Nucleation of Cu_2Te Layer by a Closed Space Sublimation Method toward the Growth of Te Based Chalcopyrite

Y. Sakurakawa[a], A. Uruno[a], and M. Kobayashi[a,b]

[a] *Waseda University, Department of Electrical Engineering and Bioscience, 3-4-1, Okubo, Shinjuku, Tokyo 169-8555, Japan*

[b] *Waseda University, The Kagami Memorial Research Institute for Materials Science and Technology , 2-8-26, Nishiwaseda, Shinjuku,Tokyo 169-0051, Japan*

The two-step closed space sublimation (CSS) growth of high quality $AgGaTe_2$ layer was successfully achieved by the formation of the Ag_2Te layer as a first step [1,2]. This $AgGaTe_2$ layer was successfully applied to the solar cells [2]. $CuGaTe_2$ has been focused on because of the lower material cost than $AgGaTe_2$. Based on the success of $AgGaTe_2/Ag_2Te$, $CuGaTe_2/Cu_2Te$ was proposed and the growth of Cu_2Te by the CSS method was attempted in this study. It has been confirmed that the surface morphology was widely varied depending on the growth parameter in case of the Ag_2Te layer growth. The realization of the membrane-filter structure for the Ag_2Te layer was the key for the formation of high quality $AgGaTe_2$ layer. In this study, Cu_2Te layer was formed on various substrate materials and surface orientations using various source materials. Judging from the phase diagram of Cu-Te [3], Cu-Te compounds would exhibit various structures depending on the temperature and the mole ratio, hence the surface structure of the layer could be drastically controlled. The substrate surface chemistry (dangling bond density, polarity, and so on) would also affect the formation process of Cu-Te compounds.

Cu_2Te layers were grown using 3N Cu_2Te powder or 3N CuTe powder. The substrate temperature during the layer growth was varied from 590 °C to 700 °C. The substrates used were Si(001), Si(111) and Al_2O_3(0001). The surface structure of the obtained layer was characterized using scanning electron microscope (SEM). The crystallographic property of the layer was mainly analyzed by the θ-2θ profile of the x-ray diffraction.

Figure 1 shows the SEM image of the layer grown on Si (001) at 590 °C. Plateaus and cells surrounding them were observed. This surface structure was probably associated with the peritectoid reaction of Cu and Te [3]. The size of plateau and their spacing were sub-micrometer scale, and such structures would be useful for fabricating various nano-structures. The size and the shape of the plateau revealed to be affected by the substrate temperature and the surface orientation of the substrate. The nucleation of the $CuGaTe_2$ layer on this surface structure would be also reported.

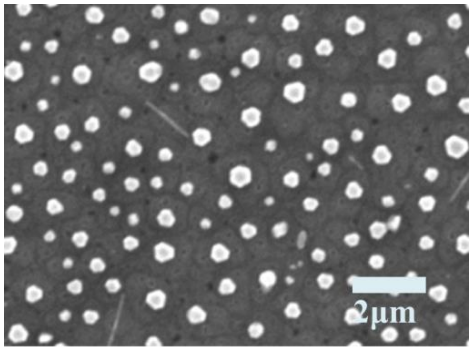

Figure 1 The surface SEM image of layer grown on Si(001) at substrate temperature of 590 °C.

+ Author for correspondence: skrkwyh.6-1-9@akane.waseda.jp

[1] A. Uruno, et al. Phys. Status Solidi C **12,** 508 (2015).

[2] A. Uruno, and M. Kobayashi, J. Electron. Mater. **45**, 4692 (2016).

[3] A. S. Pashinkin and L. M. Pavlova, Inorg. Mater. **39,** 539 (2003).