Modeling and Optimization of PEM Fuel Cell

Master Project (30 ECTS)/Semester Project (10 ECTS)

Administrative

Supervision: Riddhi Chakraborty, Prof. J. Van Herle
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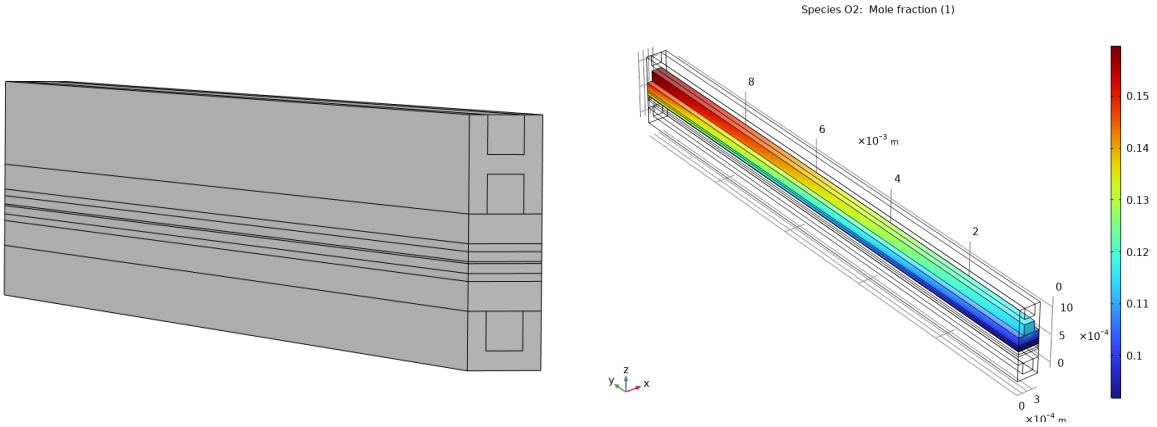
Location: Sion or remotely (travel allowance offered)
Remarks: If interested, please send your CV, with a short motivation letter, to Riddhi.
The scope and depth of the tasks may be adapted depending on whether the work is carried out as a master's or semester project.

Project description:

The increasing need for sustainable power sources in the marine sector has led to growing interest in Proton Exchange Membrane Fuel Cells (PEMFCs) as an alternative to traditional combustion engines. The long-term goal of this research is to develop a 250 kW PEMFC stack module that can be scaled up to multi-megawatt (up to 10 MW) systems through a modular architecture — pushing the current state of the art in marine fuel cell technologies. This project focuses on modeling, analyzing, and optimizing PEMFC performance to support future marine integration.
In this student project, the emphasis will be on **cell-level modeling**. A single-cell, single-channel 3D PEMFC model will be developed in COMSOL Multiphysics to study and optimize the flow field design and gas diffusion layer (GDL) properties. Special attention will be given to the introduction of two-phase flow modeling to better understand liquid water transport and accumulation, which are critical for improving PEMFC performance and durability.



Your tasks:

- Learn PEMFC fundamentals and become familiar with COMSOL Multiphysics.
- Develop and validate a 1D baseline PEMFC model reproducing polarization behavior.
- Perform parameter optimization and sensitivity analysis (e.g., GDL permeability, exchange current density).
- Introduce two-phase flow modeling to capture liquid water transport and accumulation.
- Validate and interpret simulation results against reference data.
- Extend the study to a 3D single-channel PEMFC model for flow field analysis.