



OPTICAL PROPERTIES OF SPRAYED ZnO THIN FILMS

T. Unt, M. Kriisa, A. Mere, M. Krunk

*Tallinn University of Technology
Ehitajate str. 5, 19086 Tallinn – Estonia*

ABSTRACT

ZnO semiconductor material is inexpensive and abundant material that is being widely studied as a candidate to replace indium tin oxide (ITO) or tin oxide as a transparent conductive oxide (TCO) layer in thin film solar cells. In TCO layer it is important to achieve high electrical conductivity and optical transparency. Along with transparency it is required to have good light scattering ability to make light path longer and light absorption in solar cell more efficient. Current study focuses on the optical properties of chemically sprayed ZnO films. ZnO can be easily deposited at moderate growth temperatures (~400°C) by inexpensive chemical spray pyrolysis method on glass or polymeric substrates. Indium doped ZnO films (ZnO:In) on glass substrates with thickness ca 1 micron show electrical resistivity in the order $10^{-3} \Omega \cdot \text{cm}$ and transmittance of ca. 85% in visible spectral region. It appears that the concentration of carriers in ZnO:In films, at constant dopant amount in precursor solution, is controlled by the solution spray rate. The band gap of ZnO:In films increases from 3.24 eV to 3.36 eV and carrier concentration increases from 10^{19} to 10^{20} cm^{-3} as the solution spray rate changes from 0.5 ml/min to 4.7 ml/min. The decrease of optical transmittance in the near infrared spectral region (NIR) corresponds to the increase in concentration of carriers. ZnO:In films on polyimide (PI) substrate can be grown onto ZnO buffer layer to form ZnO/ZnO:In bilayer. Depending on the buffer layer morphology ZnO/ZnO:In bilayer has mixed surface texture from smooth to scrolled belt-like grains with size up to 2-3 microns. The bilayers deposited on PI show high light scattering ability with haze factor of 85-95% in the spectral region of 350-1500 nm.

Keywords: ZnO thin films, optical properties, chemical spray pyrolysis, spraying rate, ZnO:In