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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 24 May 2022, 9:00 s.t., TU Darmstadt, Zoom

Prof. Michael Coey

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Zoom Information:
Meeting-ID: 874 0192 3488
Kenncode: 267426

Amorphous Rare Earth Transition Metal Alloys Revisited

Abstract:

Metallic alloys of 4f and 3d elements, especially Fe Co and Ni were intensively investigated in the last 4 decades of the 20th century, and the roles of crystal structure, exchange and crystal field were elucidated for binary and interstitially-modified intermetallic compounds.

This contributed to the rational design of ferromagnetic alloys with strong uniaxial anisotropy using an appropriate light rare earth (SmCo5, Nd2Fe14B), uniaxial ferrimagnetic alloys (GdCo5) and cubic ferrimagnetic alloys with strong magnetostriction but no net anisotropy (Tb0.3Dy0.7)Fe2. The nonmagnetic rare earth yttrium was invaluable for isolating the 3d contribution to the magnetism. In the 1970s, when high-quality thin films were produced by sputtering, it was found that many of the alloys could be deposited as amorphous films which exhibited perpendicular magnetic anisotropy. Ferrimagnetic Gd-Fe-Co magneto-optic recording media with compensation point writing were an interesting development [1]. The amorphous alloys with strongly anisotropic rare earth elements tend to have magnetic ground-state structures where the rare earth moments freeze along randomly-oriented axes, with a net magnetic moment — asperomagnetic or sperimagnetic order [2].

A revival of interest in these materials has been spurred by several developments. One was the reappraisal of transverse magnetotransport (Hall effects) in terms of real-space and reciprocal space Berry curvature. Another is the fibre-bundle approach to electronic structure which is is centred on points rather than an extended, periodic lattice. Atomic-scale simulations of magnetic structures and excitations have improved vastly in the past 50 years. The observation in 2013 of ultra-fast single-pulse all-optical toggle switching in thin films of perpendicular ferrimagnetic amorphous Gdx(FeCo)1-x with $x \approx 0.25$ [3] opened some new opportunities for magneto-optic applications, and understanding of the transient collapse of magnetization and anisotropy [4]. Some recent results on these amorphous alloys will be presented, including the temperature variation of the noncollinear magnetic structures,

[1] S. Tsunashima, Magneto-optic recording, J. Phys D, Appl, Phys 34 R87(2001)
[2] J. M. D. Coey, Amorphous Magnetic Order, J Appl Phys 49 1646 (1978).
[3] T. A. Ostler et al Ultrafast heating as a sufficient stimulus for magnetization reversal in a ferrimagnet Nature Commun 3 666 (2012)
[4] Zexing Hu et al, Single-pulse all-optical partial switching in amorphous DyxCo1-x and TbxCo1-x with random anisotropy, Appl. Phys. Lett, in press (2020)

About the speaker:

Prof. Mike Coey is one of most highly cited scientists in magnetism and magnetic materials, he is a member of the Royal Irish Academy (1987), a Fellow of the Royal Society (2003) and a Foreign Associate of the US National Academy of Sciences (2005). He is also a fellow of the Institut of Physics, the Mineralogical Society of America and the American Physical Society. His numerous awards include a Fulbright Fellowship, the Charles Chree Medal of the Institute of Physics (1997), the Gold Medal of the Royal Irish Academy (2005) the RDS INTEL Prize Lecture on Nanoscience (2012) in addition to being the recipient of the Humboldt (2013), Gutenberg (2015) and Max Born Medal and Prize (2019) awards. He was a founding member of the EU CEAM program. He has an honorary doctorate from the Institute National Polytechnique Grenoble (1994) and has been a Distinguished Lecturer, IEEE Magnetics Study (2006) and the Albert Einstein Professor of the Chinese Academy of Sciences (2010).

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