Laboratory for Thin Films and Photovoltaics
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Empa
Materials Science and Technology

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Master Thesis

Fully Vapor-deposited Perovskite Solar Cells and Mini-modules

Research area

Photovoltaics (PV)

Thin-film coating

Perovskite solar cells

Physical vapor deposition (PVD)

Solar module

Tandem solar cells

Focus

☒ Experimental
☒ Opto-electronic characterization
☒ Analytical
☒ Literature and research

Duration

4-6 months

Entry

As soon as possible

Contacts

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Literature

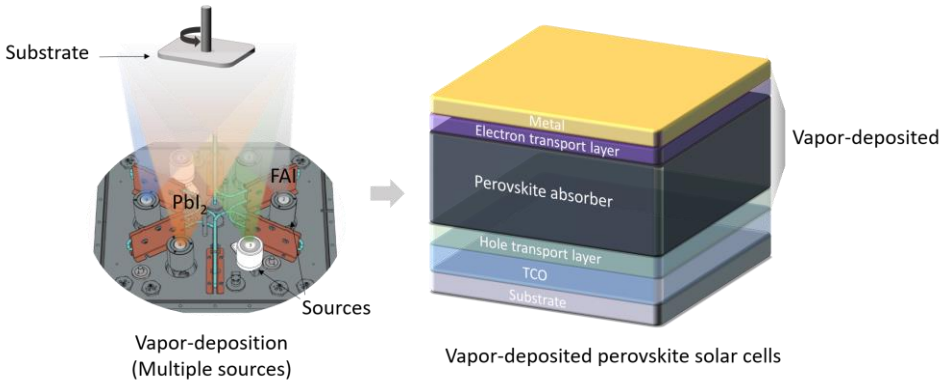
Feng, Jiangshan, et al. Energy & Environmental Science 14.5 (2021): 3035-3043.

Wang, Siyang, et al. Joule (2022).

Li, Hang, et al. Science Advances 8.28 (2022): eabo7422.

Motivation

Perovskite solar cells are poised as a promising photovoltaic technology due to their high power conversion efficiency (PCE) and low cost. Thanks to the broad bandgap tunability, perovskite could pair with commercially available narrow bandgap solar cells, such as c-Si or Cu(In,Ga)Se_2 (CIGS) in tandem solar cells with efficiency beyond the single-junction efficiency limit. However, the deposition of efficient and stable perovskite solar cells (PSCs) on top of the rough c-Si or CIGS subcell surface has always been a challenge. Physical vapor deposition (PVD) is of great potential for the up-scaling of PSCs due to its solvent-free characteristic and compatibility with large-scale production. Most importantly, the vacuum deposition technique is capable of depositing conformal films on rough surfaces, which makes it an ideal method for the coating of functional layers in perovskite-based tandem applications. This thesis will be focusing on developing fully vapor-deposited perovskite solar cells with both high efficiency and stability. This work will lay a solid foundation for the development of industrial scalable methods for upscaling of both perovskite single-junction and tandem solar cells.



Your task

You will learn to fabricate the wide-bandgap perovskite (~1.6-1.8 eV) solar cells on both glass and flexible polymer substrates. The focus will be on developing high-quality perovskite absorber using thermal vapor deposition, which requires precise control of film stoichiometry. Additive or composition engineering strategies will be explored to tune the bandgap and optoelectronic quality of the absorbers. You will learn to use SEM, XRD, PL&TRPL, etc., to study the structural and optoelectronic properties of the perovskites and evaluate the photovoltaic performance and stability of the solar cells using JV, EQE, stress test chamber, etc. In addition, you will apply thermal-evaporated perovskite absorber in mini-modules and perovskite-CIGS tandem solar cells.

Key tasks include:

- Development of high-quality perovskite absorber using vapor deposition.
- Optical and electrical characterizations, and a comprehensive understanding of the role of processing parameters affecting the growth and optoelectronic quality of the perovskite films and PV performance of the solar cells.
- Based on promising single junction results, apply the developed thermal vapor deposited absorber to demonstrate mini-modules (10 cm x 10 cm) and/or perovskite-CIGS or perovskite-perovskite tandem applications.

Requirements

- Strong interest in solar cells
- Background in materials science, semiconductors, physics, chemistry etc.
- Master students in Switzerland is preferred

Notes

Please include a CV and a transcript of records with your application. The field of photovoltaic research requires a multidisciplinary knowledge. Hence, students with backgrounds in materials science, physics, chemistry etc. are welcome to apply. The project can be tailored to student's expertise and interests. For further information, please contact Huagui Lai.