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International Centerfor Quantum Materials

Seminar

Electrical control of spins: creating new functionality using multiferroic tunnel junctions

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Abstract

Electrical control of spins has been the subject of intensive research in recent years owing to the interest in both fundamental research and practical applications of spintronics with low power consumptions. Multiferroic tunnel junctions, i.e. magnetic tunnel junctions with ferroelectric barriers, have been proposed to allow ferroelectric control of the tunneling spin polarization through the magnetoelectric coupling at the interfaces. In this talk, I will present the experimental results which showed a novel magnetoelectric mechanism producing a giant resistive switching effect in multiferroic tunnel junctions consisting of complex oxide $La_{1-x}Sr_xMnO_3$ electrodes and a ferroelectric $BaTiO_3$ barrier[1]. By inserting a $La_{0.5}Ca_{0.5}MnO_3$ interfacial layer in the tunnel barrier, the tunneling electroresistance can be increased from 30% to 10,000% due to the interfacial phase transition between ferromagnetic metal to antiferromagnetic insulator driven by the ferroelectric polarization reversal. We have also found that such interface phase transition can serve as a spin valve to control the on and off state of the spin polarized tunneling for magnetic tunnel junctions. I will also discuss some recent experimental evidence that a pulse voltage can induce magnetic state switching in the tunnel junctions.

1. Y. W. Yin, J. D. Burton, Y.-M. Kim, A. Y. Borisevich, S. J. Pennycook, S. M. Yang, T. W. Noh, A. Gruverman, X. G. Li, E. Y. Tsymbal, and Q. Li, Nature Materials 12, 397 (2013)

About the Speaker

Qi Li is a professor of Physics and Institute of Materials Research at Pennsylvania State University. Her current research interest is primarily in the areas of multiferroic and spintronics in complex oxides, nanostructures of topological insulators and superconductors, and unconventional superconductivity. She graduated from Peking University and was a visiting scholar at KFK, Germany. She joined Bellcore laboratory as a postdoc and then an assistant research scientist at Center for Superconductivity research at University of Maryland. She joined Penn State as an assistance professor in 1995 and became a full professor in 2004. She is the recipient of NSF Career award among other awards, a guest professor of USTC, and a fellow of American Physical Society.