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ÁREA: Síntese e caracterização de catalisadores e adsorventes

Development of silicon-cerium nanospheres through fast soft-template synthesis

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Abstract

The present work aimed to develop spherical silicon-cerium nanoparticles through a rapid synthesis via a soft-template method and to use them in preliminary tests of photodegradation of the Rhodamine B dye. For this purpose, CTAB was used as a template, and Tetraethyl Orthosilicate (TEOS) and cerium nitrate were used as silicon and cerium sources, respectively. The materials were synthesized with 1.5%, 2.0%, and 4.0% cerium concentrations and characterized by Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), X-ray Diffraction (XRD), X-ray Fluorescence (XRF), and N₂ adsorption/desorption. SEM images showed the formation of well-defined spheres with average diameters of 410 nm and 150 nm for samples with the highest and lowest cerium content (1.5% and 4.0% Ce, respectively). CeO₂ agglomerates outside the lattice were also observed, especially with higher cerium concentrations, indicating a possible insertion limit into the material structure. XRD identified CeO₂ through the presence of three reflection peaks (111), (230), and (331), except for the 1.5% sample, which showed only a halo, indicating the amorphous nature of the nanosphere walls. EDS results demonstrated a uniform distribution of cerium atoms across all materials, which, together with other characterizations, suggests the incorporation of Ce into the nanosphere structure. XRF analysis revealed actual cerium incorporation values close to the theoretical ones, namely 1.4%, 1.8%, and 3.7%. The materials generally showed significant N₂ adsorption at low pressures in their isotherms, indicating high surface area, absence of capillary condensation (suggesting a lack of mesoporosity), and considerable adsorption at high pressures, attributed to interparticle spaces. The proposed synthesis method proved highly efficient, enabling the direct synthesis of Si-Ce nanospheres in a short time. The Si-Ce nanospheres demonstrated photocatalytic activity in preliminary photodegradation tests of the commercial Rhodamine B dye, achieving up to 45.2% dye degradation when the material with 1.5% Ce was used.

Keywords: Nanosphere, cerium, photodegradation, rhodamine B.

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