FABRICATION OF CZTS THIN FILMS BY USING STACKED PRECURSORS

Takahiro Maeda, Tatsuya Araki, Kazuo Jimbo, Yosuke Shimamune and Hironori Katagiri

National Institute of Technology, Nagaoka College, Japan

Cu2ZnSnS4 (CZTS) is a promising candidate for one of the new type of solar cell materials in the next generation because it has suitable optical properties for an absorber. Furthermore, those constituents are all earth abundant and nontoxic\(^1\). In this study, using an RF sputtering method, we tried to fabricate CZTS thin films using 3 targets of Cu-Sn alloy, Cu and ZnS. We can adjust composition ratio more easily compared to the method of using a CZTS sintered target. By using the sequential sputtering method, a stacked precursor was prepared on Mo-coated soda lime glass substrate. Its structure was SLG/Mo/[(Cu-Sn/Cu/ZnS) \(x\) 3 periods]. To enhance the interdiffusion of each element, this multiperiod structure was introduced through the preliminary experiments. Applied RF power and the sequential sputtering time of each targets of Cu-Sn alloy, Cu and ZnS were 83[W]-8.3[min], 150[W]-5.4[min] and 150[W]-17[min], respectively. This procedure was repeated 3 times to form 3 periods precursor. So the total sputtering time of each targets were 25[min], 16[min] and 51[min], respectively. We named this stacked ordered sample Reference (Ref.). Then the precursor was sulfurized in a tubular electric furnace by using a tin vapor transport (TVT) method. The obtained CZTS thin film was characterized by XRD, XRF, SEM and GD-OES. Thereafter, the sample was used to fabricate a CZTS solar cell. Figure 1 shows the cross-sectional SEM image of the sulfurized CZTS thin film. It seems to be a 2-layered structure. We can see that the top layer was constructed with the well-developed large crystal grains. On the other hand, there are small grains in the bottom layer. Furthermore, we can see many micro voids existing at the interface between Mo and CZTS.

To improve the quality of CZTS thin films, especially to prevent the formation of micro voids at the interface between Mo/CZTS, new stacking ordered precursor of SLG/Mo/ZnS/Cu/ZnS/Cu-Sn/ZnS was prepared. Figure 2 shows the cross-sectional SEM image of CZTS thin film prepared by the new stacking ordered precursor. We can see that there are no voids at the interface and the crystal grains located at lower layer become larger than that of figure 1(Ref.). Figure 3 shows the comparison of \(J-V\) characteristics. The CZTS solar cell using the sample (Ref.) performed an efficiency of 1.09[\%], \(J_{sc}\) of 6.41[\(\text{mA/cm}^2\)], \(V_{oc}\) of 672[mV] and \(FF\) of 0.25. On the other hand, using new stacking ordered precursor, we achieved an efficiency of 3.56[\%], \(J_{sc}\) of 15.48[\(\text{mA/cm}^2\)], \(V_{oc}\) of 640[mV] and \(FF\) of 0.34.

Figure 1: Cross-sectional image of SLG/Mo/CZTS film (Ref.).
Figure 2: Cross-sectional image of New Stacking ordered CZTS film.
Figure 3: Comparison of \(J-V\) curves.

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