VIDEO ARTICLE

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Fingerprints for Superior Properties of Internal Interfaces in CIGS Thin-Film Solar Cell

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Abstract

$Cu(In,Ga)Se_2$ (CIGS) absorber grown under Cu-poor conditions give rise to the incorporation of numerous defects into the bulk, whereas the same absorber grown under Cu-rich conditions leads to a stoichiometric bulk with minimum defects. This suggests that CIGS absorbers grown under Cu-rich conditions are more suitable for solar cell applications. However, the record efficiencies of the CIGS solar cell device have been always obtained under Cu-poor conditions, despite the expectations. Therefore, in the present work, we investigate both, Cu-poor and Cu-rich CIGS cells, and prove that the superior properties of internal interfaces (such as pn junction and grain boundaries) of Cu-poor CIGS cells makes them always the record efficiency devices. More precisely, by employing correlative microscopic approach, we discover for the first time the typical fingerprints for superior properties of internal interfaces necessary for maintaining a lower recombination activity in the cell. These are the Cu-depleted and Cd-enriched CIGS absorber surface, near the pn junction region, as well as the negative Cu-factor ($\Delta\beta$) and high Na content (> 1.5 at.%) at the grain boundaries. Hence, this work provides key factors governing the device performance (efficiency) and can be employed for the design of next-generation solar cells.

Keywords: Cu-poor $Cu(In,Ga)Se_2$, Cu-rich $Cu(In,Ga)Se_2$, p-n junction, grain boundary, atom probe tomography, correlative microscopy, density functional theory, device simulation.

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