



Pathway towards improved efficiency of kesterite based solar cell

CONTACT

louis.grenet@cea.fr

Md Abdul Aziz SUZON (Ph.D. student), Louis GRENET (thesis supervisor), Henri MARIETTE (thesis director)

LABORATORIES : CEA-LITEN, INAC

CdTe and $\text{Cu}(\text{In,Ga})\text{Se}_2$ (CIGS) materials are used in commercial thin-film solar cell technologies. However, both of them contain critical raw material (toxic and/or scarce elements). Kesterite $\text{Cu}_2\text{ZnSn}(\text{S,Se})_4$ (CZTSSe) absorbers are very attractive since they are made of abundant and non-toxic constituents. However, despite very similar optoelectronic properties, CZTSSe-based solar cells exhibit half of the CIGS-based devices efficiency.

In order to improve carrier collection and to increase efficiencies in kesterite solar cells, we aimed at introducing a band gap gradient in the device absorber. It was successfully implemented by varying

the $[\text{S}]/([\text{S}]+[\text{Se}])$ ratio in the depth of the absorber as demonstrated by material characterization. In parallel, improving efficiencies of CZTSe and CZTS devices was necessary to fabricate efficient devices with bandgap gradient. In CZTS devices, it was done through the incorporation of Na (Sodium) and Sb (Antimony) into the kesterite absorber : this was found to be beneficial in terms of defect passivation (Na) and morphology quality (Na+Sb). Particularly, best efficiency with optimized Na content is doubled ($> 4.5\%$) compared to the sample without Na. Maximum efficiencies of 6.5% and 9.4% have been obtained for CZTS and CZTSe solar cells respectively (see Fig.).

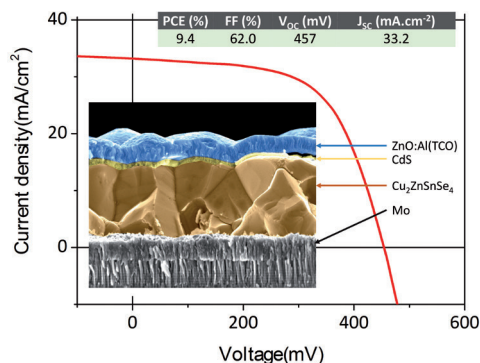


Fig. : I-V curve under AM 1.5G illumination and SEM cross section of our best experimental kesterite based device

OUTCOMES

- [1] Analysis of failure modes in Kesterite solar cells, ACS Appl. Energy Mater. (2018), DOI: 10.1021/acsaem.8b00194
- [2] Comparing strategies for improving efficiencies in vacuum processed $\text{Cu}_2\text{ZnSnSe}_4$ solar cells, J. Renew. Sust. Ener. (2018), DOI: 10.1063/1.5034526
- [3] Na and Sb doping in CuZnSnS_4 solar cells, in preparation
- [4] S/Se gradient in kesterite absorbers through sequential annealing, in preparation

Oral presentation:

- 8th EU Kesterite Workshop, Barcelona, Spain 2017
- JNPV, Dourdan, France, 2017