

Two different aspects of Spintronics: Magnetic Semiconductors and Spin-Transfer Torques in Magnetic Nanopillars

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Spintronics is the field of physics that explores the creation, detection and manipulation of the electron spin. I will present two different approaches to Spintronics. The first approach is focused on the study and investigation of semiconductors that are doped with magnetic elements, while the second concentrates on spin transport studies in metallic/magnetic multilayer structures.

I will present evidence that $Zn_{1-x}Mn_xO$ thin films, grown by reactive magnetron sputtering without external carrier doping, are ferromagnetic at temperatures significantly above 300 K. The onset of the ferromagnetic behavior is controlled by the detailed growth conditions and the magnetic properties strongly depend on the Mn concentration. In well-characterized, single-phase films, the magnetic moment is $4.8\mu_B/\text{Mn}$ at 350 K, one of the highest moments yet reported for any Mn doped magnetic semiconductor. Anomalous Hall effect shows that the charge carriers are spin-polarized electrons and participate in the observed ferromagnetic behavior. $Zn_{1-x}Mn_xO$ appears to be a promising candidate as a magnetic semiconductor and for use in spin based electronic applications of the future.

The second approach is by investigating the spin transport in alternating metallic and magnetic layers. The Giant Magnetoresistance (GMR) effect that has been successfully implemented in technology is such an example. The inverse of the GMR effect is the effect of the spin-transfer torque. It can be demonstrated in a magnetic nanopillar where a spin-polarized current flowing through a ferromagnetic layer exerts a torque on its magnetization. I investigate the effect of the normal layer on the switching characteristics of magnetic nanopillars in the case of ballistic (Cu) and diffusive transport (Cu(Ge5%)) by comparing the magnetization switching currents (ΔI_S) in Py/Cu and Py/Cu(Ge5%) nanopillars and relating these to the calculated spin-transfer torques. Spin-transfer torque can also lead to microwave-frequency dynamics and I will present very recent data of such high-frequency excitations on Py/Cu nanopillars.