Asymmetric spin injection at high current bias in all-metallic lateral spin valves

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Creation and control of spin currents is a key ingredient in spintronics, which has as a goal the use of both the spin and charge of the electron. Ferromagnetic (FM)/non-magnetic (NM) lateral spin valves are powerful devices that decouple a pure spin current from an electrical current by using a non-local geometry (**Fig. 1**). The FM/NM interface and the materials control in an essential way the generation and manipulation of a spin current in non-local spin valves (NLSV). For this reason, we have studied the electrical spin injection and subsequent spin diffusion in metallic NLSV with transparent interfaces as a function of important experimental parameters such as injection current direction and magnitude, temperature, materials, and thickness.

Using injected DC currents we find that the spin injection is perfectly symmetric when applying low currents from the FM (spin injection) or into the FM (spin extraction), reversing exactly the polarity of the spin current in the NM [1]. This provides means for a pure electrical manipulation of the spin current polarity. Very recently, we have observed a breaking of symmetry between spin injection and spin extraction at high current bias, which, unlike other systems such as semiconductors [2,3], tunnel barriers [4] or graphene [5,6], is not expected in metallic junctions. A systematic study shows that the spin diffusion length of the NM is independent of current direction, whereas the effective spin polarization of the FM appears to be larger for spin injection and smaller for spin extraction. Possible explanations for this behavior will be discussed.

The injection and diffusion of the spin current into the NM is studied by comparing the experiments with a spin-diffusion model. We identify the effect of the surface and the interface on the spin diffusion length and injection efficiency, due to an enhanced spin-flip scattering [7]. These experiments have important implications for the physics of spin currents and for the development of devices based on these phenomena.

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References

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Figures

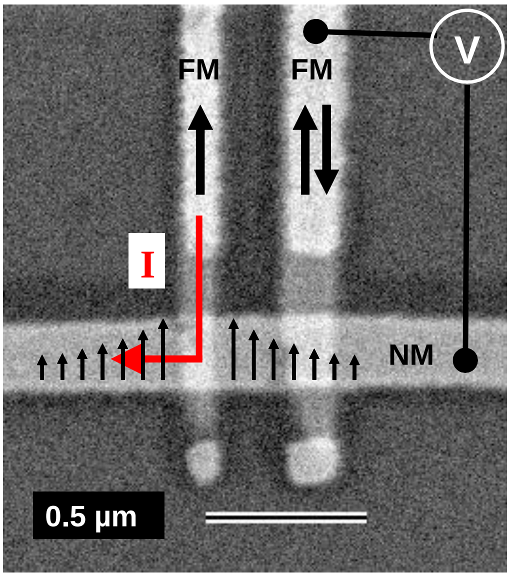

Fig. 1: Scanning electron microscope image of a lateral spin valve with a schematic illustration of spin injection, accumulation and detection in a non-local measurement.