RF スパッタリングで成膜した $CuGaS_2$ 薄膜の結晶性に Ag_2S バッファ層が与える影響

Effects of Thin Ag_2S Buffer Layers on $CuGaS_2$ Thin Films Grown with RF Sputtering

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[Introduction] $CuGaS_2$ (CGS) is one of the potential compound materials for thin-film photovoltaics because of its high optical absorption coefficient and adjustable wide band gap [1]. The effect of Ag precursor layers has been reported effective in improving the crystalline qualities of the narrow bandgap counterpart, $CuInGaSe_2$ [2]. CGS band gap of 2.46 eV is in the green part of the visible spectrum and requires improvement of its crystalline quality for potential application for high energy photon absorptions or intermediate band solar cell applications [3]. This research investigates the effect of a thin buffer layer of Ag_2S below CGS on its crystallinity.

[Method] Thin buffer layers of Ag_2S and thick CGS layers were deposited on quartz substrates using radio frequency (RF) magnetron sputtering (Fig.1). The deposition took place under S-rich environment at substrate temperature of 400 °C with 1.4 Pa of pressure and 20 W of RF power. The deposited samples were cooled down to room temperature under vacuum environment. X-Ray diffractions and UV Visible light absorbance were measured to study the crystalline nature and optical properties.

[Results and Discussion] The observed X-Ray diffraction data show increase in the intensity of CGS (112) plane diffraction peak for CGS sample grown on Ag_2S buffer layer as seen in Fig.2. This might be attributed to the improved surface of Ag_2S for crystalline growth of CGS. Experimentally, an increase in the bandgap of CGS 2.35 eV to 2.45 eV was observed with Ag_2S buffer (Fig.3).

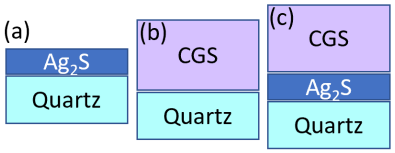

Fig.1 Sample structures on Quartz substrate: (a) 20 nm-thick Ag_2S, (b) 1µm-thick CGS, and (c) 1µm-thick CGS on 20 nm-thick Ag_2S

[Conclusion] This study focused on the effects of Ag_2S buffer layers on the crystalline growth of CGS thin films. This was observed with an improvement in crystalline quality associated with an increase in the bandgap for CGS with Ag_2S buffer layer compared to reference CGS without the buffer.

[References]

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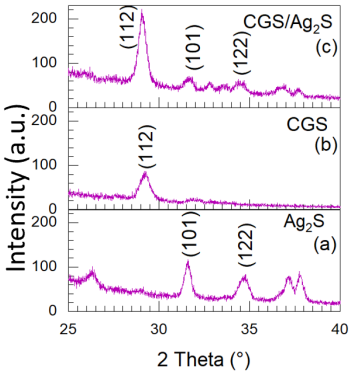

Fig.2 XRD spectra at 0.4 ° grazing angle

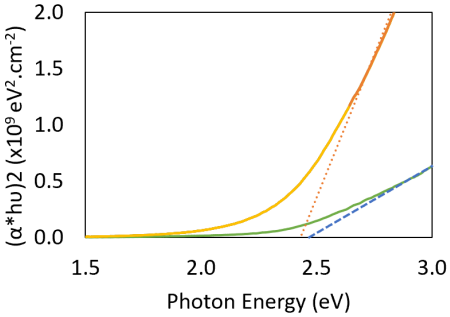

Fig.3 Tauc plot for CGS (Yellow), CGS/Ag_2S (Green)