Electric tuning of Magnetic Permeability

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Magnetic permeability, which measures the response of a material to an applied magnetic field, is crucial to the performance of magnetic devices and related technologies. It is often assumed that it is not possible to alter the characteristic permeability of a material once the material has been prepared; for instance, zero and negative magnetic permeability are specific to superconductors and metamaterials, respectively. A continuously changing permeability, particularly from positive to negative by applied electric field, in the same system is therefore an uncommon phenomenon in material science. A new way to achieve direct gate-voltage control of magnetic permeability is offered by the recently predicted mechanism of magnetoelectric interaction for ferromagnet/ferroelectric (FM/FE) composites: By interfacing FM metal with FE, a spiral magnetic ordering is triggered in FM near the interface, a magnon-driven, strong magnetoelectric coupling develops within a nanometer range determined by spin diffusion length in FM metals. Such a linear magnetoelectric effect would introduce electric field to the magnetization directly, leading to ferroelectric changes in the magnetization procession and its damping. Here we present unambiguous evidence of ferroelectric control of dynamic magnetic permeability in a series of FM-metal/FE heterostructures, in which the FE subsystem acts as an energy source for the FM metal film via the interfacial magnetoelectric interaction. The electric field tuning of the magnitude and frequency-dependence of the permeability offers a highly localized means of controlling magnetization with ultralow-power consumption. Additionally, the emergence of negative permeability promises a new way of realizing functional nano-scale metamaterials with adjustable refraction index.

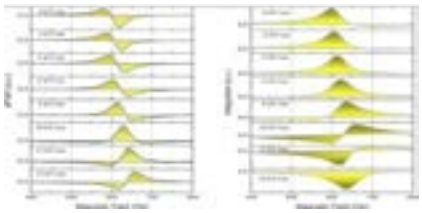

Figure 1: Observation of the electric field control of magnetic permeability via FMR.

Biography

Chenglong Jia is currently professor at Lanzhou University, China. He was the Distinguished Visiting Fellow of the Royal Academy of Engineering, UK (2015). He is the deputy-director of Key Laboratory for Magnetism and Magnetic Materials of the Ministry of Education, Lanzhou University, China. He has published more than 50 papers in reputed journals and has been serving as an editorial board member of repute.

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