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Spin transport and spin-flip scattering in magnetic multilayer structures[1]

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The existence of spin-flip scattering at the interface between ferromagnetic (F) and nonmagnetic (N) layers of magnetoresistive F/N/F structures can significantly reduce the size of the magnetoresistance, limiting the sensitivity and increasing the power consumption of F/N/F devices such as GMR magnetic field sensors, magnetic read heads, and MRAM's [1]. Detecting and measuring the degree of spin flip scattering in F/N/F structures can allow further optimization in such devices as well as increase the understanding of interfacial spin transport. Our nonlocal spin injection and detection experiments on mesoscopic Co-Al_2O_3-Cu-Al_2O_3-Co spin valves provide evidence for the existence of interfacial spin-flip scattering in magnetoresistive devices [2]. By extending the conventional picture of spin-dependent interfacial resistances ($R_\uparrow$, $R_\downarrow$) to include two additional spin-flip scattering channels ($R_{\uparrow\downarrow}$,$R_{\downarrow\uparrow}$) [3] we have shown that the nonlocal resistance contains information about both the degree of spin polarization and the degree of spin-flip scattering at the F/N interface. The magnitudes of $R_{\uparrow\downarrow}$ and $R_{\downarrow\uparrow}$ depend on the relative orientation of the detector magnetization and the nonequilibrium magnetization in the normal metal. We have observed that the difference in spin-flip scattering between up and down channels vanishes at low temperatures, but for $T>100K$ it increases nonlinearly with temperature. Further evidence for the presence of interfacial spin-flip scattering can be obtained from noise measurements, which are extremely sensitive to the microscopic transport details. [1] *Spin Dependent Transport in Magnetic Nanostructures*, edited by S. Maekawa and T. Shinjo (Taylor & Francis, New York, 2002). [2] S. Garzon, I. Žutić, and R. A. Webb, Phys. Rev. Lett. **94**, 176601 (2005). [3] E. I. Rashba, Eur. Phys. J. B **29**, 513 (2002).

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