北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Novel Materials in spin orbital torque based current induced magnetization switching

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Venue: Room W563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Electrical manipulation of magnetization is essential for integration of magnetic functionalities such as magnetic memories and magnetic logic devices into electronic circuits. The current induced spin-orbit torque (SOT) in heavy metal/ferromagnet (HM/FM) bilayers via the spin Hall effect and/or the Rashba effect provides an efficient way to switch the magnetization. The current presentation include parts (1) Current induced SOT has been used to switch the in-plane magnetization in a single layer such as ferromagnetic semiconductor (Ga,Mn)As and antiferromagnetic metal CuMnAs with broken inversion symmetry. we demonstrate the electrical switching of perpendicular magnetization in a single ferromagnetic layer, L10-ordered FePt with center symmetry. The current induced spin-orbit effective fields increase with the thickness and chemical ordering parameter (S) of L10 FePt films. In 20 nm FePt films with high S (>0.9), we observe a surprisingly large charge-to-spin conversion efficiency (3.46), which is one order of magnitude larger than that in HM/FM bilayers. Possible inversion asymmetries including surface Pt-aggregation are considered to discuss the origin of the SOT. (2) The SOT induced switching efficiency is limited by the efficiency of converting electric current to spin current, which is expressed as the spin Hall angle (SHA). To date the highest SHA in metal was reported to be 0.35. we find the effective SHA (~0.6) in epitaxial L10-IrMn almost doubles the previous record. We reveal that the SHA depends strongly on the electric current direction in the film plane. Such a direction dependence coincides fully with the spin Hall conductivity calculated based on the spin Berry phase and is induced by the underlying magnetic structure of L10-IrMn. The anisotropic SHA and the neutron diffraction consistently identify a novel magnetic structure of the antiferromagnetic L10-IrMn, which is distinct from the widely presumed magnetic configuration of bulk L10 type antiferromagnets.

About the speaker

Dr. Jingsheng Chen is associate Professor in Department of Materials Science and Engineering, National University of Singapore. His research interest includes: High anisotropic magnetic materials for Hard disk drive, magnetic dynamics, electric control of magnetism: multiferroics based on ferroelectric/ferromagnetic heterostructure, current induced magnetization switching of new materials and heterstructure based on spin orbital torque, spin transfer torque. He published more than 240 papers with citation of more than 4700 and has more than 50 invited presentations in international conference. Seagate has sponsored him for more than 10 years with total grant around US$ 1 million. He invited new media structure and materials system by which high perpendicular magnetic anisotropy and small isolate grains can be obtained. This has been applied in heating assisted magnetic recording with 2.6 Tbits/in2 demonstration by Seagate. The product will be shipped this year. Now Globalfoudries co-sponsors him about S$1.8 million together with Singapore nation research foundation on STT-MRAM project. In addition, he is leading a S$10 million programme on electric control magnetism for low power magnetic memory.