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Physical Characterization of SnO_2 Films Prepared by the Rheotaxial Growth and Thermal Oxidation (RGTO) Method

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Abstract : SnO_2 is an n-type semiconductor with a direct gap of about 3.6 eV. It is largely used in several domains such as nanocrystalline photovoltaic cells. Due to its interesting physic-chemical properties, this material was elaborated in thin film forms using different deposition techniques. It was found that SnO_2 properties were directly affected by the deposition method parameters. In this work, the RGTO method (Rheotaxial Growth and Thermal Oxidation) was used to deposit elaborate SnO_2 thin films. This technique consists on thermal oxidation of the Sn films deposited onto a substrate heated to a temperature close to Sn melting point (232°C). Such process allows the preparation of high porosity tin oxide films which are very suitable for the gas sensing. The films structural, morphological and optical properties pre and post thermal oxidation were studied using X-ray diffraction (XRD), scanning electron microscopy (SEM), UV-Visible spectroscopy and Fourier transform infrared spectroscopy (FTIR) respectively. XRD patterns showed a polycrystalline structure of the cassiterite phase of SnO_2. The grain growth was found affected by the oxidation temperature. This grain size evolution was confronted to existing grain growth models in order to understand the growth mechanism. From SEM images, the as deposited Sn film was formed of difference diameter spherical agglomerations. As a function of the oxidation temperature, these spherical agglomerations shape changed due to the introduction of oxygen ions. The deformed spheres started to interconnect by forming bridges between them. The volume porosity, determined from the UV-Visible reflexion spectra, Changes as a function of the oxidation temperature. The variation of the crystalline fraction, determined from FTIR spectra, correlated with the variation of both the grain size and the volume porosity.

Keywords : tin oxide, RGTO, grain growth, volume porosity, crystalline fraction
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