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Designing Multifunctional Nanostructures for H_2 Energy Applications and Organic Transformation Reactions †

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Abstract: Multifunctional nanostructures find the possibility for their applications in water splitting processes for hydrogen generation as a renewable source of green energy. Fe_3O_4 nanocubes were prepared in one-pot process for the electrochemical water splitting and supercapacitor applications. As-synthesized Fe_3O_4 nanocubes with a high specific surface area of 268 m^2g^{-1} are ferromagnetic at room temperature and affect the electrode materials' electro-catalytic activity. Similarly, the catalytic activity of ultrafine nanoparticles was examined against the Horseradish peroxidase enzyme and applied as a sensor for the detection of H_2O_2 in the solution. Besides that, the stimulating bifunctional electro-catalytic performance of RuO_2 nanoparticles was studied under different atmospheric conditions for electrochemical hydrogen energy. The studies of some multifunctional nanoparticles by citrate precursor route reveal the formation of monophasic nanostructures with fairly uniform distribution of nearly spherical particles, high specific surface area, and visible optical bandgap. Photocatalytic generation of hydrogen in the water-splitting process by using as-prepared nanoparticles have also been studied under visible light irradiations, which showed a significant H_2 evolution reaction rate. The development of nanostructured catalysts has also been preferred to carry out the heterogeneous catalytic organic transformations because of a greater number of surface-active sites for catalytic processes, high catalyst recovery rate, especially their -friendly environment nature, and their ease of synthesis. Besides the advances in nanocatalysis, certain challenges, including not well-defined morphologies due to loss of control over it and loss of catalytic activity during operation, need to be addressed. Herein, we discuss some nanocatalysts for certain organic transformation reactions with enhanced activity.

Keywords: Nanostructures; ferromagnetic; electro-catalytic activity (List three to ten pertinent keywords specific to the article; yet reasonably common within the subject discipline.)

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Conflicts of Interest

The authors declare no conflict of interest.