SUSTAINABLE REMOVAL OF TOLPERISONE HYDROCHLORIDE FROM AQUEOUS SUSPENSIONS BY CERIUM-ZIRCONIUM-OXIDE NANOPARTICLES

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Abstract

Pure water scarcity is an emerging global issue. Thus, new efficient and sustainable wastewater treatment techniques are required. In heterogeneous photocatalytic degradation, the photogenerated highly reactive radicals mineralize the present toxic compounds such as pharmaceuticals. CeO_2 is a semiconductor metal oxide that belongs to the first generation of photocatalysts [1]. Its utilization in photocatalysis under simulated sunlight irradiation (SSI) can be improved by the application of CeO_2 in nanoforms, when more economical performances under SSI are reached by tailoring their optical bandgap energy. Another way for the enhancement of the photocatalytic activity of CeO_2 under SSI is the preparation of the CeO_2 heterojunction with another metal oxide semiconductor to reduce the electron−hole pair recombination. The CeO_2-ZrO_2 binary system with a high ceria concentration and cubic fluorite structure is considered a promising photocatalyst-candidate and was tested so far in the photodegradation of Congo red under UV and SSI [2]. In this work, cerium-zirconium mixed oxide ($0.8CeO_2$-$0.2ZrO_2$) was prepared by a simple, low-cost, environmentally-friendly two-step mechanochemical synthesis. X-ray diffraction (XRD) analysis found the major phase of cubic CeO_2 with an average crystallite size of around 37 nm, while scanning electron microscopy (SEM) images showed agglomerates of $0.8CeO_2$-$0.2ZrO_2$ composed of spherical nanoparticles (NPs) with sizes in the range of 99-256 nm. Raman spectroscopy confirmed the structural features of the synthesized cerium-zirconium-oxide NPs, while the use of diffuse-reflectance spectroscopy enabled the estimation of the 3.17 eV optical bandgap energy. The photocatalytic efficiency of the newly synthesized NPs was investigated in the removal of tolperisone hydrochloride (TLP). Experiments were conducted in the presence of $0.8CeO_2$-$0.2ZrO_2$ NPs and under the influence of two types of irradiation (UV and SSI). Furthermore, the effect of the initial pH value was also examined. The obtained results indicate a great potential of these NPs in the removal of TLP from an aqueous environment.

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