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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 5 November 2024, 9:00 s.t., TU Darmstadt via Zoom

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Zoom information:
Meeting-ID: 655 2886 1867
Kenncode: 229266

Magnetic cooling for the efficient liquefaction of hydrogen

Abstract:

Magnetic cooling can be utilized to construct environmentally friendly cooling devices, air conditioners, and heat pumps [1]. Originally, magnetic refrigeration was used to achieve ultra-low temperatures by adiabatic demagnetization of magnetic salts. Recently, low temperatures have once again become the focus of attention as an area of application for magnetocaloric cooling namely for hydrogen liquefaction [2,3].
Hydrogen is light, energy dense and clean. If produced from sustainable resources, it represents the ultimate energy carrier for many of our needs. Liquid hydrogen has more than twice the energy density of the gas at 700 bars. What is more, it can be transported in conventional, unpressurised dewars. However, conventional liquefaction means we use up to 40 % of the lower heating value of the gas we are compressing, just to liquefy it! Magnetocaloric materials enable an alternative and more efficient approach. A large number of compounds are already known that show magnetocaloric effects in the desired temperature range and new candidates are constantly being added. In this work, I would like to discuss our recent activities for the creation of a materials library for cryogenic applications. The basis for this is our characterization infrastructure for materials research at the Dresden High Magnetic Field Laboratory in static and pulsed magnetic fields [4]. Furthermore, I provide an overview of the current progress in the demonstrator development of a magnetic hydrogen liquefier within the framework of the European project HyLICAL.

[1] T. Gottschall et al., Adv. Energy Mater. 9, 1901322 (2019).
[2] X. Tang et al., Nat. Comm. 13, 1817 (2022).
[3] W. Liu et al., Appl. Mater. Today 29, 101624 (2022).
[4] C. Salazar Mejia et al., J. Phys. Energy 5, 034006 (2023).

About the speaker:

Tino Gottschall is a group leader at the Dresden High Magnetic Field Laboratory of the Helmholtz-Zentrum Dresden-Rossendorf (HZDR). In 2016, he defended his doctoral thesis in the field of magnetic refrigeration for room-temperature application at TU Darmstadt. End of 2016, he moved to the University of Barcelona as a postdoctoral researcher and since May 2017 he has been working at the HZDR on the advanced characterization of magnetic materials in static and pulsed magnetic fields. His scientific interests also include the investigation of so-called multicaloric effects in materials under the influence of several external stimuli. In 2019, the startup MAGNOTHERM was founded, of which he is one of the co-founders. The company aims at the market entry of magnetic refrigeration for room-temperature applications. Last year, the HZDR and MAGNOTHERM entered a strategic partnership to jointly advance the development of magnetic hydrogen liquefaction