The R[O_2]% Ratio Effect on the Optical Properties of Ag_xO Thin Films Grown by RFM-Sputtering

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Silver oxide is studied extensively for its application in optical and electrical industries[1]. The sophisticated growth method for Ag or Ag_xO thin film deposition is well developed, including electron beam evaporation[2], Ar without/with O_2 reactive plasma aroused by microwave sputtering[3], and aroused by DC magnetron sputtering [4]. In this study, we use radio frequency magnetron sputtering (RFM-SPT) to deposit Ag and Ag_xO thin films. We found that the introducing oxygen, the oxygen flow ratio is R[O_2] % = [O_2 / (O_2 + Ar)] % and was changed from 0% to 30%, induces the silver transition from conductor to semiconductor or insulator. In order to investigate its crystal structure and optical properties, the grazing incident X-ray diffraction (GIXD) spectra and the UV-visible spectrometer had been used for the measurements. Afterward the band gaps were calculated and confirmed by Tauc plot. The Tauc plot was built on the data extracted from the transformation of transmittance spectra into absorption spectra.

The influence of R[O_2]% ratios on crystal structure was investigated via GIXD spectra with different thickness of 150 nm and as shown in Fig. 1. While oxygen R[O_2] % = 0% is neglected, the Ag-related diffraction peaks are detected as: (111), (200), (220), and (311), respectively. The relative intensity of Ag (111) diffraction peak is significantly higher than the others. After introducing oxygen into the depositions, all the diffraction peaks of Ag were diminished. Ag cations started to bond with oxygen ions forming transparent Ag_xO films, its related peaks were determined as marked in Fig.1. and Ag_xO tended to be the multi-mixture crystal. The variations in transmittance with the wavelength of different R[O_2]% of 150 nm Ag_xO films are shown in Fig. 2 (a). The optical band gaps were widened from 1.2 to 2.5 eV with increasing R[O_2] % from 10% to 17%. After the R[O_2]% increased to 20% and 30%, the band gap and resistivity both decreased. On the other hand, the observation from Fig. 2 (b) of absorption edges curves of higher R[O_2]% (>10%) along with the two different trends indicate that the Ag_xO depositions were a mixture of two individual oxides. When magnifying into the smaller range of absorption edge, as shown in the inset of Fig. 2 (b), another band gap value could be confirmed. There is the possibility that the thickness of the films impacted the optical evaluation. Then we decided to evaluate a thinner sample with a thickness of 50 nm. The detail of 50 nm Ag_xO thin films and other properties will be specifically presented at the conference.

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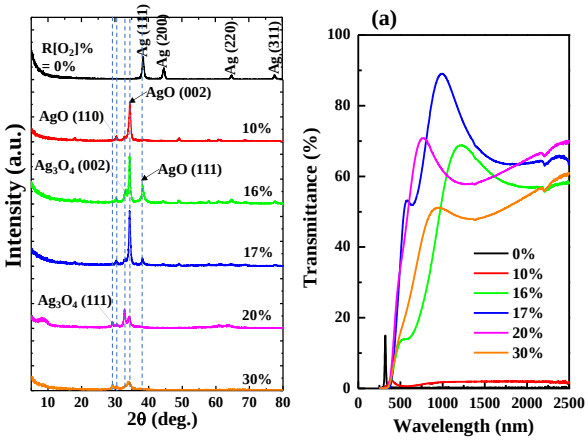

Fig. 1. GIXD of Ag_xO films

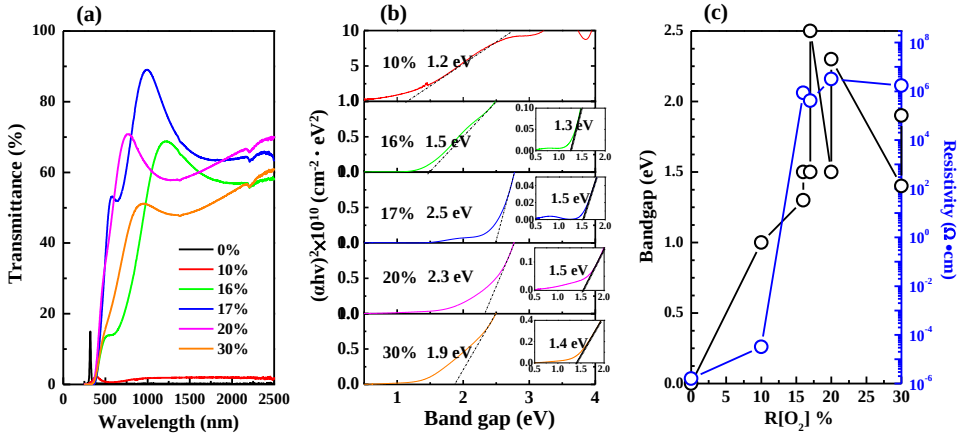

Fig. 2. Variations in transmittance and band gap