PhD Position in Fluid Mechanics, focusing on Water Management in Polymer Electrolyte Membrane (PEM) Fuel Cells

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Carlos III University of Madrid is a relatively small, innovative, public university, providing teaching of the highest quality and focused primarily on research. The mission of Carlos III University of Madrid is to contribute to the improvement of society through teaching of the highest quality and cutting-edge research in line with stringent international guidelines. UC3M is included in the QS Top 50 Under 50, a ranking of the world's top 50 universities established within the last 50 years.

The Fluid Mechanics Research Group of the Department of Thermal and Fluids Engineering carries out research on a wide variety of topics in fluid mechanics and combustion, encompassing theoretical, numerical and experimental studies.

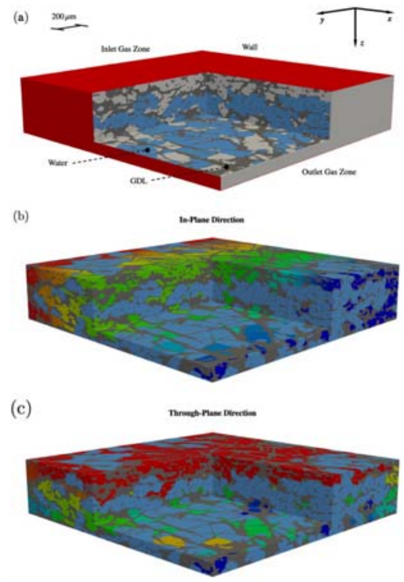
Project: The transition to an energy system based on renewable energy sources represents the only possible long term solution to the scarceness of fossil fuels and the urgent need to reduce the emissions of greenhouse gases. With this in mind, the European Commission defined in 2007 a series of targets to be achieved by 2020 commonly known as the 20-20-20 Targets: a reduction of 20% in emissions of greenhouse gases as compared to 1990 levels; an increase of 20% in the share of renewables in the EU energy mix; and a 20% reduction in energy consumption at EU level. Achieving these goals requires a great effort in R&D to reach the market deployment of renewable energy sources, as stated in the Challenge 6.4.3 Safe, Efficient, and Clean Energy of the Spanish State Plan 2013-2016.

This project aims to enhance the current understanding of different fundamental aspects (fluid dynamical, thermal, mechanical, electrical, and geometrical) that affect the design and operation of one of the systems that is meant to lead the energetic transition to renewable energy sources in the XXI century, namely hydrogen based fuel cells. The specific target of this project is to increase our understanding of **water management issues in low-temperature PEM Fuel Cells running on hydrogen**. This goal will be achieved by pursuing a multiscale analysis of the multiphase flow established in the porous electrodes of polymer electrolyte membrane fuel cells. The analysis will start with the detailed simulation of the flow at the pore scale (~ 10-30 microns), will follow with the continuous macroscopic modeling of flow in the entire thickness of the porous layers (~ 100-200 microns), and will end with the modeling of the spatio-temporal evolution of the water content along the flow channels of a single cell (~ 10-100 cm).

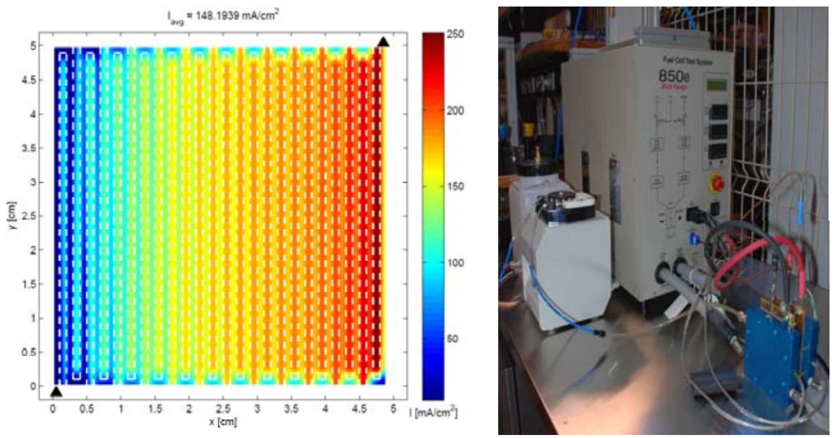
The study will be addressed through a methodology that combine s theoretical analysis with mathematical modeling and numerical integration. The models developed in this project will be validated using experimental results obtained in-house or facilitated by international partner groups (such as DLR-Stuttgart, McGill University, and others, including short research stays of the PhD candidate). This will enable the development of prediction tools that could be used to optimize the design and operation of the devices under study.

Condition: Doctoral studies extend over a 4-year period during which the PhD-student will receive a salary as an employee of the department. Doctoral students are expected to engage in full-time study and research, and to participate actively in the department's activities. The candidate should have finished his/her Masters studies by September 2016.

Funding: Spanish Ministry of *Economía y Competitividad* (Project # ENE2015-68703-C2-1-R)
Placement: Department of Thermal and Fluids Engineering @ Carlos III University of Madrid
Type of employment: Full time, 4 years
Number of positions: 1
Working hours: 100 %
Town / Province / Country: Leganés / Madrid / Spain



(a) Computational domain used for effective gas diffusivity calculations with the Lattice Boltzman Method, showing the different elements of the system. (b) and (c) Computed concentration fields corresponding to simulations in the in- and through-plane directions, respectively. The resolution of the 1.3 × 1.3 × 0.28 mm 10% PTFE-treated GDL domain was downscaled by a factor 3 × 3 × 1 to avoid memory limitations of the 48 GB rendering workstation.



(left) Current density distribution in a 25 cm^2 PEM cell operating under dry cathode and fully-humidified anode conditions as predicted numerically with ANSYS-FLUENT. (right) Facility for experimental testing of PEM Fuel Cells at the Department of Thermal and Fluids Engineering (UC3M).