Electrochemical Properties of TiO2 Electrode Prepared by Various Methods

Morozová, Magdalena
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M. Morozová, P. Klusoň, J. Krýsa, [1]M. Veselý, [1]P. Dzik, O. Šolcová
Institute of Chemical Process Fundamentals of the ASCR, v. v. i., Rozvojová 135, 165 02 Prague 6, Czech Republic, e-mail: morozova@icpf.cas.cz
[1]Brno univesity of Technology, Faculty of Chemistry, Purkynova 464/118, 612 00 Brno, Czech Republic

Titanium dioxide (TiO_2) is well known as a semiconductor photocatalyst widly used in applications for air or water purification. The photocatalytic activity arises from the ability of the electron-hole pairs generation after light irraditaion. Due to these good photo-excitation properties, TiO_2 has become an interesting candidate as an n-type photoanode which can be used in fields of photovoltaics, energy storage, sensing, photo-electrocatalysis etc.

Thin transparent TiO_2 layers were created on the conductive ITO glass by means of the templated sol-gel technique and by the subsequent calcination at 450° C. The sol-gel method using molecular tamplating is based on a chemical process utilizing hydrolysis and polycondesation of metal alkoxides in the core of reverse micelles which allows a production of uniform particles in layers. The sol-gel method was chosen by reason of the sol-gel layers electrodes are transparent and possess very stabile surface. For the preparation of the thin sol-gel TiO_2 films, numerous deposition techniques were applied. This contribution is focused on the study of structural and photo-electrochemical properties of the sol-gel nanostructured layers deposited by various techniques (a dip-coating, a spray-coating and an inkjet printing).

The dip-coating belongs to the traditional and widely used methods of the thin layer preparation. It is based on dipping the substrate into the sol and pulling it out at constant speed. The spray-coating is the other elementary technique which applies liquid precursor on the substrate by the spray head with one three axes system nozzle. It is a simple method for fast coating of large substrate areas with thick film in a single step. As a new process of the liquid sol application the ink-jet printing has been appeared. The print head contains 9 piezoelectric nozzles ejected very small droplets of low viscosity ink. Inkjet printing proved to be very elegant, clean and precise method for sol deposition and patterning.

The sol's viscosity, concentration, solvent volatility, speed of pulling etc. may influence the final sturctural properties of layers, such as film thickness, nanoparticles size and surface morphology. The surface properties were determined by XRD, Raman, SEM, AFM and UV-Vis analyses. Photo-induced electrochemical properties were measured by potentiodynamic methods in the three-compartment electrochemical cell. This Pyrex cell contained supporting electrolyte (0.1M Na_2SO_4) and the TiO_2/ITO electrode was used as a working electrode. As an UV source the polychromatic mercury lamp was employed and the wavelength of the incident light was focused by an interference filter on 365 nm.

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