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ABSTRACT

Lanthanide doped zinc oxide nanoparticles have shown great potential application in different field such as photoluminescence devise and energy. However, their applications for real wastewater remediation, disinfector agent and *in vivo* therapeutic agent against cancer cell (breast cancer and hepatocellular carcinoma (HepG-2) cell line) and their toxicity are largely unexplored.

In this study, we have produced low toxic nanomaterials based on Ln^{3+}-ZnO and $Ln(OH)_3$: ZnO for different potential applications such as real wastewater remediation, water disinfection and in vitro and/or in vivo antitumor applications. x mol Ln^{3+} modified ZnO nano-particles (Ln= Sm^{3+}, Eu^{3+} and Gd^{3+} ions; x = 0.008, 0.015, 0.025, 0.03 and 0.05) were synthesized by simple precipitation method. Also, 0.025 mol $Ln(OH)_3$: ZnO (Ln^{3+} = Gd^{3+} and Sm^{3+}) were prepared with precipitation followed by post hydrothermal treatment at 200^{o}C for different times (2, 5 and 10 h). The obtained nanomaterials were characterized using different advanced techniques; such as X-ray diffraction (XRD), transmission electron microscope (TEM), energy dispersive spectroscopic (EDX), UV–Visible diffuse reflectance, and fluorescence (FL) spectroscopy. The obtained results shows that lanthanide ion improves the crystal, surface area, porosity, morphology, as well as the optical absorption and emission of UV light properties of the prepared ZnO nano-semiconductor. Photo-catalytic activity for the prepared nano-materials was determined using both, fluorescent probe and dye methods. Results showed that the 0.025 Gd^{3+}-ZnO, 0.025 mol $Sm(OH)_3$:ZnO (2h) and 0.025 mol $Gd(OH)_3$:ZnO (10 h) are promising photocatalysts for different environmental applications. The high active 0.025 mol Gd^{3+}- ZnO nanoparticles was successfully mineralized textile dye and real refractory wastewater samples under sunlight illumination using CPC photo-reactor. The prepared photo-catalysts were also applied for water sample disinfection from E-coli under UVA illumination.

Moreover, the cytotoxicity of 0.015 mol Ln^{3+}-ZnO (Ln^{3+} = Eu^{3+}, Sm^{3+} and Gd^{3+}) were evaluated against Erlish Ascites carcinoma (EAC) cell line. The nanoparticle of Sm^{3+}-ZnO shows the highest activity where 95% of tumor cells died. Also, the high active Sm^{3+}-ZnO nanomaterials shows high antitumor activity against Hepatocellular carcinoma (HepG-2) human cell line. The obtained lethal dose (LD_{50} = 250 mg/Kg bw) confirms that 0.015 mol Sm^{3+}-ZnO characterized with low toxicity. The in vivo antitumor results show that 0.015 mol Sm^{3+}-ZnO yields induces tumor-selective cell death without any major effect in the surrounding normal cell.

Also, the antitumor activities of the prepared nanomaterial were evaluated against Hepatocellular carcinoma (HepG-2) human cell line. The high Inhibitory activity against HepG-2 was found in case of 0.025 mol $Sm(OH)_3$:ZnO hydrothermally treated for 5 h (13.2 μg/ml); making it a promising nontoxic nanomaterials in field of cancer therapy.

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