Helmholtz - OCPC - Programme 2017-2021
for the Involvement of Postdocs in Bilateral Collaboration Projects with China

PART A

Title of the project: Transport of electrolyte through the electrodes of Vanadium Redox Flow Batteries (VRFBs)

Helmholtz Centre and institute: Karlsruhe Institute of Technology (KIT), Helmholtz Institute Ulm (HIU)

Project leader: Dr. Roswitha Zeis

Web-address: http://www.hiu-batteries.de/batterieforschungszentrum-in-deutschland/forschung/hiu-nachwuchsgruppen/nachwuchsgruppe-zeis/

Description of the project

Vanadium Redox Flow Batteries (VRFBs) provide an attractive solution for large-scale (Megawatt scale and higher) energy storage, with relatively small losses. It is desirable to further improve the energy cycle efficiency (energy lost in charging and discharging). This project investigates the losses incurred during the charge – discharge cycling and generates valuable input for accurately modelling the power losses.

Two of the major limitations of VRFBs is the transport limitations of getting the electrolyte into the electrode and to the reaction sites with minimum resistance; and electrolyte access to maximum reaction sites by achieving high saturation. Although the porous carbon electrodes have a high porosity, there can be a large pressure requirement for the electrolyte to be pumped through the electrode during operation. This pressure can be further increased when the electrodes are under compression, as is the case during operation. This can result in high pumping losses which reduce the overall efficiency of the VRFB cells. Additionally, it is extremely difficult to get the electrolyte into

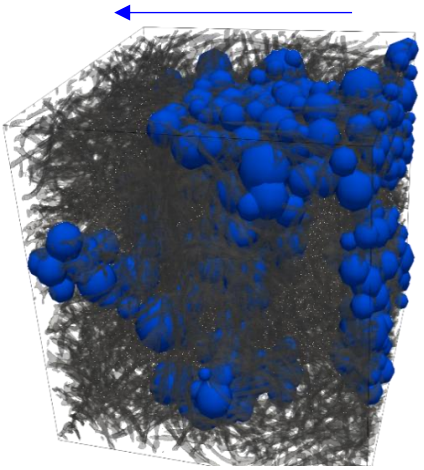

Figure 1: Transport of electrolyte through the porous carbon electrode

KIT – International Affairs (INTL) Contact: Oliver Kaas Phone: +49 721 608 45323 Email: oliver.kaas@kit.edu

smaller pores within the electrode, leading to inaccessible surface area where the reaction could occur.

To visualize the electrolyte flow through the porous carbon electrodes we plan to conduct Synchrotron X-ray radiography and tomography experiments. The information obtained from these measurements aids us to develop models, which enhances our understanding of the flow dynamics within the porous material and the impact of saturation on the mass transport of the electrolyte. The aim of this project is to develop a modelling tool, which would allow us to evaluate the materials currently being used for VRFB electrodes and propose new improved materials.

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

There is already an existing collaboration between Professor Pang-Chieh Sui (Wuhan University of Technology, Wuhan) and my group. He is an expert for modelling transport phenomena in porous media. We just submitted our first joint publication "Solid Mechanics Simulation of Reconstructed Gas Diffusion Layers for PEMFCs" to the Journal of the Electrochemical Society. The paper investigates the stress and strain distributions at the fiber's scale of PEMFC gas diffusion layers (GDLs). We visit each other quiet frequently. The collaboration not only is successful because of the complementary expertise of the two groups but also Professor Sui and I are interested to facilitate student exchanges. Due to Professor Sui contacts we also started to collaborate with Professor Rong Chen (School of Energy and Power Engineering, Chongqing University) who works on related topics.

Required qualification of the post-doc:

- PhD in Mechanical Engineering, Physics or related fields
- Experience with microfluidic device design and fabrication
- Modelling of multiphase flow and interfacial phenomena
- Microscale visualization and characterization (optical, X-ray)
- Additional skills in CFD software (for example Fluent, Comsol)
- 3D CAD software such as Solidworks, Sketchup, Keyshot

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

KIT – International Affairs (INTL) Contact: Oliver Kaas Phone: +49 721 608 45323 Email: oliver.kaas@kit.edu

- 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

KIT – International Affairs (INTL) Contact: Oliver Kaas Phone: +49 721 608 45323 Email: oliver.kaas@kit.edu