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Effects of Erbium Incorporation on Structural, Surface Morphology, and Degradation of Methylene Blue Dye of Magnesium Oxide Nanoparticles

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Abstract: This paper reports the chemical synthesis of MgO and Er-doped MgO nanoparticles (NPs) by the sol–gel method. Their microstructural, optical characterization and the evaluation of their photocatalytic activity are presented. The synthesized NPs were characterized by means of X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Environmental Scanning Electron Microscopy (ESEM), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray Spectroscopy (EDX), UV–Visible and Photoluminescence (PL) spectroscopy. The effective synthesis of cubic MgO compound is attested by XRD, FTIR and electron diffraction in TEM. Er2O3 cubic secondary phase is found in the 2 and 3 wt% Er-doped MgO samples. The average size of the roundish cuboid-shaped crystallites decreases from 50 to 32 nm upon the incorporation of the rare earth element (TEM, XRD). Concomitantly, the size of flakes in which the NPs do agglomerate follows the same trend (ESEM). UV–Visible results show that the calculated band-gap energy of the NPs was in the 5.23 to 5.35 eV range. PL analysis showed that all samples have visible emissions owing to the formation of defects in the MgO band-gap. The photocatalytic activity against methylene blue dye was evaluated under UV light irradiation. The photocatalytic results showed an improvement in degradation efficiency with the addition of erbium in samples, with a maximal MB dye removal for the 3 wt% Er-doped MgO sample after 90 min irradiation. The performance is ascribed to a higher separation of the photo-generated (electron–hole) and larger surface area.

Keywords : Erbium, methylene blue, MgO, Photocatalytic activity, X-ray diffraction