19a-D7-12

Impact of Ga/(In+Ga) Content in Different Cu(In,Ga)Se_2 Part on Cell Performance Investigated by Correlation Coefficient

Department of Electrical and Electronic Engineering, Ritsumeikan University [1], Environment & Energy Research Center, Nitto Denko Corporation[2], ○(P)J. Chantana[1], D. Hironiwa[1], T. Watanabe[2], S. Teraji[2], K. Kawamura[2], T. Minemoto[1]

E-mail: jakapan@fc.ritsumei.ac.jp

The Cu(In,Ga)Se_2 (CIGS) solar cells are fabricated, where CIGS absorbers with various Ga/III, Ga/(In+Ga), profiles are prepared by the so-called “multi-layer precursor method” [1]. The Ga/III profile is investigated by dynamic-secondary ion mass spectroscopy. In this work, the correlation (linear dependence) between cell parameters and the averaged Ga/III ratios, calculated in different depth ranges of the Ga/III profiles, is examined by correlation coefficient. The correlation coefficient, calculated as shown in ref. [1], determines the degree to which two variable's movements are associated. It varies from -1 to +1. A -1 indicates perfect negative correlation, and +1 indicates perfect positive correlation.

In Fig. 1, V_{OC} and averaged Ga/III, calculated in the range (A) from 0 to 200 nm, indicate high correlation (less scatter data), whereas V_{OC} and averaged Ga/III, calculated in the range (B) from 800 to 1600 nm, show less correlation (more scatter data), thus leading to correlation coefficient of V_{OC} (0.97) in the case of A higher than that (0.92) in the case of B. Moreover, the correlation coefficient of V_{OC} in Fig. 2 is close to 0.97 when the depth range (< ~320 nm) for calculating averaged Ga/III. Based on the results in Figs. 1 and 2, it is implied that V_{OC} is strongly influenced by Ga/III content near CIGS absorber surface of the solar cell. Motivated by the results, we also observe the correlation (linear dependence) between other cell parameters (*FF*, and J_{SC}) and various averaged Ga/III ratios calculated in several depth ranges in CIGS absorber to distinguish which part of the absorber primarily affects each cell parameter (*FF*, and J_{SC}), providing general insight into the requirements for the improvement of cell efficiency. The detail will be discussed.

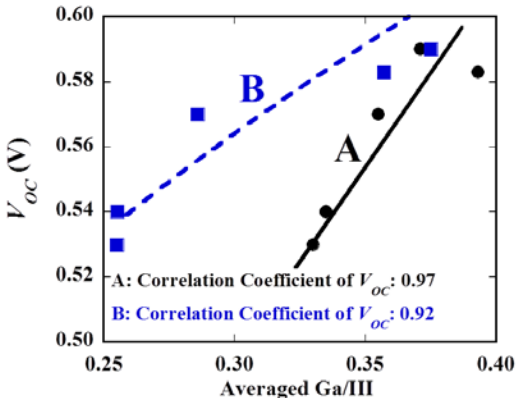

Fig. 1. V_{OC} of solar cells on SLG substrates as a function of the averaged Ga/III ratios calculated in ranges; (A) from 0 to 200 nm, and (B) from 800 to 1600 nm, respectively, expanding from CIGS surface.

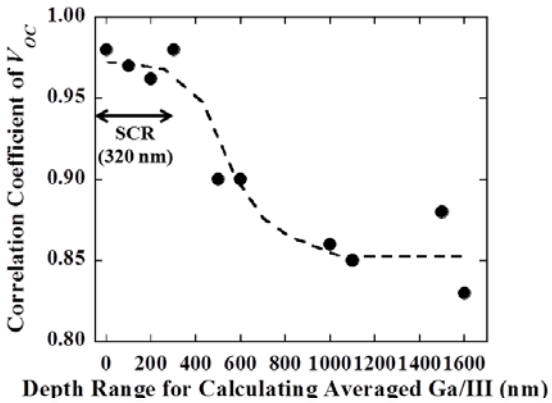

Fig. 2. Depth range from CIGS absorber surface expanding into its bulk using for the calculation of various averaged Ga/III ratios potted against correlation coefficients of V_{OC}

Reference

[1] Jakapan Chantana et. al., Journal of Applied Physics **114** (2013) 084501.

Acknowledgement

This work is partly supported by NEDO.