

Thermal calcination-based production of SnO₂ nanopowder: an analysis of SnO₂ nanoparticle characteristics and antibacterial activities

ABSTRACT

SnO₂ nanoparticle production using thermal treatment with tin(II) chloride dihydrate and polyvinylpyrrolidone capping agent precursor materials for calcination was investigated. Samples were analyzed using X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), energy dispersive X-ray (EDX), transmission electron microscopy (TEM), Fourier Transform Infrared Spectroscopy (FT-IR), X-ray photoelectron spectroscopy (XPS), diffuse UV-vis reflectance spectra, photoluminescence (PL) spectra and the electron spin resonance (ESR). XRD analysis found tetragonal crystalline structures in the SnO₂ nanoparticles generated through calcination. EDX and FT-IR spectroscopy phase analysis verified the derivation of the Sn and O in the SnO₂ nanoparticle samples from the precursor materials. An average nanoparticle size of 4–15.5 nm was achieved by increasing calcination temperature from 500 °C to 800 °C, as confirmed through TEM. The valence state and surface composition of the resulting nanoparticle were analyzed using XPS. Diffuse UV-vis reflectance spectra were used to evaluate the optical energy gap using the Kubelka-Munk equation. Greater calcination temperature resulted in the energy band gap falling from 3.90 eV to 3.64 eV. PL spectra indicated a positive relationship between particle size and photoluminescence. Magnetic features were investigated through ESR, which revealed the presence of unpaired electrons. The magnetic field resonance decreases along with an increase of the g-factor value as the calcination temperature increased from 500 °C to 800 °C. Finally, *Escherichia coli* ATCC 25922 Gram (–ve) and *Bacillus subtilis* UPMC 1175 Gram (+ve) were used for in vitro evaluation of the tin oxide nanoparticle's antibacterial activity. This work indicated that the zone of inhibition of 22 mm has good antibacterial activity toward the Gram-positive *B. subtilis* UPMC 1175.

Keyword: Tin oxide nanoparticles; Calcination method; Antibacterial activity