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: Generation of CO2-based chemicals in photovoltaic-electrochemical devices

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

Project leader: Dr. Vladimir Smirnov/ Dr. Tsvetelina Merdzhanova

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

Description of the project:

Fossil fuels (coal, oil and natural gas) are currently the world's primary energy source. However, they are limited in supply and non-renewable. Therefore, the production of renewable energy sources is becoming one of the key technologies enabling a sustainable future. Significant efforts have been directed in the development of converting solar energy into chemical energy of a fuel (solar fuels).The substantial worldwide level of CO2 emission stimulated research towards the conversion of carbon dioxide to carbon containing fuels, such as methanol, for example.

In this project, an integrated photovoltaic-electrochemical device for highly efficient CO2 reduction will be developed. The integrated device includes two main components: (i) photovoltaic cell/modules, used as a power source for the electrolysis, and (ii) electrochemical cells, where the electrolysis (CO2 reduction reaction) takes places. Appropriate solar cells/mini modules with a photovoltage in the range of 2-3V will be developed in the course of this project.

The work will also include the development of efficient and selective catalyst materials suitable for the CO2 reduction process. Materials with suitable properties (for example, Cu based catalysts) can be prepared by, for example, electrodeposition methods and evaluated by cyclic voltammetry and chronoamperometry measurements. Photoelectrochemical two- and three-electrode measurements under a simulated AM1.5G solar spectrum will be used to evaluate the performance of the integrated device and the solar-to-fuel efficiency. The amount of products occurring in the course of CO2 reduction experiments will be evaluated by collecting the products (gas or liquid) and evaluating the composition by Gas Chromatography (GC) and other methods. Overall, the aim of the project is to maintain efficient, long term stable integrated device utilizing inexpensive materials.

The work will involve the following major task:

- Fabrication of silicon based solar cells/modules with flexible photovoltages for efficient photon conversion
- Development of earth abundant nanostructured catalysts with high activity, selectivity and stability for CO2 electroreduction
- Elaborate the best photovoltaic-electrochemical device design to minimize energy loss

References:
[1] F. Urbain et al., Energy & Environmental Science 9(1), 145 - 154 (2016).
[2] K. Welter et al., J. Mater. Chem. A, 6, 15968 (2018).

Description of existing or sought Chinese collaboration partner institute:
We have a very good cooperation with the National Centre for Nanoscience and technology in Beijing, Prof. Jian Ru Cong.
We also welcome collaboration with any Chinese institution that deals with the same subjects and shares our scientific interests.

Required qualification of the post-doc:

- PhD in chemistry
- Experience with Gas chromatography, electrochemistry: fabrication and characterization of catalyst materials for generation of CO2-based chemicals
- Additional skills in LSV, CV, EIS, CA techniques

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