Laboratory for Neutron Scattering and Imaging
Paul Scherrer Institute

Invitation for a LNS PhD Student Presentation

Date: Thursday, August 12, 2021, 10:30

Location: Paul Scherrer Institute, Area West, Bldg. **WHGA/001 (Auditorium)** and

Via ZOOM: **https://psich.zoom.us/j/61122571434**

Speaker: Antonia Ruffo, Paul Scherrer Institut, LNS & LEC

Neutron nanomediators for non-invasive temperature mapping of fuel cells

The polymer electrolyte fuel cells (PEFCs) reached relevant importance in the last century due to the capability to convert the chemical energy of hydrogen into electrical one. Nevertheless, this technology still needs some refinements: polarization, ohmic, and mass transport losses are manifested as heat release in the device, which affects water management and the durability of the device. In order to better understand these processes, the knowledge of the temperature at the very center of the cell structure is highly desired. However, the reported methods using micro-thermocouples(1) are highly invasive, which impacts the cell operation and limits the data accuracy.
The project aims to attempt to overcome the latter problem, using ferromagnetic nanoparticles for a non-invasive temperature mapping on these devices. A key part of this novel method is the application of Neutron Imaging through a polarized beam (2), a method which may detect the temperature distribution on the nanosensors' surrounding. The dispersed ferromagnetic nanomediators, in these conditions, will depolarize the incoming neutron beam due to the random magnetic field produced by the nanoparticles themselves. Furthermore, as the temperature rises above the Curie temperature (Tc), the nanosensors lose their magnetic proprieties, maintaining the beam polarization unchanged.
Here, we will present the first steps conducted on this project, including finding a suitable material, synthesizing the nanoparticles through solution techniques (3), and eventually physical and magnetic ex-situ characterizations. The initial candidate material for this application was nickel, which may have a Tc in the interesting range (~70 ˚C) depending on the particle size (4), and first interesting results have been obtained with neutron depolarization imaging. Possible future directions include alloying Ni with other transition metals (Cu, Fe, Co), decreasing in this way the Tc as reported in the literature (5), but also using Nd based magnets such as NdFeB.

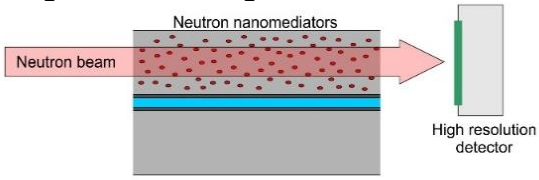

Fig 1: Measurement scheme of the proposed concept though neutron nanomediators.

References

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[3] A. Pătru*, et al.*, *International Journal of Hydrogen Energy*, **38**, 11695 (2013).
[4] J. Chatterjee, et al., Journal of Magnetism and Magnetic Materials, **293**, 303 (2005).
[5] E. P. Wohlfarth, *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, **45**, 647 (1954).

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