Development of binary and ternary Sb-chalcogenide based thin film solar cells for BIPV and IPV applications

Summary

The ambition of the Laboratory for Thin Film Energy Materials at TalTech is to create and provide the next generation of thin film photovoltaic technology capable of powering IPV/IoT devices and adaptable for integration in solar windows and related BIPV products. This PhD research topic explores the effect of Ag concentration in the precursor solution, from the doping side (Ag-Sb2S3) to the ternary compound (AgSbS2) formation, to the formed thin film properties. Sb2S3 is an emerging inorganic PV material that have drawn much interest in recent years due to its excellent stability, suitable bandgap (Eg=1.7 eV), relatively high absorption coefficient (ca104 cm-1 at 450 nm), earth abundance, environmentally benign characteristics and low-cost. Due to its unique properties Sb2S3 could be applied in semi-transparent, tandem, and indoor solar cells. This research topic foresees characterisation of material and device properties at TalTech and at research group collaboration partners (e.g., Liverpool University, or Czech Technical University or University of Verona or Helmholtz Centrum Berlin). We offer an opportunity to be part of the COST action CA21148 - Research and International Networking on Emerging Inorganic Chalcogenides for Photovoltaics, RENEW-PV, https://renewpv.eu/

Research field:	Chemical, materials and energy technology
Supervisors:	Prof. Dr. Ilona Oja Acik Prof. Dr. Malle Krunks
Availability:	This position is available.
Offered by:	School of Engineering Department of Materials and Environmental Technology
Application deadline:	Applications are accepted between October 01, 2024 00:00 and October 25, 2024 23:59 (Europe/Zurich)

Description

We have established baseline technology platform based on Sb-chalcogenide thin film solar cell fabrication by ultrasonic spray pyrolysis (USP) technology and were the first to demonstrate semi-transparent Sb_2S_3 solar cell fabricated by USP. In the current stage of the development, Sb_2S_3 thin film solar cells show efficiency of ca 7.5 % under 1 Sun. The average visible transparency of the structure glass/TCO/TiO_2 /Sb_2S_3/HTM is 32% fulfilling the semitransparency requirement of solar windows. The key for further increasing the efficiency of the solar cells relays on optimization of the optoelectronic properties of Sb_2S_3 absorber layer.

In the frame of this research topic, we will explore the effect of Ag concentration in the precursor solution, from the doping side to the ternary compound formation, to the formed Sb-chalcogenide binary and ternary thin film properties. In this PhD thesis, antimony chalcogenide and metal oxide thin films will be fabricated by robust, resource saving, and easily scalable method such as ultrasonic spray pyrolysis. Spray deposition has great potential to become front-line technology for rapid, cost-effective, large-area and high yield mass production of solar cell.

The project will involve identification of suitable precursors for USP deposition, synthesis of precursors for Ag- doped Sb_2S_3 and $AgSbS_2$ this film fabrication, fabrication of thin films and solar cells, characterization of materials and devices.

Responsibilities and (foreseen) tasks

- Identification of suitable USP precursors, incl. component complexation, solubility, and thermal decomposition profile by means of TG/DTG/DTA methods.
- Developing the fabrication protocol and engineering the device quality properties of Ag-Sb_2S_3 and $AgSbS_2$ thin films deposited by chemical spray pyrolysis method.
- Development and optimization of solar cells and its constituent layers (absorber layer, electron transport layer, hole transport layer) by chemical deposition methods.
- Characterisation of material and device properties at home institution and at research group collaboration partners (COST action CA21148, RENEW-PV partners)

- Analysis of the research data, preparing reports, oral and/or poster presentations at conferences, publishing research articles.

Applicants should fulfil the following requirements:

The successful applicant will hold a master's degree in Chemistry, Materials Science, Physics or a related field. Previous research experience in thin film technologies and material characterization will be an advantage. Excellent team working attitude and communication skills in English (both written and oral) are an essential requirement. Competences in using data analysis and graphing software: Microsoft Office (Word, Excel and PowerPoint), Origin.

The candidate should submit a research plan for the topic, describing the understanding of the current state of the art of Sb_2S_3 thin films and solar cells development and propose the research activities plan for the Ag-doping of Sb_2S_3 and $AgSb_2S_3$ ternary compound development.

We offer:

- 4-year PhD position in one of the most internationalized and leading PV research groups in Estonia
- The chance to do high-level research in one of the most booming emerging photovoltaic field.
- Opportunities for conference visits, research stays and networking with globally leading universities and research centres in the fields of material science.
- Opportunity to be part of the COST action CA21148 - Research and International Networking on Emerging Inorganic Chalcogenides for Photovoltaics, RENEW-PV, https://renewpv.eu/

About the research group

The main research topic of the Laboratory for Thin Film Energy Materials is the development of metal oxide and sulphide thin films and nanostructured materials for solar cells, electronics and environmental applications by chemical technologies such as spray pyrolysis, chemical bath deposition and sol-gel. The technologies that are developed in the laboratory are simple, inexpensive, and easily transferrable to industrial scale. A new type of ultra-thin absorber based solar cell design and its component layers were developed in the laboratory and secured by several international patents. Over the last 25 years the main topics in the research group has been development of emerging thin film photovoltaic materials such as $CuInS_2$, Sb_2S_3, Sb_2Se_3, $Sb_2(S,Se)_3$ and Sb-Bi alloys, and the fabrication of solar cells based on them. The research group has extensive knowledge on development of CdTe thin film solar cells by close spaced sublimation. The laboratory staff is coordinating or being involved in several international and national research projects and are the grant holders of the COST action project RENEW-PV. RENEW-PV is a joint network of more than 200 researchers and industry partners from more than 30 countries worldwide developing emerging inorganic PV materials and devices.

(Additional information)

For further information, please contact Prof Ilona Oja Acik Ilona.oja@taltech.ee, Prof Malle Krunks malle.krunks@taltech.ee or visit https://taltech.ee/en/laboratory-thin-film-energy-materials

To get more information or to apply online, visit https://taltech.glowbase.com/positions/864 or scan the the code on the left with your smartphone.