# Growth of $Cu_2ZnSnS_4$ films by RF sputtering using a $Cu_2ZnSnS_4$ single phase target

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Chalcopyrite-type semiconductors have large absorption coefficient because of the direct bandgap structure. Their band gap has a wide range of wavelengths that is between 0.8 eV of $CuInTe_2$ and 3.5 eV of $CaAlS_2$. Therefore, the chalcopyrite-type semiconductors have been expected for solar cell technologies. Especially solar cell based on $CuInGaSe_2$ (CIGS) polycrystalline thin film is reported to have conversion efficiency of 19.9% [1].

Recently, $Cu_2ZnSnS_4$ (CZTS) films is a promising material for absorber layers of thin film solar cells since the film has suitable bandgap energy of 1.5 eV and large absorption coefficient of $10^4$ $cm^{-1}$. Furthermore, each element of CZTS films is abundant in the crust of the earth and non-toxic. In general, CZTS polycrystalline thin film of absorption layer is produced by co-sputtering method using Cu, SnS and ZnS targets before annealing by using $H_2S$ gas. In spite of accurate material characterization, solar cell based on CZTS polycrystalline thin film is reported to have conversion efficiency of 6.7% [2]. We expect a solution for a process without $H_2S$ which is a toxic gas. In the present study, we propose sputtering method by CZTS single phase target for developing super straight type CZTS based solar cell.

The CZTS films were prepared by RF magnetron sputtering under argon gas. The target used in the sputtering experiments consisted of single phase $Cu_2ZnSnS_4$. Deposition pressure was from 0.1 to 5 Pa and sputtering power was from 20 to 50 W. The substrate temperature was kept from RT to 100 °C, soda-lime glass was used as the substrate. The samples were evaluated by X-ray diffraction (XRD), SEM, EPMA, Hall, thermo probe and optical absorption measurements.

Fig. 1 shows XRD patterns of CZTS thin films grown under 1 Pa and 50 W by the CZTS single phase target as a function of Zn/Sn ratio. No secondary phases such as sulfide materials can be observed in CZTS (Zn/Sn=1) patterns. No secondary phases also can be observed with changing Zn/Sn ratio. The (112) diffraction peak becomes strong orientation with increasing Zn/Sn ratio. Furthermore, all samples indicate p-type conductivity by thermo probe and hall measurements. Sulfur vacancy is assumed to be a few in all samples from EPMA results

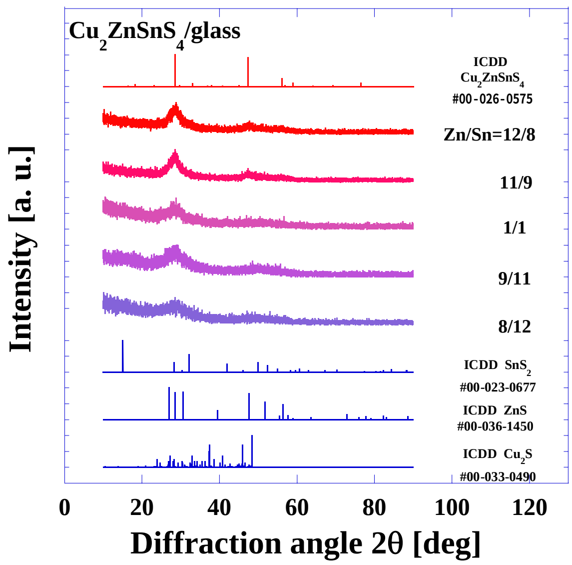


Fig.1 XRD pattern

[1] I. Repins et al., Prog. Photovol. Res. Appl. **16** (2008) 235.
[2] H. Katagiri et al., Appl. Phys. Express **1** (2008) 41201.