Master thesis or internship in Germany

Numerical simulation of air-breathing fuel cells

Fuel cells convert hydrogen into electricity. A conventional polymer electrolyte fuel cell (PEMFC) requires an active ventilation system for air supply and water management. However, an air-breathing PEMFC can work passively consuming quiescent ambient air, without any active ventilation. Renouncing to valves, gas channels and pumps, such cells can be built amazingly small. During operation, water is generated as a reaction product in a PEMFC. Especially at high current density, the vapor condenses into liquid water, blocking the reaction zones. Liquid water is, therefore, one of the main reasons for low cell voltage and high internal resistance, decreasing conversion efficiency. Water management is especially important for air-breathing cells, as there is no active air flow available that could remove the water. Liquid water must be transported from the reaction side by means of evaporation and natural convection.

Numerical simulation can help to understand where liquid water forms, how it is transported and where it accumulates. All of these processes depend on temperature, current density, ambient humidity, porosity of the electrodes, and many other parameters. Understanding the influence of all of these factors on water transport is crucial to increase the current and power density of air-breathing fuel cells.

Within a master thesis a three-dimensional model of an air-breathing cell shall be developed. Simulations will be carried out using the open-source CFD library OpenFOAM – an appropriate solver for PEMFC is already available. Finally, the simulations shall be compared and validated using experimental data from CIEMAT, Spain.

The work will be carried out at HZDR, Dresden, Germany. The remuneration will depend on the education of the applicant, and will typically be 380-735€.

Requirements:
- interest in numerical simulation of electrochemical processes

Helpful:
- knowledge of c++, OpenFOAM, numerical simulation
- knowledge of electrochemistry and fluid dynamics

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