Abstract No: 104 ***Physical Sciences***

HIGHLY CONDUCTING FLUORINE-DOPED TIN OXIDE THIN FILMS BY SPRAY PYROLYSIS TECHNIQUE FOR OPTOELECTRICAL APPLICATIONS

K.U.R.R.S. Rathnayaka[1*], T.M.W.J. Bandara[1, 2], G.R.A. Kumara[3] and K. Wijayaratne[1, 2]

[1]Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka
[2]Department of Physics, University of Peradeniya, Peradeniya, Sri Lanka
[3]National Institute of Fundamental Studies, Kandy, Sri Lanka
[*]roshanrathnayaka1994@gmail.com

Transparent conductive oxide (TCO) films are one of the main components of many electrochemical devices, such as dye solar cells (DSCs) and supercapacitors. Fluorine-doped tin oxide (FTO) films are the most widely used TCO substrates due to their inexpensive preparation and higher temperature tolerance. As a rule-of-thumb, FTO films with 80% transmittance and a standard sheet-resistance (R_{sh}) value of 10 $\Omega\ \square^{-1}$ are usually chosen for solar cell applications. Optical transmittance and electrical sheet resistance trade off each other. Here, the effect of spray time on FTO layer thickness, sheet resistance, transparency, and film morphology was studied. For this purpose, a series of FTO films were prepared on glass substrates by changing the film thickness by varying the spray time. The precursor solution, containing 9.01 g of $SnCl_4.5H_2O$ and 2.40 g of NH_4F in 400 cm3 of methanol, was sprayed onto a soda-lime glass substrate at 500 °C. The electrical, optical, structural, and morphological properties of fabricated FTO films were compared with a commercially available FTO glass (CFTO) sample. In addition, a series of DSCs was prepared using fabricated FTO films and CFTO. By using a simple spray pyrolysis technique, it was possible to reduce the sheet resistance of FTO film below 1 $\Omega\ \square^{-1}$ while keeping the resistivity around 3.5 Ω cm. According to the DSCs prepared using these films, better energy conversion efficiencies can be obtained via FTO films with low transparency and low sheet resistance. Their stability and fill factor were significantly better (higher than 70%) than standard commercial FTO films with higher transmittance (T) and average Rsh. The efficiency of the DSC series showed a linear relationship with T^2/R_{sh}. The results indicate the transparency of FTO is not a dominant factor, and translucent FTO films with carefully controlled light scattering properties may be used in fabricating dye solar cells with superior efficiency.

Financial assistance from PGIS (Grant No PGIS/2020/05) is acknowledged.

Keywords: Dye-sensitized solar cell, FTO, Optical transparency, Spray pyrolysis, Sheet Resistance