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Fe3O4 Decorated ZnO Nanocomposite Particle System for Waste Water Remediation: An Absorptive-Photocatalytic Based Approach

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Abstract : Contamination of water resources has been a major concern, which has drawn attention to the need to develop new material models for treatment of effluents. Existing conventional waste water treatment methods remain ineffective sometimes and uneconomical in terms of remediating contaminants like heavy metal ions (mercury, arsenic, lead, cadmium and chromium); organic matter (dyes, chlorinated solvents) and high salt concentration, which makes water unfit for consumption. We believe that nanotechnology based strategy, where we use nanoparticles as a tool to remediate a class of pollutants would prove to be effective due to its property of high surface area to volume ratio, higher selectivity, sensitivity and affinity. In recent years, scientific advancement has been made to study the application of photocatalytic (ZnO, TiO2 etc.) nanomaterials and magnetic nanomaterials in remediating contaminants (like heavy metals and organic dyes) from water/wastewater. Our study focuses on the synthesis and monitoring remediation efficiency of ZnO, Fe3O4 and Fe3O4 coated ZnO nanoparticulate system for the removal of heavy metals and dyes simultaneously. Multitude of ZnO nanostructures (spheres, rods and flowers) using multiple routes (microwave & hydrothermal approach) offers a wide range of light active photo catalytic property. The phase purity, morphology, size distribution, zeta potential, surface area and porosity in addition to the magnetic susceptibility of the particles were characterized by XRD, TEM, CPS, DLS, BET and VSM measurements respectively. Further on, the introduction of crystalline defects into ZnO nanostructures can also assist in light activation for improved dye degradation. Band gap of a material and its absorbance is a concrete indicator for photocatalytic activity of the material. Due to high surface area, high porosity and affinity towards metal ions and availability of active surface sites, iron oxide nanoparticles show promising application in adsorption of heavy metal ions. An additional advantage of having magnetic based nanocomposite is, it offers magnetic field responsive separation and recovery of the catalyst. Therefore, we believe that ZnO linked Fe3O4 nanosystem would be efficient and reusable. Improved photocatalytic efficiency in addition to adsorption for environmental remediation has been a long standing challenge, and the nano-composite system offers the best of features which the two individual metal oxides provide for nanoremediation.

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