FABRICATION OF POROUS, CRISTALLINE-ORIENTED TITANIA FILM ON TRANSPARENT ELECTRODE BY MAGNETIC FIELD-ASSISTED EPD

Tetsuo Uchikoshi, National Institute for Materials Science, Japan
uchikoshi.tetsuo@nims.go.jp
Tohru S. Suzuki, National Institute for Materials Science, Japan
Hiroyuki Muto, Toyohashi University of Technology, Japan
Atsunori Matsuda, Toyohashi University of Technology, Japan

Key Words: Titania, Porous layer, Magnetic orientation, Transparent electrode, Electrolysis of water

Dye-sensitized solar cells (DSSCs) are the most extensively investigated systems for the conversion of solar energy into electricity, since it can convert light at longer wavelengths into electricity and can be manufactured using less energy compared to the bulk semiconductor-type cells with a p-n junction. Despite these advantages, DSSC commercialization is still limited because of its low conversion efficiency and low reliability of the liquid electrolyte. The low conversion efficiency is due to the non-uniformity of the electrode components with respect to the packing density of TiO2 particles and film thickness of the electrode. Therefore the research on DSSC in general has been directed toward improving the photo-current and photo-potential. In order to significantly enhance the cell performance, it is important to optimize the photo-anode structure of the DSSC on the basis of its fundamental properties. In this study, crystalline-oriented porous TiO_2 thin films were fabricated on indium-tin oxide (ITO) or fluorine-doped tin oxide (FTO) glass substrates by electrophoretic deposition (EPD) in a superconducting magnet.

Commercial TiO_2 particles with an average particle size of 30nm (Nanotek TiO_2, 80% anatase 20% rutile) were dispersed in 2-propanol + acetylacetone solvent mixed with some amount of distilled water to prepare suspension. The EPD was conducted at a constant voltage mode of 20-80 V, which is higher than the theoretical decomposition voltage of water (1.23 V at room temperature). The distance of a conductive glass substrate and a palladium counter electrode was fixed at 2 cm. The deposit layer was characterized by XRD for crystalline-orientation check and SEM for microstructure observations.

During the EPD, the water in the solvent was decomposed by electrolysis causing bubble incorporation in the deposits and worked as a pore former; however, tarnish of ITO surface was observed at higher voltages. This problem was eliminated by using FTO glass substrate. Crystalline- oriented porous TiO_2 films were successfully obtained through the deposition process in a 12 T strong magnetic field.

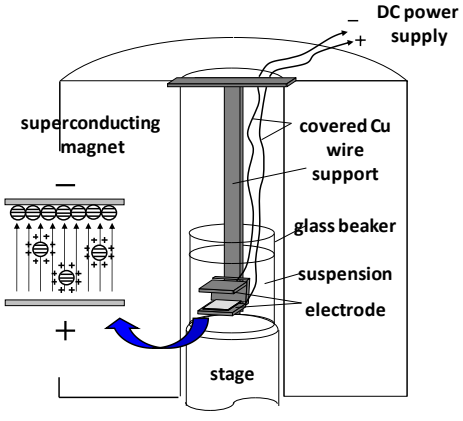

Figure 1 Schematic diagram showing the experimental setup for EPD in a superconducting magnet.

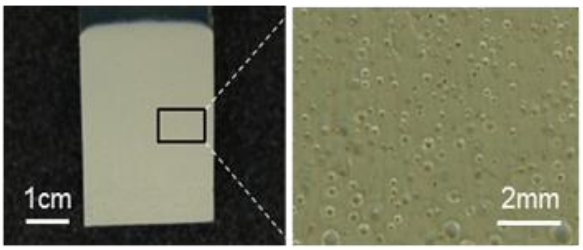

Figure 2 Image of crystalline-oriented porous titania film prepared on FTO glass by EPD in a 12 T strong magnetic field. Composition of the solvent was 40vol% water – 30vol% acetylacetone – 30vol% 2-propanol.