocubes, using nontoxic and biocompati-ble organic ligand sodium tartrate. The electronic structural modification of the nanocubes imparted through functionalization and subsequent water solubilization reveals multiple absorption bands in the UV-vis region. Further surface modification of the solubilized nanocubes, leads to the emergence of intrinsic multi-color fluorescence (from blue, cyan, green to red region of the spectrum), upon excitation at proper wavelengths, where the respective excitation wavelengths have a direct correlation with the observed UV-vis absorption bands. Using a multitude of spectroscopic tools we have investigated the mechanistic insight behind the origin of different UV-vis absorption bands and emergence of multicolor photoluminescence from the functionalized nanocubes. Our detailed study shows that ligand to metal charge transfer (LMCT) from tartrate ligand to Co2+/Co3+ ions and d-d transitions involving Co2+/Co3+ ions are responsible for generation of this novel optical properties. Magnetic study reveals that, antiferromagnetic nature of Co3O4 nanocubes changes to ferromagnetic behavior upon functionalization, however, the overall magnetic response was very weak. To combine strong magnetism with this novel optical property, we followed the same surface modification strategy in case of CoFe2O4 nanoparticles, which reveals that irrespective of size and shape, all Co-based oxides can develop intrinsic multi-color fluorescence upon facile functionalization with sodium tartrate ligands and the magnetic response was significantly higher. Surface modified Co-based oxide nanostructures also show excellent catalytic activity in degradation of biologically and environmentally harmful dyes. We hope that, our developed facile functionalization strategy of Co-based oxides will open up new opportunities in the field of biomedical applications such as bio-imaging and targeted drug delivery.

Keywords : co-based oxide nanostructures, functionalization, multi-color fluorescence, catalysis
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