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Physical & Electrochemical Properties of Green Synthesized Bunsenite NiO Nanoparticles via *Callistemon Viminalis'* Extracts

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P-type Bunsenite NiO powders with an average crystallite size of 21 nm (as shown by x-ray diffraction analysis) were produced via biosynthesis and heat treatment using aqueous extracts from red flowers of the plant, *Callistemon viminalis*. SEM showed that the NiO powders consisted of particles with sizes in the 20-35 nm range while XPS confirmed the formation of highly pure NiO. From Raman spectroscopy, strong 1 phonon vibrations at 507.4 cm^{-1} and the existence of a broadened 2-phonon band of reduced intensity at 1096 cm^{-1}confirmed that biosynthesized NiO powders were not only defect-rich/ rich in surface effects but were also nanosized with dimensions less than 100 nm. Through UV-Vis-NIR spectroscopy, the optical band gap for an annealed spin-coated thin film of NiO obtained using the green coloured Ni^{2+}-containing extract of *Callistemon viminalis*, was calculated to be 3.35 eV. A cyclic voltammetric study of the NiO nanopowders on Ni showed the redox processes to be quasi-reversible with the films showing potential for pseudocapacitance and the specific capacitance of the NiO thin films on Ni being estimated at 101 F/g. Electrochemical impedance spectroscopy showed the associated redox processes to be primarily diffusion controlled at room temperature. Through these findings the use of natural plant extracts is hereby shown to be a cost-effective and environmentally friendly alternative to preparing Nickel oxide nanosized powders that can be of use in a variety of energy storage applications.

Keywords: Green synthesis, NiO nanoparticles, Raman spectroscopy, Electrochemical Impedance Spectroscopy, Pseudocapacitance.

FULL TEXT