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ELECTRICAL AND OPTICAL PROPERTIES OF F-DOPED SnO_2 NANOSTRUCTURED THIN FILMS SYNTHESIZED BY SEQUENTIAL NEBULIZER SPRAY PYROLYSIS

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Transparent conductive films are widely used to prepare photovoltaic solar cells, photoelectrochemical solar cells, flat panel displays, touch screens, light-emitting diodes, smart windows, gas sensors and frost-resistant surfaces. Both high electronic conductivity and high optical transmission are essential properties of transparent conductive oxides (TCO) for applications. In this work, transparent and electrically conductive F-doped tin oxide (FTO) thin films were deposited on glass substrates (soda-lime glasses). Sequential nebulized spray pyrolysis (NSP) was used to synthesize nanostructured FTO layers with the aid of a homemade low-cost spray gun. The surface morphology of FTO layers prepared was analyzed using scanning electron microscopy (SEM) and X-ray diffraction (XRD). The study confirmed the formation of pure SnO_2 phase with F being incorporated into the crystal structure. XRD pattern showed peaks at 2θ values of 26.64° (110), 33.90° (101), 37.95° (200), 51.87° (211), 56.17° (200), 60.05° (310) and 61.89° (301), corresponding to respective crystal planes of SnO_2. SEM images reveal that synthesized films have homogeneous surface coverage, and the size of crystallites is in the range of 5 - 15 nm. The results are in accordance with crystallite sizes calculated from Rietveld refinement. The optical transparency of the films was evaluated by absorption spectroscopy, which revealed more than 65% transparency in the visible regime for the films having 25 Ω cm^{-2} sheet resistance. The bandgap energies were estimated from standard Tauc plots, which resulted in 3.7 eV for the substrate with 25 Ω cm^{-2} sheet resistance. The FTO conductive films prepared in this research were used to prepare a quasi-solid-state dye-sensitized solar cell (DSC). The DSCs exhibited 4.8% power conversion efficiency, 86% fill factor and higher short-term stability.

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Keywords: FTO, Optical transparency, Spray pyrolysis, Surface morphology, Transparent conductive films