Model development for the investigation of solar cell to module efficiency losses in flexible CIGS technology

$Cu(In,Ga)Se_2$ (CIGS) is one of the most promising materials for highly efficient thin film solar cells for energy generation. One of the main advantages is that CIGS can be grown on very thin flexible substrates enabling scalable, large-area production at low cost of lightweight solar panels for different applications, i.e. building integration of photovoltaic systems (BIPV) or mobility applications. CIGS technology has already demonstrated its potential at the industrial level. Nevertheless, there is still a significant efficiency gap between the record laboratory solar cells and commercial modules, which includes numerous solar cells interconnected in series. The main reasons are the presence of non-uniformities in the electrical and material properties resulting in localized paths of leakage current and the losses at the interconnection between the solar cells in the module.

In this project, numerical or circuit models will be developed for further understanding the physical and electrical mechanisms responsible for the efficiency gap from solar cells to modules. Different approaches could be explored depending on the profile of the candidate. The student will apply device models to describe the solar cell behavior and build a tool for the simulation of a module in 2-D or 3-D. Based on this model, optimized designs or new strategies for module design will be proposed to mitigate the effect of various patterns of inhomogeneity in material and electrical properties. The numerical tool will be validated against experimental data available from solar cell characterization: I-V measurement, external quantum efficiency, spectral or time resolved photoluminescence and electroluminescence imaging, among others. The student will also get familiar with the principles of such measurements to obtain a better understanding of the physics of solar cells.

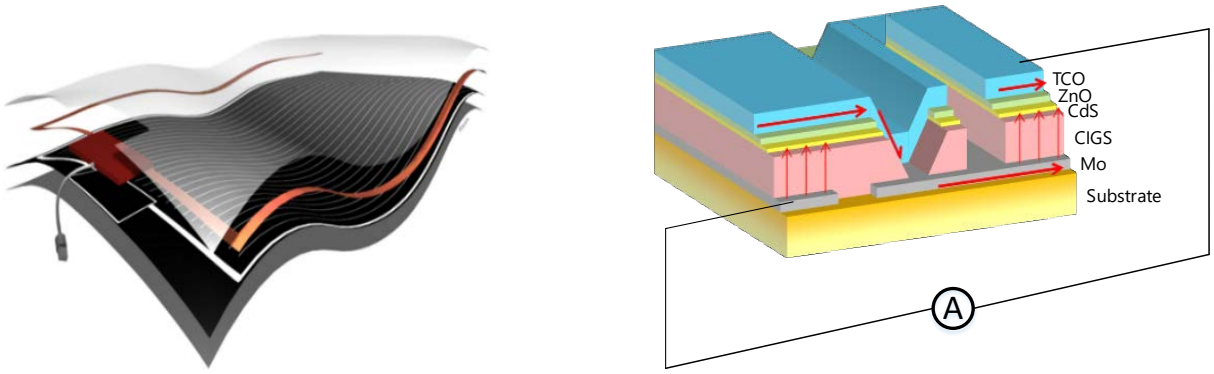

Figure 1. Left: A flexible commercial CIGS module. Right: schematics of the interconnection between two solar cells in a module.

We are looking for students in the field of Materials Science/Physics/Electrical Engineering willing to work in a motivated, multi-disciplinary team performing cutting-edge science in the field of thin-film solar cells. The ideal candidate is dedicated to model development with a strong focus on applied research. Do not hesitate to contact us.

Duration: 4-6 months (Semester project or Master thesis)

Starting date: anytime

Required skills: Programming and basic solid state physics knowledge.

Contact: Mario.ochoa@empa.ch, romain.carron@empa.ch

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