2020 HGF – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

Title of the project:

High-efficiency hybrid solar cells employing organic spectral conversion layers

Helmholtz Centre and institute:

Helmholtz-Zentrum Berlin für Materialien und Energie

Project leader:

Prof. Dr. Klaus Lips

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Department: (at the Helmholtz centre or Institute)

EE-ASPIN: Department Spins in Energy Conversion and Quantum Information Science

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Description of the project (max. 1 page)**:**

Spectral conversion materials can re-shape the spectrum of light by controllably redistributing energy between high- and low-energy excited states. When implemented within optoelectronic devices, particularly solar cells, spectral converters can modify device performance in new and interesting ways. In this project, we study organic spectral converters consisting of dense arrays of organic chromophores capable of singlet fission and triplet fusion, combining these with crystalline silicon and perovskite solar cells. We characterise these systems using a variety of spectroscopic methods, including steady-state and time-resolved optical measurements, synchrotron techniques, and electron paramagnetic resonance.

A particular aim of the project is to develop comprehensive insight into the structure, energy levels, and excited state dynamics at hybrid interfaces formed between organic spectral converters and crystalline semiconductors. On the organic side of these hybrid interfaces, the system is characterised by localized states on the scale of molecules and high exciton binding energy; on the crystalline semiconductor side, band structure and carrier trapping gives a near-complete description of the system. Understanding energy and charge-transfer between these material domains, across the hybrid interface, is therefore a challenge. The potential gain is large, however. Spectral conversion materials offer a pathway for single-junction-style solar cells to exceed the Shockley-

Queisser limit. Successful design and characterisation of the hybrid interfaces in these devices therefore pave the way for next-generation high-efficiency photovoltaics.

The Helmholtz-Zentrum Berlin (HZB) is an ideal venue in which to study device-oriented spectral conversion processes. The centre hosts renowned experts in the fabrication and characterization of all varieties of crystalline and thin film solar cells, as well as the characterization of carrier dynamics, interface processes, and spin resonance effects. The HZB is located in Berlin, a renowned international destination and home to a strong intellectual and artistic tradition.

The applicant is expected to be involved in the preparation and characterization of thin film small molecule semiconductor films using vacuum deposition and solution-processing methods. The project covers fundamental investigations of hybrid interfaces using optical, photoelectron, scanning probe, and other spectroscopies, as well as device-oriented work. Experience in one or more of these areas is highly desirable.

The work is collaborative within a small group of postdocs and PhD students. The applicant should integrate well into this environment. They are also expected to bring their own understanding and expertise to positively impact the project.

Description of existing or sought Chinese collaboration partner institute (max. half page)**:**

We seek a collaboration partner with a strong background in the preparation and characterization of solar energy materials based on organic semiconductors.

Required qualification of the post-doc:

- PhD in Physics, Chemistry, or Materials Science
- Experience with thin film methods, spectroscopy, working in a close-knit team
- Language requirement: English C1 – Effective operational proficiency or advanced (according to the *Common European Framework of Reference for Languages: Learning, Teaching, Assessment*, CEFR)