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HoMMage

Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 15 February 2022, 9:00 s.t., TU Darmstadt, Zoom

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Fe2P type alloys an intriguing magnetic playground

Abstract:

The Fe2P intermetallic compound, is a prototypical example of a first order ferromagnetic phase transition, known since the 1980s to exhibit a sharp, but weak, FOMT at 216 K (-57°C)[1]. In this hexagonal system, the Fe atoms occupy two inequivalent atomic positions, referred to as 3f (in a tetrahedral environment of non-metallic atoms) and 3g (in a pyramidal environment). Also for P we find two distinct lattice sites 1a and 2b. One intriguing aspect is the large uniaxial magnetic anisotropy leading to an anisotropy field of about 6T at 5K. This anisotropy is quite unique for a mainly itinerant electron system as evidenced by the reduction (partial quenching) in the magnetic moments of the iron atoms on the 3f sites when TC is crossed from the ferromagnetic to the paramagnetic state, whereas there is only a limited decrease on the 3g site. This observation has led to a cooperative description of the FOMT, linking the loss of long-range magnetic order at TC with the loss of local moments on the 3f site[3]. Replacing Fe and or P by other elements leads to a rich variety of phenomena. Magnetic ordering temperature and first order character of the phase transition can be either enhanced or reduced. The anisotropy is strongly reduced on reduction of the c lattice parameter and a wide range of compositions display easy-plane anisotropy rather than easy axis, which is favourable for magnetocaloric applications. We will discuss both theoretical and experimental results for a wide range of elements substituting either Fe or P and combined substitutions on both Fe and P sites, while maintaining the hexagonal Fe2P type of structure.

O. Beckman et al., Specific Heat of the Ferromagnet Fe2P. Physica Scripta 25 (1982) 679-681.

L. Caron, et al., Magnetocrystalline anisotropy and the magnetocaloric effect in Fe2P, Phys. Rev. B 88 (2013) 094440

H. Yamada and K. Terao, First-Order Transition of Fe2P and Anti-Metamagnetic Transition, Phase Transitions 75 (2002) 231–242.

About the speaker:

Ekkes Brück full professor at the Faculty of Applied Sciences at Delft University of Technology and head of the section Fundamental Aspects of Materials and Energy. Employing microscopic and macroscopic techniques, my main research interest is in materials for renewable energy and energy saving (MCE, Li-ion batteries, H storage, solar cells, self-healing materials, catalysts). In this work in-situ, neutron scattering, X-ray diffraction, positron annihilation and Mössbauer spectroscopy play an important role.

My major scientific effort and scholarly contribution of the past 20 years is to establish magnetocaloric material as a new, sustainability-oriented discipline.

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