2020 HGF – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

Title of the project:

NANOCAT - Revealing photo-electrocatalytic properties of CO_2 conversion catalysts *in-situ* at the nanoscale

Helmholtz Centre and institute:

Helmholtz Center Berlin for Materials and Energy

Fritz Haber Institute of the Max Planck Society

Project leader:

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Department:

Nanoscale Operando CO_2 Photo-Electrocatalysis (Helmholtz Center Berlin)
Department for Interface Science (Fritz Haber Institute Berlin)

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Description of the project:

Tailoring the chemical reactivity and selectivity of photo- and electrocatalysts at the nanometer / atomic level represents a key challenge in catalysis research. In order to design catalysts with enhanced structural robustness, tailored compositions / geometries and improved catalytic selectivity / activity, fundamental understanding of these complex systems must be obtained. As many catalysts undergo structural and chemical changes during reactions, *in-situ* / *operando* methods that allow real-space analysis of electrode surfaces while reactions proceed in the liquid phase are a keystone in future catalysis research.

This project focuses on photo-/electrocatalytic conversion of CO_2 and aims at revealing the catalytic activity and chemical/physical properties of state-of-the-art materials *in-situ* with nanometer resolution. The project brings together two leading research institutes in the fields of

catalysis and material science, the Helmholtz Center Berlin for Materials and Energy (Helmholtz Association) and the Fritz Haber Institute of the Max Planck Society, and seeks to establish a strategic collaboration with a Chinese partner institute. The successful candidate will take advantage of a variety of cutting-edge experimental methods and will work in a synergistic approach on:

(i) Preparation of state-of-the-art cathode/anode material systems that feature well-controlled structure and composition. Selected thin film metal oxide photo-materials will be produced in collaboration with established research groups at the HZB. Prior and after testing under reaction conditions, synthesized materials will be characterized by complementary techniques including electron microscopy and X-ray spectroscopy.
(ii) *In-situ* characterization of the materials' nanoscale photo-electrical and photo-electrochemical properties by liquid-phase conductive atomic force microscopy (AFM) and AFM-based scanning electrochemical microscopy (SECM) methods. It is aimed both to resolve local catalytic activity and to decipher prevailing material degradation processes due to (photo-) corrosion.
(iii) Evaluation of the catalytic performance of selected materials by gas and liquid product analysis, combined with a suite of spectroscopic characterization tools.

Through combining fundamental insights by *in-situ* scanning probe microscopy and complementary catalyst characterization, the project will establish structure-property correlations and advance synthetic strategies for the design of next-generation catalysts.

The successful candidate will obtain cutting-edge experience in advanced *in-situ* scanning probe microscopy, catalyst preparation and analytic characterization. A highly stimulating scientific environment with unique access to state-of-the-art synthesis and characterization tools, research facilities and interdisciplinary collaborations both at HZB and FHI is offered.

Description of existing or sought Chinese collaboration partner institute:

The project seeks to establish a strategic research collaboration between the potential Chinese partner institute, the Helmholtz Center Berlin for Materials and Energy (Helmholtz Association) and the Fritz Haber Institute (Max Planck Society). Through this partnership, it is anticipated to create synergies at the boundaries of nanoscale catalysis and material synthesis, complementing the methodological portfolio and expertise of involved partner institutes. While research contacts and collaborations do exist with various leading Chinese institutions, it is intended to identify through this program most promising and scientifically relevant bilateral collaboration and academic exchange.

Required qualification of the post-doc:

- PhD degree in chemistry, physics, material science, or related fields
- Expertise in material synthesis (e.g. 2D materials, colloidal nanocrystals, electrode interfaces), photo- and electrocatalysis with related analytic characterization techniques (e.g. mass-spectrometry), and / or scanning probe microscopy
- Highly-motivated, detail- and goal-oriented working style with excellent analytic skills
- Very good written / oral communication skills in English and organisational skills.