# Impedance Modelling of Electrochemical Systems – application to PEM fuel cells and supercapacitors

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*Position:* Associate professor

*Institution:* LEMTA, University of Lorraine

*Email:* Julia.mainka@univ-lorraine.fr

## Biography and expertise

Dr. Julia Mainka is an associate professor at the University of Lorraine (UL) and at the laboratory of Energy and Applied and Theoretical Mechanics (LEMTA). She obtained her MSc in Physics in the international program SaarLorLux between the University of Saarland (Saarbrücken, Germany), the University Henri Poincaré (Nancy, France) and the Centre Universitaire du Luxembourg (Luxembourg). She holds a Ph.D. in Mechanics and Energetics from the University Henri Poincaré in Nancy, France. After a post-doctoral position on modelling of porous media at the laboratory LNCC in Petrópolis (Brasil), she obtained an assistant professor position at the University of Lorraine in 2013. Her research concerns the modelling and characterization of electrochemical systems, mostly hydrogen systems, such as PEMFCs, with a special focus on electrochemical Impedance Spectroscopy (EIS). She heads the "Hydrogen and Electrochemical Systems" group at LEMTA since 2018, and is responsible of the Master 2 on Energy, speciality Mechanics and Energy, at the Faculty of Science and Technology (FST) of UL.

## Presentation

The lecture will focus on the modelling of electrochemical devices such as PEM fuel cells and supercapacitors (SCs) and on their characterization using electrochemical impedance spectroscopy (EIS). Impedance modelling is usually done under the form of equivalent electrical circuits (EECs) in which the individual elements (resistors, capacitances, etc) represent the main physico-chemical phenomena at the material scale underlying the electrical output.

The lecture will start with an introduction to the operation principle of electrochemical generators (PEMFCs) and storage devices (supercapacitors), as well as EIS. EIS is an extensively used characterization techniques. It allows *in-situ* characterization without significant impact on the operation of the systems. The main impedance elements that are derived represent charge and mass transport phenomena in the different components (gas diffusion layers, electrodes and membrane) and electrochemical reactions at the electrodes. Application examples of EIS characterization of PEMFCs and SCs are presented and discussed in terms of performance and degradation during operation.