Synthesis of ITO nanoparticles by solvothermal microwave process

E. G. S. Firminiano¹, C. J. Dalmaschio¹, A. J. Chiquito², E. R. Leite¹
¹LIEC, Department of Chemistry, Federal University of São Carlos
²Nanolab Laboratory, Department of Physics, Federal University of São Carlos

Indium tin oxide (ITO) used as transparent conducting oxide (TCO) have drawn great interest due to their prominent electro-optical behavior. ITO films have high luminous transmittance, high infrared reflectance, good electrical conductivity, excellent substrate adherence, hardness, and chemical inertness and hence, have been widely and intensively studied for many years. Thus, transparent conducting oxide film is now indispensable in electrical and optical devices. In this respect, microwave irradiation as a heating tool to ITO synthesis opens up new perspectives because microwave-mediated synthesis routes are characterized by short reaction times, often with excellent yields. The synthesis route was carried out through heating in a microwave oven designed for this purpose by using 3 mmol of indium acetylacetonate In(acac)₃ and 0.3 mmol of tin(IV) tert-butoxide Sn(OC(CH₃)₃)₄ dissolved in 30 grams of Polietilenglycol Mw = 1000. The material was then separated by centrifugation with the use of organic solvents to destabilize the colloidal dispersion formed, and subsequently dried in a vacuum oven at 70 °C for 6 hours. It can be inferred from the X-ray diffraction pattern obtained that the diffraction maximums are related to the cubic, single phased and crystalline system of the indium oxide doped with tin. From the XRD results, using Scherrer's model to determine the extent of crystallographic domain a value of 9.9 nm was obtained, which is associated to the particle size of the synthesized material.

Thermogravimetry (TG) measurements allowed to observe a mass loss of 10.3%, which is directly associated with the presence of a high amount of organic material on the surface of ITO nanoparticles. Infrared spectra were obtained in order to confirm the presence of organic material on the surface of the nanoparticles, and the spectra allowed the observation of a shift in a series of characteristic absorption bands for the absorption bands characteristic of pure polyethyleneglycol. This displacement effect of the bands is a function of the electron donor effect from the oxide to the organic molecules attached to the surface of nanoparticles. The oxide was shaped into tablet form with the objective of determining the electrical characteristics of the synthesized material. Measurements of current x voltage indicated ohmic behavior at different temperatures when contacts were investigated. Measurements of resistivity as a function of temperature were performed in the range from 10 to 250 K for a more accurate characterization of electronic transport, indicating a typical metal electronic transport behavior with resistivity of about 10⁻² Ω.m. The results of structural and electronic characterization showed that the proposed synthetic route enables the achievement of ITO nanoparticles with surface functionalized with organic molecules. Besides obtaining the desired properties of the oxide, microwave solvothermal synthesis reduces the processing time compared to conventional heating methods used.

Keywords: ITO, Microwave heating

Work supported by CNPQ


E-mail: edneyfirmiano@yahoo.com.br; C. Postal 676, 13565-905 - São Carlos, SP, Brazil