DEVELOPMENT OF ATOMIZED SPRAY PYROLYSIS FOR FABRICATION OF THIN FILMS AND DEVELOPMENT OF DYE-SENSITIZED SOLID-STATE SOLAR CELLS

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In this thesis a detailed description of eight research topics is presented. Here, old atomized spray pyrolysis deposition (ASPD) setup was modified in to a novel ASPD instrument to meet the versatile fabrication demands. The FTO thin films were fabricated on soda-lime glasses using the ASPD technique and they were used as the substrates for TiO_2 based dye-sensitized solar cells (DSCs). The dye cocktail effect of N719 dye and Black dye on dye-sensitized solid-state solar cell (DSSC) based on TiO_2 and CuI hole conductor was investigated and their absorption spectra were studied. Also to develop alternative DSSCs to conventional TiO_2 based DSSCs, ZnO and SnO_2 based DSSCs have been investigated. There, conductivity of the CuSCN hole conductor was improved to obtain high power conversion efficiencies (PCEs). To develop low cost Pt free counter electrodes for DSCs, a novel FTO-activated carbon composite counter electrode was fabricated. Finally, DSCs modules have been constructed and their performances were studied. Here for characterization of materials and solar cells, scanning electron microscopy, UV-Visible spectrometry, conductivity and Hall measurements, current-voltage (I-V) measurements, impedance spectrometry, cyclic voltammetry and X-ray diffraction were used.

The FTO thin films fabricated using the new ASPD instrument, on the soda-lime glass substrate have shown transmittance, electrical conductivity, electron mobility and the carrier density of, 85.2% at 660 nm, 1.71×10^3 S cm^{-1}, 10.89 cm^2 V^{-1} s^{-1} and 9.797×10^{20} cm^{-3}, respectively at room temperature. The DSCs fabricated using these FTO substrates and commercial FTO substrates have shown PCEs of 10.4% and 9.1%, respectively. The N719 and Black dye cocktail sensitized DSSC has shown a PCE of 4.6% where, individual N719 and Black dye sensitized DSSCs have shown 3.8% and 3.0%, respectively. The ZnO-CuSCN based DSSC has shown a maximum PCE of 2.28% at a dense layer sheet resistance of 1500 Ω and ZnO porous layer thickness of 9 μm. Furthermore, the SnO_2, SnO_2-MgO, SnO_2-ZnO, and SnO_2-$CaCO_3$ based DSSCs with CuSCN have shown maximum PCEs of 0.32%, 2.82%, 2.38% and 1.84%, respectively. The DSC with the counter electrode fabricated using activated carbon 0.400 g per 40.0 mL of FTO solution and sintered at 500 °C has shown the highest PEC of 7.6%, where the Pt-Cr mirror-FTO type counter electrode has shown 9.4%. The DSC modules of 10 cm × 10 cm have shown over 0.700 mV of voltage and over 0.5 A of current under the exposure of direct sunlight.