

MASTER INTERNSHIP M2 CDM (5 months, Feb. - June)

2024-2025

Title of the project: Elaboration and characterization of thin-film chalcogenide photovoltaic systems with wide band gap.

Supervisor(s):

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Collaborations: INSA Lyon

Subject situation:

Today, the use of photovoltaic energy on a large scale requires solar cells (SC) made of abundant and non-toxic materials. Silicon technology widely dominates the photovoltaic (PV) market with an efficiency of 26.3%, but its manufacturing cost remains high, which limits its use at the terawatt level. Moreover, many areas cannot be covered by this technology (indoor, flexible transparent and lightweight SC...).

The thin-film technology with Kesterite absorber ($\text{Cu}_2\text{ZnSnS}_4$ named CZTS or $\text{Cu}_2\text{ZnSnSe}_4$ named CZTSe) based on copper, zinc, tin and sulphide or selenide is promising for the development of environment-friendly SC (but with still weak performance about 12.6%)

In our Nanoform team, we produce and optimise full chalcogenide SC with wide band gap using eco-friendly and inexpensive processes and chemical products for indoor and tandem applications. Our practical and theoretical works contribute to understanding the origin of the limitation of the efficiency of chalcogenide SC and to develop full systems for new applications.

Objectives of the internship:

The subject of this internship is the realisation and the characterisation of thin films and devices. The steps of this work should be:

- 1) realize the thin layers for full device solar cells (absorber layer (CZTS, ACZTS, Sb_2S_3 ...), buffer layer (ZnS ...), hole transport layers... using the protocols developed by the Nanoform
- 2) identification of the phases and characterisation (structural, optical, electric)
- 3) realisation of the device (full solar cell with all layers)
- 4) characterisation of the chalcogenide solar cells (structure, efficiency, I/V curve...)
- 5) build a database for further processing using AI.

Subject collaborations:

This project will be based on the complementary expertise of i) the Nanoform team (nanosciences axis, ICB lab.) for the elaboration of chalcogenide materials and devices by chemical routes (Nanoform Team); ii) technical characterisation departments (ARCEN, ICB teams...) for structural and physicochemical characterizations (XRD, XPS, TEM, SEM EDS...); INSA Lyon for photovoltaic device knowledge and elaboration/characterisation tools.

Type of project (theory / experiment): Experimental (elaboration, characterization...)

Funding : 5-month scholarship

Location of the internship: This internship will take place at ICB (Laboratoire Interdisciplinaire Carnot de Bourgogne, UMR6303, Dijon)

Required skills in: chemistry and physicochemistry, some knowledge in solid state physics. And a knowledge in solar cells would be appreciate

And : autonomy, curiosity, practicality

And: this subject could be started during the *M2 Projectlab* (familiarization with the topic, setting up the work to be carried out during the *M2 internship*). It could be followed by a PhD (depending on funding).