Novel Indium Oxide Based Transparent Conductive Oxide Material

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Transparent conductive oxide (TCO) films are used for various applications such as liquid-crystal displays, solar cells, touch screens and so on. Among the TCO films, indium oxide (In_2O_3) based TCO films, especially tin doped In_2O_3 (ITO) films, are mainly used in industry due to their low resistivity and high transmittance in the visible range. ITO films are normally crystallized by post-annealing above 200 ℃ in order to obtain low resistivity and high transmittance films [1]. However, recent development of devices requests TCO films to realize very low resistivity (about 200μΩcm) by annealed even under 150℃ , which is too difficult for conventional ITO materials to achieve. Therefore, main purpose of this work is developing TCO materials which is able to achieve 200μΩcm by annealed under 150℃ .

Experimental procedure is briefly described below. 30nm thick In_2O_3 based TCO films were deposited on the commercially available glass substrate by DC magnetron sputtering from In_2O_3 based ceramic sputtering targets. Substrate temperature during sputtering process was room temperature. After film deposition, post-annealing of the films was performed in air for 60 minutes and annealing temperature was under 150℃. Properties of annealed films were investigated by various measurements such as hall effect measurements, X-ray diffraction and spectrophotometry. Novel TCO material, which is named USR, has been developed by optimizing doping elements and their concentrations.

Fig.1 shows temperature dependence of resistivity of USR and ITO (SnO_2:3wt%) films. USR reached 197μΩcm by 150℃ annealing and, in addition, 230μΩcm by 100℃ annealing. Fig.2 shows transmission spectra of USR and ITO (SnO_2:3wt%) films. USR film shows high enough transmittance to be adopted in optical devices. Therefore, USR is expected to be applied to advanced applications.

[1] H. Morikawa, M.Fujita, Thin Solid Films 61-67, (2000) 359.

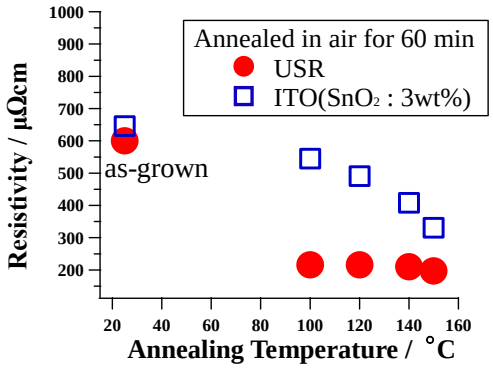

Fig. 1 Temperature dependence of resistivity

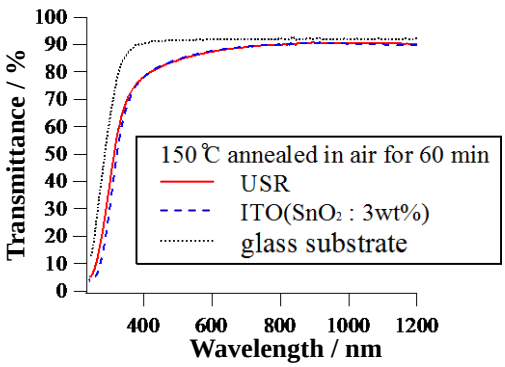

Fig. 2 Transmission spectra of USR and ITO films