Effect of heat-bias-soaking on CsF-treated CIGS thin film solar cells

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Introduction: Post-treatments such as light soaking [1], bias soaking [2], and combine effect of heat and light soaking (HLS) [3] have beneficial effect to improve the efficiency of CIGS solar cells with Zn compound buffer layer. Recently, we observed similar positive effect on KF-treated CIGS solar cells with CdS buffer layer. This improvement was attributed to increased net carrier concentration (N_{cv}), and not the change in the atomic concentration of buffer layer. A positive bias generated due to the illumination was suggested as a driving force for the increased N_{cv} (because of migration of alkali ions), thereby, improving solar cell efficiency [4]. Based on these results, it can be expected that by applying positive bias close or greater to the V_{oc} of the solar cells from external source, the cell efficiency of the alkali-treated CIGS solar cell can be improved. To verify this hypothesis, we investigated the effect of heat-bias-soaking (HBS) on CsF-free and CsF-treated CIGS solar cells.

Results and discussion: As expected, HBS improved V_{oc} and efficiency of CsF-treated CIGS solar cell, whereas such beneficial effect was not observed on CsF-free CIGS solar cells. The J_{sc} losses after HBS was noticed a severe factor limiting the efficiency improvement. Capacitance-voltage measurement confirmed a significant increase in N_{cv} after HBS for CsF-CIGS solar cells, which at least suggest one of the possible reasons for increased V_{oc}. Due to the extremely high N_{cv}, J_{sc} reduces because of narrower depletion width. Therefore, a subsequent HS process was found beneficial method after HBS to tune the N_{cv}, thus the depletion width, for lesser J_{sc} losses. Similar results were also obtained for NaF-treated CIGS solar cells after HLS [5]. Furthermore, by optimizing post-treatment parameters, we could able to improve efficiency gain using HBS by increasing bias voltage as shown in Figure 1. The detail will be presented during the conference with the AIST certified data (obtained after HBS).

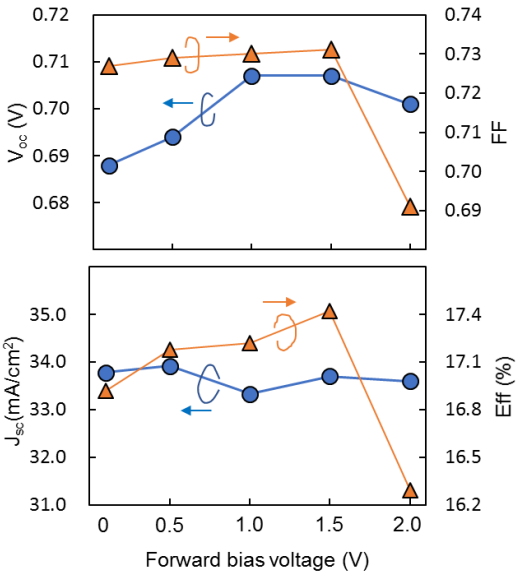

Figure 1. Basic solar cell parameters of CsF-treated CIGS solar cells at different forward bias voltages. HBS was performed at 130˚C.

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