Neutron nanomediators for non-invasive temperature mapping of fuel cells

Principle investigators:

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In situ characterization methods are of high importance to elucidate the complex physical processes occurring inside fuel cells. In particular, the distribution of temperature across the different layers of the cell plays an important role in water management and in durability. To date, only invasive techniques (e.g. insertion of thermocouples whose dimensions are similar to the layer thickness) have been reported for this measurement. In this project, we will explore the use of magnetic nanoparticles as mediators for the temperature measurement.

A polarized neutron beam such as the one provided at the BOA beam line of the Paul Scherrer Institute (PSI) will be depolarized by ferromagnetic nanoparticles due to the randomly oriented magnetic field they produce. When heated above their Curie temperature, these particles will become paramagnetic and the beam will stay polarized. Using a spin analyser and an imaging detector, we will therefore obtain an image of the temperature distribution in a non-invasive way, thanks to the ability of neutron to penetrate a large variety of materials used in fuel cell design.

The scope of this PhD thesis will include the synthesis of nano-particles, the *ex-situ* characterization of their physical and magnetic properties, their inclusion into fuel cell materials and the characterization of their suitability for the temperature measurement using a polarized neutron beam. Additionally, the inclusion of material into real operating fuel cells will be conducted in collaboration with other students and researchers. This PhD thesis will be conducted as a collaboration between the Laboratory for Neutron Scattering and Imaging (LNS, PSI) and the Electrochemistry Laboratory (LEC, PSI).

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