Effects of compositional distribution on secondary phase and defect in CZTS thin-film solar cell

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Although Cu_2ZnSnS_4 (CZTS) has attracted attention as an alternative absorber material to replace $CuInGaSe_2$ (CIGS) in solar cells, the current level of understanding of its characteristic loss mechanisms is not sufficient for achieving high power conversion efficiency. In this study, we examined the correlations between the compositional ratio distribution within the CZTS absorber layer, which depends on the temperature of the sulfurization process, and the subsequent defect and surface electrical characteristics. As the sulfurization process temperature increases, the crystallinity of the absorber layer improves, and the compositional ratio distribution exhibits a more uniform Cu-poor/Zn-rich composition. Additionally, the degradation of the back-contact barrier characteristics can be controlled by suppressing the ZnS secondary phase formation at the CZTS/MoS_2 interface. Furthermore, this improvement suppresses the formation of deep-level defects, thereby enabling the current and voltage losses to be minimized. This result was verified by analyzing the surface electrical characteristics. We anticipate that the PCE of a CZTS solar cell with a highly uniform compositional ratio distribution can be further increased.

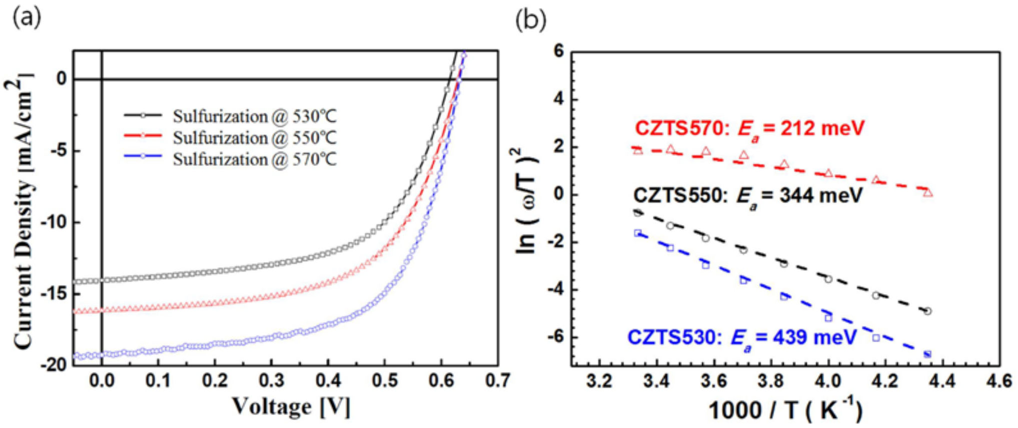

Fig. 1. CZTS solar cell characteristics at various sulfurization temperatures : (a) current density–voltage characteristics of CZTS solar cells and (b) is the Arrhenius plot of the inflection point of the capacitance function calculated from the derivative of the Admittance spectroscopy. E_A corresponds to the bulk defects (hole traps) within an absorber layer.

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References

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