

Development of emerging antimony chalcogenide thin film solar cells employing innovative hole transport layers

Summary

The overall goal of the project is to develop and optimize the non-toxic and earth-abundant Sb-chalcogenide ((Sb₂S,Se)₃) absorber material and thin film solar cells, incorporating in the device structure new innovative hole transport layers. The project addresses the following research questions: What will be the most suitable deposition parameters for synthesis of hole transport layers and their incorporation in a thin film solar cell. How to identify the band alignment matching between antimony chalcogenide absorber material and hole transport layer? How to use complex characterization techniques to analyze and understand the transport mechanisms in such devices?

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| Research field: | Chemical, materials and energy technology |
| Supervisor: | Dr. Nicolae Spalatu |
| Availability: | This position is available. |
| Offered by: | School of Engineering Department of Materials and Environmental Technology |
| Application deadline: | Applications are accepted between October 01, 2022 00:00 and October 23, 2022 23:59 (Europe/Zurich) |

Description

The candidate will carry out a multidisciplinary scientific activity in the framework of the projects PSG689 and PRG627 and European Union's H2020 programme under the ERA Chair project 5GSOLAR grant agreement No 952509, ETAG21014, on the development and characterization of Sb₂(S,Se)₃ based thin films and solar cell devices employing innovative hole transport layers.

The PhD student will be involved in all solar cells processing stages and optimization of hole transport layer. This will include the fabrication of absorber layers by physical techniques such as close spaced sublimation (CSS) and vapor transport deposition (VTD). The PhD student will also fabricate different window layers such as CdS, by CSS and chemical bath deposition methods (CBD), and TiO₂ by chemical spray pyrolysis (CSP) and will identify the optimal window/buffer partner in solar cells.

The student will prepare the photovoltaic solar cells based on these materials, and apply various new innovative hole conductor layers (HTLs) as well as self-assembler monolayers (SAMs) to the back surface of the photoactive absorber layer and will define the ad hoc for HTL and SAMs for efficient charge extraction in the solar cell device.

The proposed research project will help the student to acquire a vast range of competences and skills in developing and design thin film solar cells, will strengthen the researcher's ability to publish in international journals, as well as broadening the network of international contacts with companies and other research groups in the PV field from EU and the world at large through the participation at different international conferences.

Responsibilities and (foreseen) tasks

- Screening and optimization of deposition processes of antimony chalcogenide-based absorbers, to create well-oriented, continuous, uniform films on appropriate substrates
- Optimization of deposition processes for the absorber and HTLs, SAMs layers
- Map the key technological parameters of the used experimental approaches
- Identification of optimal buffer layers and electron/hole selective transport layers for efficient cell device architectures
- Development and optimization of thin film solar cells based on antimony chalcogenide-based absorbers incorporating HTLs and SAMs
- Characterization of materials and solar cell devices using various dedicated characterization techniques.
- Analysis of the research data, preparing reports, presentation at conferences (poster, oral talk), write research papers

- Contribute to the organization and dissemination of research and practitioner workshops where project findings are presented

Applicants should fulfil the following requirements:

- Bachelor and Master degree in Physics, Chemistry, Electronic Engineering, Materials Engineering or a related field
- Previous research experience in thin film solar cell technologies, with a strong focus on the fabrication/characterization of films and solar devices, and knowledge on the use of different physical and chemical deposition techniques (CSS, VTE, sputtering, CBD, CSP), processing equipment (PDTs, furnaces) and characterization tools (XRD, SEM, Van-der-Pauw, solar simulator, spectral response) will be well evaluated
- Previous experience on the development of chalcogenide solar cells (including CdTe, SnS, CIGS based devices) on different kinds of substrates suitable for device integration in different kinds of elements and systems will be well evaluated
- Excellent communication skills in English (both written and oral) are an essential requirement
- Capacity to work both as an independent researcher and as part of an international team
- Capacity and willingness to provide assistance in organizational tasks relevant to the project
- Competences in using data analysis and graphing software: Microsoft Office (Word, Excel and PowerPoint), Origin

We offer:

- 4-year PhD position in the research group focused on emerging PV technologies in Estonia
- The chance to do high-level research in one the most booming emerging photovoltaic field
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of material science

Additional information

For further information, please contact Dr. Nicolae Spalatu, nicolae.spalatu@taltech.ee



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