Tunability band edges of valence band and conduction band in amorphous Cd-In-Ga-O system

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Band engineering of semiconductors is one of important techniques to design semiconductor devices such as solar cells, laser diodes and thin film transistors. In order to fabricate such semiconductor devices, it is important to consider band edges of valence band and conduction band. Among various semiconductors, amorphous oxide semiconductors (AOSs) have good advantages such as no lattice constants and high mobility comparing with amorphous Si, and low processing temperatures.

In this study, amorphous Cd-In-Ga-O films are fabricated to demonstrate the individual tunability of band edges of valence band and conduction band. Films were fabricated by a radio frequency magnetron sputtering system connected with ultraviolet photoelectron spectroscopy (UPS) vacuum chamber: Ionization potential (I_p) of films, which is the energy difference from the vacuum level and the VBM, can be measured by UPS without exposing atmosphere. Electron affinity (χ), which is the energy difference from the vacuum level to the CBM, was estimated by I_p and optical band gaps.

Fig.1 (a) and (b) show χ and I_p of amorphous Cd-In-Ga-O system, respectively: χ values were changed from 4.3 eV to 3.8 eV by tuning Cd:In ration. On the other hand, I_p values were decreased from 8.2 eV to 6.5 eV by increasing In concentration. Accordingly, we demonstrated that the energy positions of the VBMs and CBMs of amorphous Cd-In-Ga-O system, which are I_p and χ, respectively, could be individually controlled by tuning Cd:In:Ga ratios.

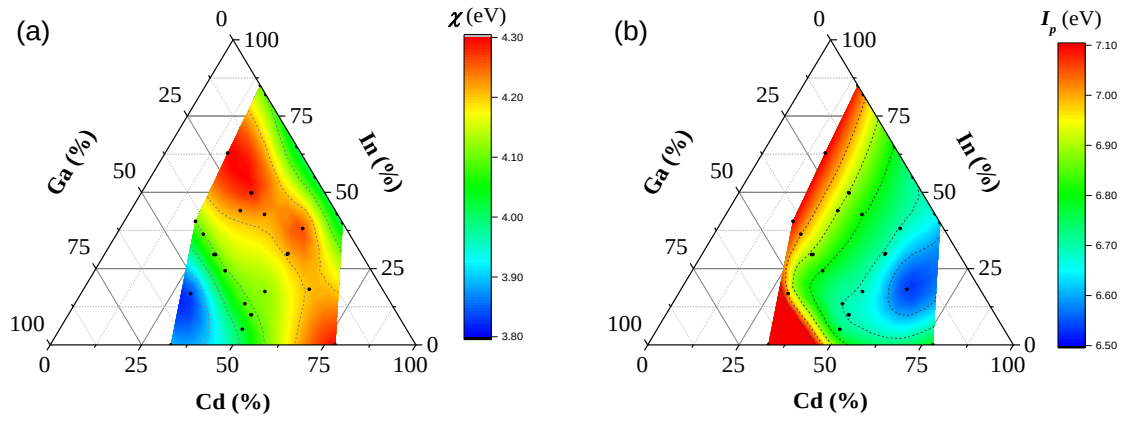

Fig. 1 (a) Electron affinity of amorphous Cd-In-Ga-O system (b) ionization potential of amorphous Cd-In-Ga-O system