Characteristics of Fluorine-Doped Tin Oxide as a Transparent Heater on PET Prepared by ECR-MOCVD

Chairul Hudaya[1,2], Ji Hun Park[1], Wonchang Choi[1,2], Joong Kee Lee[1,2*]

[1]Advanced Energy Materials Processing Laboratory, Center for Energy Convergence, Green City Research Institute
Korea Institute of Science and Technology, Hwarangno 14 gil 5, Seoul 136-791, Republic of Korea
[2]Department of Energy and Power Conversion Engineering, University of Science and Technology,
176 Gajungro Yuseong-gu, Daejeon 305-350, Republic of Korea
* Corresponding author : leejk@kist.re.kr

A transparent heater is a transparent semiconductor coating material that can generate heat when the electric current passes through the coating material. It can be widely applied for various purposes, including public information displays, material handling equipment, military ground-based vehicles, naval flight deck equipment, control panels on heavy agricultural and earth moving equipment, periscopes, off-shore oil platforms, and electric vehicle windows. The flexible transparent conductive heater of fluorine-doped tin oxide (SnOx:F or FTO) thin films on a polyethylene terephthalate (PET) was prepared by electron cyclotron resonance plasma-assisted – metallic oxide chemical vapor deposition (ECR-MOCVD). Tetra-methyl tin (TMT) of organometallic and sulfur-hexafluoride (SF_6) of doping gas were used as the precursors for tin and fluorine, respectively. Tin precursors were carried with argon gases at -10.2℃ in the cyro-canister. The FTO films were prepared under TMT bubbler pressure of 43 Torr, O_2/Ar flow rate of 52.3 sccm, a working pressure of 10 mTorr, H_2/Ar flow rate of 5.2 sccm, deposition time of 15 min, magnetic current of 165 A and microwave power of 1,400 W. In particular, we investigated the effects of changes in fluorine content in tin oxide film and the relationship between the film characteristics such as surface morphology, electrical, optical and thermal properties. While keeping other process parameters fixed as mentioned above, the SF_6 flow rates of ECR-MOCVD system were varied at 6.58, 12.18 and 17.78 sccm in order to prepare the samples with different fluorine contents. The result shows that the FTO films have nanocrystalline structure with a grain size of 40-50 nm, a thickness of 300 nm and transmittance over 85 %. The doped thin film with the sulfur hexafluoride flow rate of 12.18 sccm was found as the lowest sheet resistance of 253 Ω/square in our experimental range. The PET coated FTO is sandwiched with glasses, supported by fiber-glass and connected with copper electrodes at each edge. A variable power supply equipped volt and ampere meter and digital thermometer are used. This device was used to evaluate the heat-cycle test of FTO thin film.