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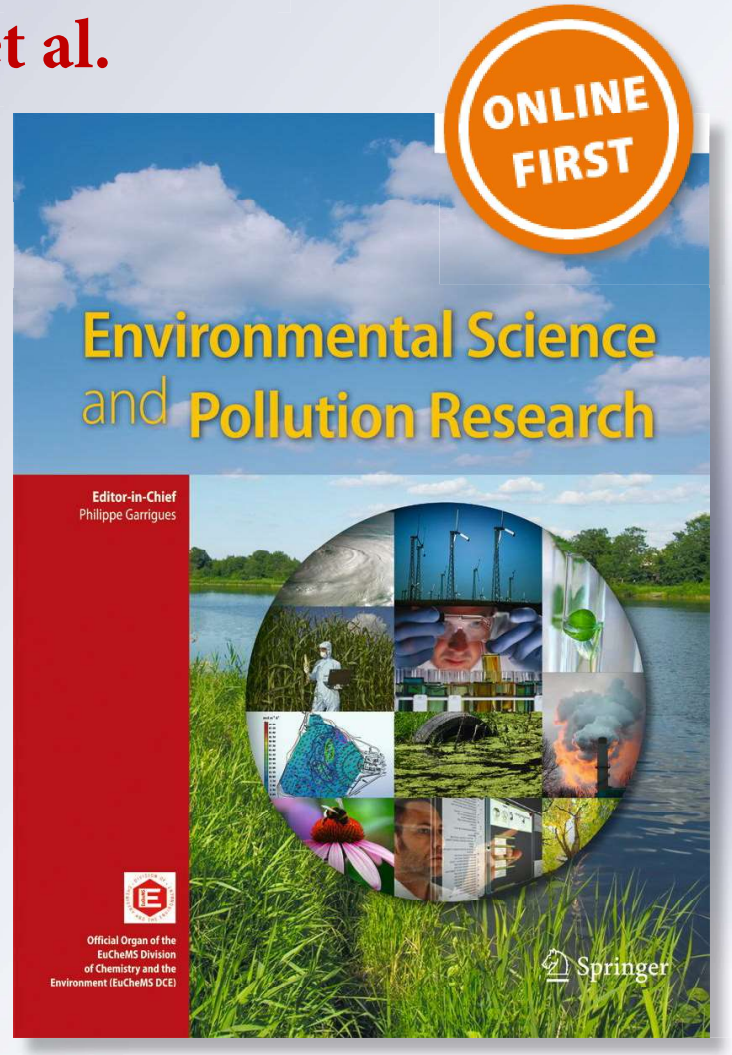

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RESEARCH ARTICLE

Synthesis and characterization of $Ag_2O/B_2O_3/TiO_2$ ternary nanocomposites for photocatalytic mineralization of local dyeing wastewater under artificial and natural sunlight irradiation

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Abstract

In this work, $Ag_2O/B_2O_3/TiO_2$ ternary nanocomposite was synthesized by a combination of green and precipitation method involving mixing of different concentrations of silver nitrate, boric acid, and titanium (IV) isopropoxide precursor with *Plumeria acuminate* leaf extract. The extract was obtained by boiling the mixture of distilled water and the powdered leaves in a beaker for few minutes followed by filtration. The microstructure, morphology, chemical composition, surface area, phase structure, and optical properties of the various prepared nanomaterials were determined by HRTEM, HRSEM, UV-Vis/DRS, BET, XRD, and XPS. The photocatalytic potential of TiO_2 nanoparticles and $Ag_2O/B_2O_3/TiO_2$ nanocomposites to degrade local dyeing wastewater under artificial and natural sunlight irradiation was investigated. The extent of degradation of the organic pollutants was measured using chemical oxygen demand (COD) and total organic carbon (TOC) as indicator parameters. The XRD pattern of $Ag_2O/B_2O_3/TiO_2$ nanocomposites revealed that the formation of pure anatase TiO_2 phase and the addition of both silver and boron precursors did not influenced the phase structure of the nanocomposites. The oxidation states of +1 and +3 for both Ag and B on the surface of $Ag_2O/B_2O_3/TiO_2$ nanocomposites were confirmed by XPS. Optical characterization of the sample revealed reduction of band gap energy from 2.6 to 2.0 eV for TiO_2 and $Ag_2O/B_2O_3/TiO_2$, respectively. The $Ag_2O/B_2O_3/TiO_2$ nanocomposites demonstrated excellent photocatalytic activity under natural sunlight and artificial light than mono and binary oxide systems with TOC and COD degradation efficiencies of 86.11% and 75.69%, respectively. The kinetics of degradation of organic dyes in the wastewater followed the order of Langmuir–Hinshelwood pseudo-first-order > Freundlich > Zero > Parabolic diffusion model. The coupling effect of Ag_2O and B_2O_3 onto TiO_2 framework was responsible for the enhanced photochemical stability of the nanocomposites even after five repeated cycles.

Keywords Green synthesis · Co-doping · Boron trioxide · Silver oxide · TiO_2 nanoparticles · Photocatalytic activity · Local dyeing wastewater · Light sources

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