Nanomaterials for multifunctional properties and applications

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Abstract: Inorganic Nanostructures are among the most challenging areas of current scientific and technological research because of the variety of interesting changes in their properties at nano-dimension. The preparation of nanoparticles with well-defined size and morphology is an important challenge for various industrial applications. Multiferroic materials exhibit ferromagnetic and ferroelectric properties which may lead to number of applications for future computer memory concepts, multiple state memory devices, sensors, spin valves, actuators and transducers etc and play an important role in solid oxide fuel cells, catalysts materials for electrodes and chemical sensors. Multiferroic YMO_3 (M = Fe, Mn & Cr) nanoparticles have been prepared successfully by using polymeric citrate precursor method. XRD studies revealed the monophasic orthorhombic structure of $YFeO_3$, $YCrO_3$ and hexagonal structure of $YMnO_3$ nanopowder. The TEM and SEM studies showed that the particles are nearly spherical and hexagonal with an average grain size of 22-77 nm. Highest specific surface areas of nano-sized $YFeO_3$, $YCrO_3$ and $YMnO_3$ were found by using multipoint BET surface area studies. UV−visible reflectance studies of YMO_3 (M = Fe, Mn & Cr) and photoluminescent properties of $YMnO_3$ were studied. The temperature and frequency dependences of electrical properties including dielectric constant, dielectric loss and conductivity properties of YMO_3 (M = Fe, Mn & Cr) were investigated. The room temperature ferroelectric properties of nanocrystalline YMO_3 (M = Fe, Mn & Cr) compounds were also reported. Magnetic results of YMO_3 (M = Fe, Mn & Cr) possesses wasp-waisted, wedge shaped, and normal ferromagnetic loop of $YFeO_3$, $YCrO_3$ and $YMnO_3$ respectively with well saturation magnetization (M_s), remanent magnetization (M_r) and coercive field. Dye sensitized solar cell of $YFeO_3$ nanoparticles was fabricated, which showed enhanced power conversion efficiency as compared to TiO_2 based DSSC. Photocatalytic splitting of water by using $YFeO_3$ nanoparticles under visible light irradiation showed a significant H_2 evolution rates up to 131.6 µmol h^{-1} g^{-1}. Delafossite $CuCrO_2$ nanoparticles were found to have 2-4 times higher specific surface area than reported nanoparticles and showed remarkable enhancement in catalytic degradation of methylene blue in aqueous media under the sunlight irradiation.

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