Time-resolved Photo-assisted Kelvin Probe Force Microscopy on Cu(In,Ga)Se_2 Solar Cells

T. Kuroiwa,[1] S. Li,[1] and T. Takahashi[1,2,#]

[1]*Institute of Industrial Science, The University of Tokyo, Tokyo 153-8505, Japan*
[2]*Institute for Nano Quantum Information Electronics, The University of Tokyo, Tokyo 153-8505, Japan*

takuji@iis.u-tokyo.ac.jp

Photo-assisted Kelvin probe force microscopy (P-KFM)[1] is very useful for examining local photovoltaic characteristics on solar cells, and improvement of a time resolution in P-KFM is desired for investigating carrier dynamics in time domain. In this study, we have developed time-resolved photo-assisted Kelvin probe force microscopy[2], referred to as Tr-PKFM, by combining an intermittent bias application method[3] and a pump-probe method[4] to realize time-resolved measurements at μsec order and have applied it to Cu(In,Ga)Se_2 [CIGS] solar cells. From the temporal waveforms of photovoltage observed by Tr-PKFM on the CIGS solar cells with different Ga compositions shown in Fig. 1, we have found certain differences of rising and decay rates of photovoltage between the samples. Especially for the photovoltage rise, the photo-generated electrons in CIGS have to be injected into a surface *n*-type layer, and the slow rising rate of photovoltage means a decrease in the injection rate of the photo-generated electrons from CIGS. Therefore, we consider that the rising time constant becomes one indicator of the solar cell performance, and have found that a difference in rising time constant was consistent with a difference in conversion efficiency. From the temporal change in photovoltage distribution after the onset of the light pulse shown in Fig. 2, in addition, the spatial distribution of photovoltage related with the surface topography were recognized, which is attributable to the in-plane band diagram around the grain boundary in CIGS.

The CIGS solar cells used in this study were provided by Professor T. Minemoto of Ritsumeikan University, Japan.

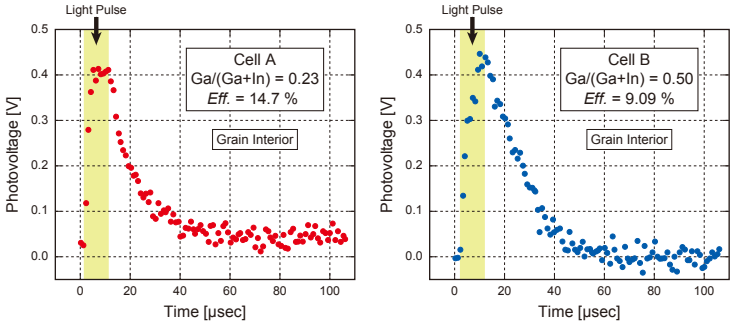

Figure 1. Temporal waveforms of photovoltage on the CIGS solar cells with different Ga compositions.

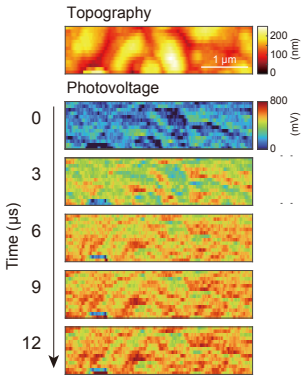

Figure 2. Photovoltage distribution on Cell B after the onset of the light pulse.

References

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