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Spin injection, diffusion and detection in lateral spin valves

YI JI, Materials Science Division and Center for Nanoscale Materials, Argonne National Lab

Metallic heterostructures involving ferromagnetic metals (FM) and non-magnetic metals (NM) offer very rich spintronic phenomena, such as giant magnetoresistance and spin-transfer torque. Recently, new interests have been found in heterostructures that feature lateral variation of materials. The motivation originates from the possibility of lateral integration of future spintronic devices and the advantage of extra degrees of freedom in controlling spin accumulation offered by lateral structures. In this work, we demonstrate non- local spin injection and detection in lateral spin valves. A lateral spin valve consists of a NM nanowire connected with two FM electrodes, one as the spin injector and the other as the spin detector. The measurement configurations are arranged in such a way that the current injection circuit and voltage detection circuit are separated, and so are the charge current and the spin current. A pure spin current without charge flow can be obtained in lateral spin valves, and the detected spin signal exhibits very large percentage change. The spin accumulation in lateral spin valves strongly depends on the spin diffusion length of the NM and the injection polarization of FM/NM interface, both of which can be determined by measuring a series of spin valves with different injector detector separations. We have determined the spin diffusion lengths and injection polarizations for Py/Au/Py and Co/Cu/Co lateral spin valves, fabricated by different techniques. The differences of these quantities in two systems will be discussed. This work is done in collaboration with Axel Hoffmann, Sam Jiang, John Pearson, and Sam Bader, and supported by U.S. DOE Office of Basic Energy Science-Materials Science under contract No. W-31- 109-ENG-38.