Characteristics of Oxide Semiconductor Films Deposited by Reactive Plasma Deposition

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We have fabricated and provided reactive plasma deposition with direct current (DC) arc discharge (RPD). The RPD enables us to achieve highly transparent conductive oxide (TCO) films deposited on amorphous substrates at low temperature; TCO films are based on indium tin oxide (ITO) and Ga-doped zinc oxide (GZO) films [1, 2]. We have been investigating the factors limiting growth rates and determining structural and electrical properties of ITO and GZO films deposited on glass substrates at temperature of 200°C by RPD. For ITO and GZO films during the deposition of those films, at the substrate level, we measured the incident fluxes (IF) of the neutral atoms, In and O, and Zn and O as host atoms, respectively, and their positively charged ions, i.e., Zn^+, In^+, O^+, and O_2^+. For the measurements, we used a mass-energy analyzer (Hiden, EQP300), a Langumuir probe, and a diaphragm gauge [3]. Figures 1(a) and (b) show the growth rates of ITO films and the count rates of the fluxes of In atoms and In^+ ions as functions of various total working pressure. For RPD-deposited ITO films, those clearly show that the fluxes of In^+ (>10 eV) ions were a dominant factor limiting the growth rate of ITO films. From Figure 2 that shows the growth rates of RPD-deposited GZO films as functions of the sum of IFs of the neutral O atoms, O^+ and O_2^+ ions, we concluded that the sum of IFs of the O-related species govern the film-growth rates. We elucidate what determines electrical properties of the ITO and GZO films.

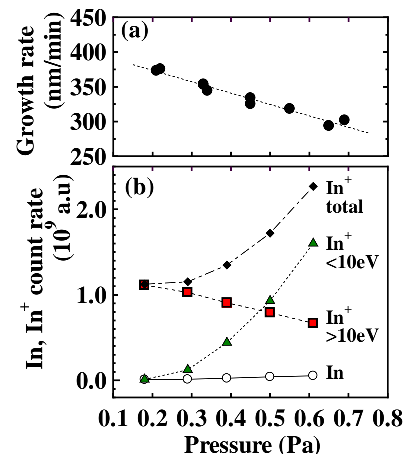

Fig. 1 (a) growth rates and (b) the count rates of neutral In atoms and In^+ ions of RPD-deposited ITO films.

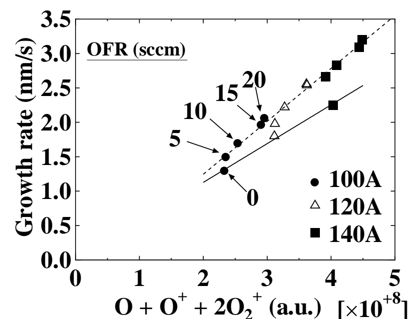

Fig. 2 Growth rates as functions of O-related species fluxes of GZO films.

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