Voltage Controlled Antiferromagnetics and Future Spin Memory

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Interconnections between magnetic state and transport currents in ferromagnetic (F) heterostructures are the basis for spintronic applications, e.g. tunneling magnetoresistance and spin-transfer torque phenomena provide a means to read and write information in magnetic memory devices like STT-RAM. Similar interconnections were proposed [1] to occur in systems where F-components are replaced with antiferromagnets (AFM) which are especially interesting for high-speed memory applications thanks to their high natural frequencies. We demonstrated experimentally the existence of interconnections between magnetic state and transport currents in antiferromagnetic Sr_2IrO_4 and $Sr_3Ir_2O_7$: first, we found [2] a very large anisotropic magnetoresistance (AMR) which can be used to monitor (read) the magnetic state of AFM; second, we demonstrated [3] a reversible voltage-driven resistive switching which can be used for writing in AFM memory applications; finally, we found the switching behavior to be strongly affected by high-frequency (microwave) currents applied to AFMs. The microwaves at 3-7 GHz suppress the dc switching and produce resonance-like features that we tentatively associate with the dissipationless magnonics recently predicted to occur in antiferromagnetic insulators subject to ac electric fields [4]. These results support the feasibility of high-speed AFM spintronics where antiferromagnets are used in place of ferromagnets.

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BIO: Maxim Tsoi is a Professor of Physics at the University of Texas at Austin. A graduate of Moscow Institute of Physics and Technology, Russia (B.S. 1993; M.S. 1995) and Konstanz University, Germany (Ph.D. 1998), Dr. Tsoi joined the UT faculty in 2003, after serving as a postdoctoral member of the technical staff at IBM Almaden Research Center, Michigan State University, and the Grenoble High Magnetic Field Laborotory of Max-Planck-Institut für Festkörperforschung and Centre National de la Recherche Scientifique. His research interests include conduction electron/interface interactions, spin-polarized transport in mesoscopic structures, nanomagnetism and spintronics. Dr. Tsoi is a pioneer of experimental studies of Spin-Transfer Torque (STT). He was the first to demonstrate STT phenomenon in experiments with magnetic multilayers [1]. His point-contact experiments with microwaves provided the first evidence of STT nano-oscillators [2]. His experiments with exchange-biased spin valves [3] gave the first evidence of STT in antiferromagnetic (AFM) materials and can be taken as the first step towards all-AFM spintronics. Dr. Tsoi is a recipient of the “Ragnar Holm Plaquette” awarded by the Royal Institute of Technology, Stockholm, Sweden (2002) and the National Science Foundation CAREER Award (2006).

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