Electrical transport, microstructure and optical properties of Cr-doped In2O3 thin film prepared by sol–gel method

ABSTRACT

High transparent In2O3 and Cr-doped In2O3 (In2−xCrxO3) nanocrystalline thin films were prepared using a simple sol–gel method followed by a spin coating technique. The effect of Cr concentration on the structural, microstructure, electrical and optical properties of In2−xCrxO3 were systematically investigated using X-ray diffractometer (XRD), atomic force microscopy (AFM), UV–vis spectroscopy, field emission scanning electron microscopy (FESEM) and Hall effect technique. The films have good crystallization with preferred orientation to (2 2 2) direction. The lattice parameters, a, of In2O3 system increased at lowest dopants (x = 0.025) and decreased as the dopant was further increased. The optical transmittance of films increased up to 98% for x = 0.05 and decreased for further Cr concentrations. From AFM measurement the films nanocrystals morphology was depending on Cr concentrations. The band gap was around 3.76 eV for pure and with $x \leqslant 0.075$ however it increased. The effect of Cr concentrations on conducting mechanisms of In2O3 film has been investigated from 80 to 300 K using thermal activated conduction band and hopping models. The films, at x = 0.0–0.075, have typical semiconductor behaviour. Three different conducting mechanisms have been estimated. All thermal activation energies and conduction hopping parameters have been determined and analysed in details.

Keyword: Conducting mechanism; Hopping conductivity models; Indium oxide; Porosity; Sol-gel; Transmittance.