Ministry of Human Resources and Social Security

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

2020 Helmholtz – OCPC – Program

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:
Interface engineering of all-inorganic halide perovskites for photovoltaics

Helmholtz Centre and institute: Forschungszentrum Jülich, Institute of Energy and Climate Research, Photovoltaics (IEK-5)

Project leader: Prof. Dr. Thomas Kirchartz

Web-address: www.fz-juelich.de/iek/iek-5/EN/

Description of the project:
Perovskite materials with the structure of ABX_3 have become a intense field of research in the area of photovoltaics. Particularly, organic-inorganic perovskite solar cells, which feature organic A-cations such as $CH_3NH_3^+$ and $NH_2CH{=}NH_2^+$, exhibit excellent photovoltaic power conversion efficiencies with values reaching 25%. However, the organic cations give rise to stability issues in these highly efficient devices. A possible alternative is therefore the use of all-inorganic perovskite materials that replace the organic cation typically by Cs. To date, all-inorganic perovskite materials, including $CsPbI_3$, $CsPbI_2Br$, $CsPbBr_3$, *etc*. have revealed favorable thermal and photo-stability. Nevertheless, challenges including phase transition in high-humidity ambient and suboptimal power conversion efficiencies exist and are therefore at the center of current research efforts.

Apart from the intrinsic material properties, the device architecture, charge carrier transport and the properties of interfaces affect the photovoltaic performance all-inorganic perovskites. For all-inorganic perovskite materials and devices, their band structure, physico-chemical property and interface property are different from that of hybrid perovskite materials. Therefore, targeted approaches and intensive research on all-inorganic perovskite solar cell performance improvement are needed. Hence, this project aims at optimization of the electron and hole transport layers, improved band alignment at interfaces and reduction of surface recombination losses. These electronic optimization criteria will be combined with efforts to further improve device stability by studying the relation between the choice of contact materials and long-term device stability. In particular, the project aims at developing high-quality inorganic hole-transport-layer materials with beneficial band alignment and sufficiently high conductivity. These contact layers will be prepared by methods such as atomic layer deposition, solution processing using nanoparticle or sol-gel precursor approaches. Finally, the quality of the interfaces will be studied using a combination of transient and steady state photoluminescence to study recombination rates, ultraviolet photoelectron spectroscopy to study band alignment and impedance spectroscopy to study the effect of ions and interfacial charge accumulation.

Description of existing or sought Chinese collaboration partner institute:
The Institute for Solar Energy System, Sun Yat-sen University (IESE-SYSU) is one of the top photovoltaic research institutes in China with a strong influence on the Chinese photovoltaic industry. The institute possesses a rich experience in solar cell research and in innovative production techniques. The IEK-5 at FZJ has several established collaborations with IESE-SYSU. Joint studies on high-efficient heterojunction solar cells are underway and have made advances. Apart from the high potential for joint investigations, the IESE-SYSU possesses equipment for the preparation and characterization of perovskite solar cell preparation and characterization. The proposed post-doctoral project is aiming at further strengthening a mutually beneficial collaboration program between IEK-5, FZJ and ISES-SYSU in advanced thin film solar cells. Besides, Jinan University, who has a close cooperation relationship with ISES-SYSU and has advantage in all-inorganic perovskite devices, is another potential Chinese collaboration partner to establish collaboration with IEK-5, FZJ.

Required qualification of the post-doc:

- PhD in material sciences and engineering, graduate from “Double First-Class” universities.
- Experience with fabrication of photoelectric devices, interface engineering and band regulation optimization. Experience in perovskite thin film optimization and interfacial modification is preferred.
- Additional skills in written and spoken English and skilful operation of vacuum equipment *e.g.* ALD.

PART B

Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

PART C

Additional requirements to be fulfilled by the post-doc:

- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team