Ministry of Human Resources and Social Security

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

2019 Helmholtz – OCPC – Program
for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:
Analytical *ex*- and *in-situ* transmission electron microscopy study of supported catalysts for C–H/C–O bond activation.

Helmholtz Centre and institute:
Forschungszentrum Jülich, Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons

Project leader: Prof. Dr. Rafal E. Dunin-Borkowski, Dr. Marc Heggen

Web-address: www.er-c.org, http://www.fz-juelich.de/er-c/EN/

Description of the project:

Metal or metal oxide clusters supported on oxide surface form the basis for many catalysts, which are of significance in energy technology, pollution prevention, and environmental cleanup. These catalysts take advantage of the synergy between supports and metal phases, and can be optimized by tuning the composition and interface of the metal nanoparticles and oxide supports. Rational design of metal (or metal oxide)-metal oxide interfaces in nanostructured catalysts is critical to achieve better reaction activity and selectivity. Thus, profound understandings of the catalyst structure at the nanometer or sub-nanometer scale represents a key issue to be addressed.

The project will investigate efficient methods to control the position of metal active sites and their fine-tuned engineering, with key issues including the interface microstructure, metal dispersion and electronic states, defects, structural changes during reaction, nature of deactivation and so on. The target metals will feature precious metals such as Pd or Pt, and a non-precious metal like Ni or Cu. Oxide supports will mainly feature reducible metal oxides, especially for ceria, or ceria mixed with other non-reducible oxides. The related alloy catalysts are also under our consideration. Detailed experimental studies and theoretical calculations will be involved in this programme. The catalytic reactions will feature model reactions such as CH_4 oxidation and CO_2 reduction.

The aim of this project is to analyse the structure of the catalysts' interface and active sites in the transmission electron microscope, in order to identify their structural evolution and degradation and to establish structure-activity relationships. In the first part of this project, the catalysts will be investigated on the atomic scale using the unique aberration-corrected analytical transmission electron microscopy equipment at the Ernst-Ruska Centre including X-ray and electron-energy-loss spectroscopy. In a second step, advanced *identical-location* and *in-situ* experiments will be performed under realistic gas atmosphere. For example *in-situ* experiments will be performed using a DENSsolutions nanoreactor system in the TEM which allows pressures up to 1 bar and temperatures up to 800°C. This project is of

great importance by integrating fundamental catalytic studies with leading-edge techniques at an atomic scale.

Description of existing or sought Chinese collaboration partner institute:
Since several years, we have got a successful cooperation with Professor Feng Wang from Dalian Institute of Chemical Physics that has already led to a high number of publications. Furthermore, we have a number of other cooperations with China, especially with Xi'An Jiaotong University and Tsinghua University. In addition we held a joint seminar between the Ernst Ruska-Centre in Jülich and Beijing University of Technology and identified several possibilities for collaboration, which could be carried out in our institute by young scientists from China. Applicants from these institutions are highly welcome.
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 materials science, chemistry, physics or a related discipline
• Experience with metal/metal oxide catalysts and transmission electron microscopy
• Additional skills in analytical microscopy techniques, *identical-location*, or *in-situ* experiments are welcome

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