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Electrical & Computer Engineering Seminar Series

"APPLICATIONS OF SPIN-TRANSFER TORQUE IN SPINTRONICS"

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Friday, April 5th, 2013

Lecture: 10:00 AM – 12:00 PM
Engineering Center
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Bio: A graduate of Moscow Institute of Physics and Technology, Russia (B.S. 1993; M.S. 1995) and Konstanz University, Germany (Ph.D. 1998), Professor Tsoi joined the University of Texas at Austin faculty in 2003, after serving as a postdoctoral member of the technical staff at IBM Almaden Research Center. He was promoted to Associate Professor in 2009. His research topics include conduction electron/interface interactions, spin-polarized transport in mesoscopic structures, nanomagnetism and spintronics. Dr. Tsoi was the first to demonstrate Spin-Transfer Torque (STT) phenomenon in experiments with magnetic multilayers. The quality and significance of Dr. Tsoi's work is documented in the most prestigious science journals such as Nature, Physical Review Letters, Applied Physics Letters. In 2002 his work was recognized by the "Ragnar Holm Plaquette" awarded by the Royal Institute of Technology, Stockholm, Sweden for outstanding contributions in applied physics. Dr. Tsoi is a recipient of the National Science Foundation CAREER Award ('06).

Abstract: Spintronics is a new technological discipline which refers to studying the role played by an electron spin in solid state physics and aims at developing a revolutionary new class of electronic devices based on the spin degree of freedom of the electron in addition to, or in place of, the charge. Spintronics is built on a complementary set of phenomena in which the magnetic configuration of a system influences its transport properties and vice versa. In ferromagnetic (F) systems these interconnections are exemplified by Giant Magnetoresistance (GMR) – where the system's resistance depends on the relative orientation of magnetic moments in constituent F-parts [1], and Spin-Transfer Torque (STT) – in which an electrical current can perturb the system's magnetic state [2]. In this talk I will focus on STT which may be the method of choice to control and manipulate magnetic moments in future spintronic devices. I will describe several experiments where transport currents alter the magnetic state in various solid state systems:

(i) In ferromagnetic/nonmagnetic (F/N) multilayers a dc electrical current can switch and/or drive its constituent F parts into high-frequency precession [3] which is of interest for microwave and magnetic recording technologies. Interestingly, application of high-frequency currents can also drive the multilayer, e.g. into STT-driven ferromagnetic [4] and parametric [5] resonances.

(ii) In antiferromagnetic (AFM) systems I will focus on our experiments with exchange-biased spin valves [6] where extreme current densities were found to affect the exchange bias at F/AFM interfaces. As exchange bias is known to be associated with interfacial AFM magnetic moments, this observation can be taken as the first evidence of STT in AFM materials and first step towards all-AFM spintronics.

(iii) Finally I will discuss STT associated with an electric current traversing a magnetic domain wall that can drive it into motion [7]. The inverse effect, in which an emf is induced by a moving domain wall, has also been predicted [8]. We recently detected a small voltage generated during the field-driven motion of a single domain wall in a Permalloy nanowire [9]. Our observations confirm the theoretical predictions and can be used to extract information about the wall motion.

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