Formation of 1-D Nanostructured Fluorine-Doped Tin Oxide Thin Films

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1. Introduction

Thin films of the transparent conducting oxides (TCOs) such as ITO, FTO and AZO have been used in many opto-electronics applications. The FTO (Fluorine-doped SnO_2) has high thermal and chemical stability, good electrical conductivity and optical transmission in the visible range.

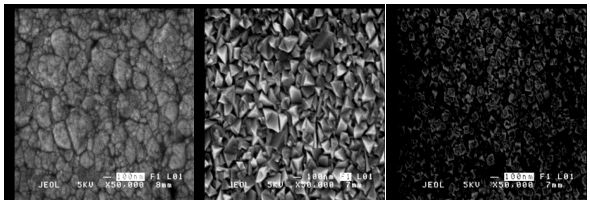
We are developing a one-dimensional (1-D) nanostructures of FTO to improve the light transmittance and scattering resulting in an enhancement of light absorption and surface area in the dye-sensitized solar cell application. In this report, we fabricate the 1-D nanostructured FTO thin films by using a simple and cost effective novel spray pyrolysis deposition (SPD) technique and investigate a relationship between spray condition and surface morphology of the film.

2. Experimental

A precursor solution containing $SnCl_4.5H_2O$, NH_4F, distilled water, acetone and HCl was withdrawn at 0.20 MPa by using a pressurized air flow, with the help of a sequence of pulses of 2 s on and 13 s off. The solution–processed materials are transferred to the commercial FTO glass substrate by atomizing the solution and the 1-D nanostructures are formed after evaporation of the solvent.

3. Results and Discussion

The new SPD technique allows for the perfect control of spray conditions to fabricate the 1-D nanostructured FTO thin films. Spraying at a low angle to the substrate surface is mandatory for an erection of the well-aligned 1-D nanostructures. The prepared nanostructured thin films have optical transmissions in the range between 83% and 86% in the visible range and resistance along the vertical direction of nanostructures is around 22.3 Ω. Structural characterization of nanostructured thin films will be discussed.



(a) (b) (c)

Figure: Commercial FTO (a), FTO nanoparticles on commercial FTO (b) and 1-D FTO nanostructures on commercial FTO (c).