Cu(In,Ga)Se_2 growth by magnetron sputtering with Cu-rich and Cu-poor targets

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High-efficiency Cu(In,Ga)Se_2 (CIGSe) thin-film solar cells are typically fabricated by a multi-stage co-evaporation process, where one of these stages leads to a Cu-rich composition [1]. Cu-rich conditions favor the growth of CIGS grains, improving the overall efficiency of the solar cell [2]. In this work, we explore the effect of the copper stoichiometry of sputtering targets on the grain size of the CIGSe absorber and on the efficiency of the solar cells. Cu(In,Ga)Se_2 absorber layers were deposited on Mo/soda-lime glass substrates under the same conditions with two different Cu-In-Ga targets: $Cu_{0.6}In_{0.25}Ga_{0.15}$ and $Cu_{0.5}In_{0.35}Ga_{0.15}$. Selenium was supplied simultaneously by a pulsed valved-cracker evaporation source [3]. Scanning electron microscopy analysis revealed that CIGS films sputtered with the Cu-rich target exhibited larger grains than those deposited with the Cu-poor target (Fig. 1). To fabricate complete solar cells, the CIGSe layers were submitted to a KCN-etching process to remove $Cu_{2-x}Se$ impurity phases, after which a CdS buffer layer was deposited by chemical bath deposition and a i-ZnO/ZnO:Al double layer was sputter-deposited as the front contact. Solar cells based on the Cu-rich deposited CIGSe absorbers show better photovoltaic parameters compared to those based on the Cu-poor deposited CIGSe, as evidenced by current-voltage curves (Fig. 2). We attribute the improved performance to the larger grain size enabled by the Cu-rich growth conditions.

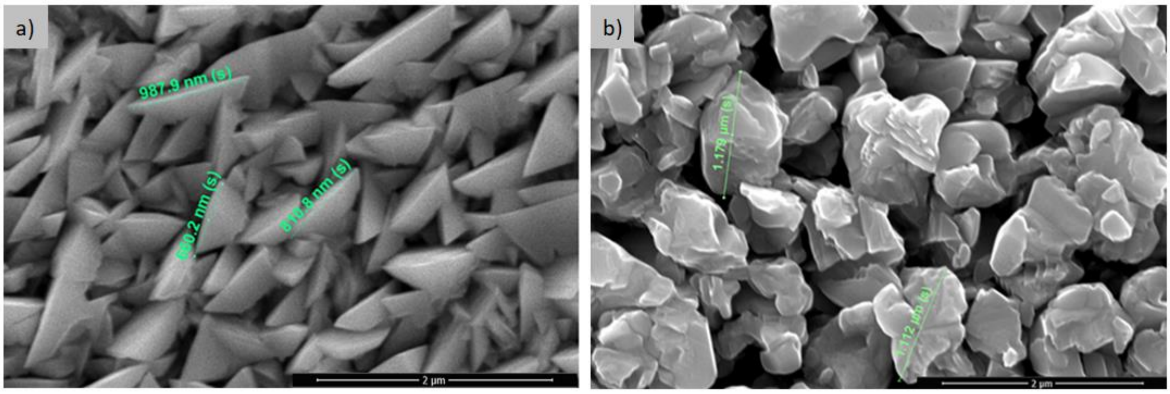

Figure 1. CIGS crystals grown at 400°C with (a) Cu-poor target and (b) Cu-rich target.

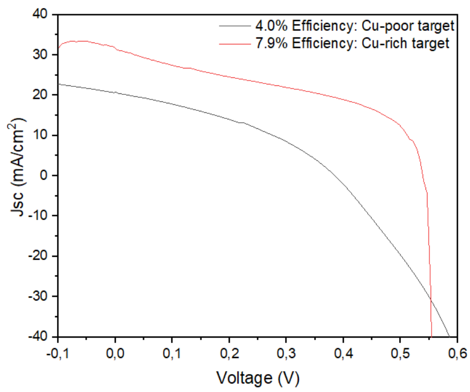

Figure 2. I-V curve of the best solar cells achieved at a deposition temperature of 400ºC with Cu-poor and Cu-rich targets.

REFERENCES
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