POSTDOC SUBJECT

Postdoc in science / semiconductor physics - 2D numerical simulation of perovskite/heterojunction silicon tandem solar cells - Le Bourget du Lac (FR) - 2 years

Silicon heterojunction solar cells, as developed at CEA-INES [1], are reaching conversion efficiencies close to the feasible limit (26.81% [2]). To go beyond the physical limit of ~29.5% for a silicon single junction, many research groups around the world are now developing tandem solar cells, that allow to absorb more energy from the incoming sun light. Longi and KAUST [3] [4] recently obtained conversion efficiencies above 33.5% for cells made from perovskites (PK) and silicon heterojunction (SHJ). Nonetheless, these results were obtained on small areas (typically 1cm²) whereas the silicon photovoltaic industry is now working on areas >274cm². Additionally, the PK top cell fabrication techniques are not yet up-scalable (in most cases). In this context CEA-INES is working at increasing the conversion efficiency of PK/SHJ tandem cells on large areas, as well as with industry compatible techniques. A power conversion efficiency of 27.1% on 9 cm² was recently achieved together with CEA industrial partner 3Sun (Enel Green Power, Italy) [5]. To support these developments, CEA-INES is looking for a post-doc to work on 2D simulation of perovskites/silicon heterojunction tandem solar cells.

The candidate will have the responsibility to develop a model of the PK/SHJ tandem cell on the TCAD simulation package Silvaco. A realistic description of the materials will be implemented, based on in-house characterization of actual layers used (potentially performed during the post-doc), or based on literature. Then the focus will be set on the adjustment of the interface between the two sub-cells (so-called recombination junction, or tunnel junction).

This model will afterwards be used to improve our understanding of the tandem cell working principle. In particular, inhomogeneity in layer properties, defects and there influence on cell efficiency will be investigated and brought face to face with experimental results.

Finally, strategies to mitigate the influence of these defects will be defined to help the development teams to increase the device efficiency on large areas.

The candidate will join the silicon heterojunction lab, internationally recognized for its expertise on SHJ cell at industrial level. He/she will have the opportunity to capitalize on a long experience of silicon based solar cell simulation at CEA-INES [6, 7, 8]. The tandem cell lab will provide all its expertise on PK materials and cells required for the correct configuration of the simulation model.

For this post-doc position, the candidate needs solid background in semi-conductor physics, as well as previous record in working with simulation tools. He/She will need strong organization skills. The results will be published in peer-reviewed journals, as well as in conferences.

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[1] A. Danel, «A versatile pilot line to support heterojunction solar cell industrial development,» chez *Proc. 33rd EU PVSEC*, Amsterdam, The Netherlands, 2017.

[2] H. Lin, «Silicon heterojunction solar cells with up to 26.81% efficiency achieved by electrically optimized nanocrystalline-silicon hole contact layers,» *Nature Energy,* pp. 789-799, 2023.

[3] [En ligne]. Available: https://www.longi.com/en/distributorbriefing/longi-reached-new-record/. [Accès le 09 2023].

[4] «PV Magazine,» 30 05 2023. [En ligne]. Available: https://www.pv-magazine.com/2023/05/30/kaust-claims-33-7-efficiency-for-perovskite-silicon-tandem-solar-cell/. [Accès le 28 09 2023].

[5] «CEA-LITEN,» [En ligne]. Available: https://liten.cea.fr/cea-tech/liten/Pages/Medias/Actualites/PV-Haut-Rendement/Enel-Green-Power-et-le-CEA-ameliorent-leur-record-de-rendement-avec-27-1-sur-9-cm.aspx. [Accès le 26 09 2023].

[6] V. Giglia, «Understanding of the influence of localized surface defectivity properties on the performances of silicon heterojunction cells,» *Progress in PV,* 2020.

[7] J. Veirman, «Silicon wafers for industrial n-type SHJ solar cells: Bulk quality requirements, large-scale availability and guidelines for future developments,» *Sol. En. Mat. & Solar Cells,* 2021.

[8] R. VARACHE, «Investigation of selective junctions using a newly developed tunnel current model for solar cell applications,» *Solar Energy Materials and Solar Cells,* pp. 14-23, 2015.