



PROPERTIES OF NIO THIN FILMS PREPARED BY CHEMICAL SPRAY PYROLYSIS

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ABSTRACT

A simple and inexpensive spray pyrolysis technique was used to deposit NiO thin films from $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ or $\text{Ni}(\text{CH}_3\text{COO})_2 \cdot 4\text{H}_2\text{O}$ solutions on preheated glass substrates placed onto soldered tin bath at temperatures of 400 - 550 °C. NiO thin films synthesized by spray pyrolysis could be used as stable photocathode material for dye-sensitized photoelectrochemical cells. The precursor salt was dissolved in deionized water or in mixture of alcohol (ethanol or isopropanol) and deionized water. All films were deposited using precursor concentration of 0.05 M and spraying rate of ~ 1 ml/min. The effect of the precursor solution and growth temperature on the NiO thin film structural, morphological and optical properties was studied using X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX) and optical spectroscopy (UV- VIS) techniques. According to XRD, NiO films possess the cubic bunsenite crystal structure, crystallites show preferential orientation along (111) plane parallel to the substrate independent of the growth temperature and precursor. The increase of the bath temperature from 450°C to 550°C decreases the film thickness from 1.1 to 0.05 μm , and increases crystallite size from 4 to 25 nm. According to SEM, NiO films from nickel acetate solution have significantly smoother surface than films prepared from nickel chloride solutions. The precursor salt has influence on NiO film chemical composition according to EDX. NiO films grown at 400°C from nickel chloride solution contain 3 at.% of chlorine, at bath temperature of 550°C chlorine concentration in the film is below 1 at.%. Optical transparency of NiO films is 70% in visible spectral region for the films obtained at tin bath temperature around 500 °C. The optical band gap of the NiO films sprayed from nickel acetate solution changes from 3.41 to 4.14 eV increasing the deposition temperature from 400 to 550°C.

Keywords: Nickel oxide, spray pyrolysis, Thin films, XRD, SEM, EDX, UV-VIS