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: High-quality inorganic perovskite thin film materials for solar cells

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 ABX_3 structure have outstanding optoelectronic properties making the material system ideal for applications in light emission and photovoltaics. Photovoltaic power conversion efficiencies have risen up to 25% over the last years. However, thermal decomposition and halide segregation strongly affect the stability of the commonly used organic-inorganic perovskites, which is a considerable challenge for a successful industrial application. All-inorganic perovskite materials, which are free of thermally decomposed organic groups are stable up to temperatures of 400°C and are a promising candidate to solve the current stability problems. At present, the power conversion efficiency of all-inorganic perovskite materials is ~ 17%, which implies that the material is promising while nevertheless leaving a substantial efficiency gap relative to the more intensely studied organic-inorganic halide perovskites.

One of the reasons limiting the efficiency of all-inorganic perovskite based solar cells is their thin film quality, which contains numerous bulk and surface defects affecting carrier transport and recombination. This could be attributed to the solute agglomeration phenomenon of the precursor solution during the solution process because of the strong bonding ability of polar solvents. Therefore, one of the tasks of this project is to obtain high-quality, pinhole-free all-inorganic perovskite thin films with a homogeneous crystal structure and uniform morphology. The process of precursor solution configuration, perovskite thin film growth and post-processing will therefore be optimized.

In addition, the relatively wide bandgap of all-inorganic perovskite materials is another challenge for efficiency improvements. For example, the bandgap for $CsPbI_3$ is 1.73 eV, which means it can hardly absorb the sunlight longer than 700 nm and consequently lead to photocurrent loss. Other all-inorganic perovskite materials, *e.g.* $CsPbBr_3$, and $CsPbI_2Br$, have even wider bandgaps and feature even larger photocurrent losses. Therefore, tuning of the band gap by doping alkali metal (*e.g.* Na, K, and Rb) or Sn, and mixing halide compounds is another task of this project. Investigations on the A-cation and the X-anion will be carried out.

Besides, doping with Eu, Ag or alkali metal will also be considered to reduce nonradiative recombination, aiming at open-circuit voltage and efficiency improvements.

Description of existing or sought Chinese collaboration partner institute:
Sun Yat-sen University (SYSU) is in the leading position in the field of materials science in China. The university possesses many innovative research achievements on advanced materials and photoelectric materials. The Institute for Solar Energy System (ISES) in SYSU is a major photovoltaic research institute in China and has a big influence on Chinese photovoltaic industry. The institute contains state-of-the-art perovskite thin film solar cell platforms. The IEK-5 at FZJ has already established collaboration with ISES. Joint studies on heterojunction solar cells are underway with favorable progress. In addition, Jinan University is another potential collaboration partner institute owing to its remarkable research results in the field of all-inorganic perovskite materials.

Required qualification of the post-doc:

- PhD in material sciences and engineering, both bachelor's and doctor's degree from "Double First-Class" universities.
- Experience with preparation of photoelectric thin film materials and fabrication of photoelectric devices, in particular the all-inorganic perovskite materials and devices. Experience in perovskite thin film optimization is preferred.
- Additional skills in scientific English writing, glovebox operation and evaluation tools *e.g.* Originlab.

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