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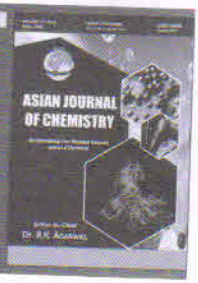

Synthesis and Comprehensive Characterisation of Pure SnO_2 Nanoparticles: Insights into Photocatalytic Activity and Electrochemical Performance

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Tin oxide nanoparticles (SnO_2 NPs) were synthesized *via* a straightforward hydrothermal approach and subsequently annealed at temperatures of 500 °C, 600 °C and 700 °C. Comprehensive characterisation of these nanoparticles was performed using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), field emission scanning electron microscopy with energy-dispersive X-ray spectroscopy (FESEM-EDS), high-resolution transmission electron microscopy with selected area electron diffraction (HRTEM-SAED), UV-visible diffuse reflectance spectroscopy (UV-DRS) and X-ray photoelectron spectroscopy (XPS). XRD patterns revealed a tetragonal crystal structure, with the average crystallite size increasing from 8 nm to 28 nm as the annealing temperature was raised, a finding that was corroborated by TEM analysis. FTIR spectroscopy confirmed the presence of Sn–O–Sn bonds, indicated by absorption peaks at 644 cm^{-1}. FESEM analysis showed a predominantly spherical morphology and EDX spectra verified the presence of tin and oxygen. The optical band gap of Sn7 NPs was determined to be 3.43 eV through UV-DRS using the Kubelka–Munk method. XPS analysis provided insights into the electronic structure and confirmed the phase purity and elemental composition of the samples. The SnO_2 (Sn7) electrode delivered a specific capacitance of 271 F g^{-1} at a current density of 0.2 A g^{-1} and exhibited remarkable cyclic stability, retaining 86.14% of their capacitance after 2000 cycles. Furthermore, the photocatalytic activity of Sn7 catalyst was assessed under sunlight, revealing a notable 85% degradation of methyl violet dye. These findings highlight the dual functionality of nanosized SnO_2, making it a promising material for both energy storage and environmental applications.

Keywords: Hydrothermal method, SnO_2 NPs, Photocatalytic behaviour, Supercapacitor.