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The essential role of spin-memory loss at 3d/5d metallic interfaces in spin pumping

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I will present a review of experiments and theory of spin-pumping in Co/(Cu)/Pt 3d/5d metallic systems in the ferromagnetic resonance (FMR) regime of spin injection [1]. By combining i) FMR analyses of the resonance linewidth of the Co spectra in contact with the Pt (or Cu/Pt) reservoir and ii) detection of the inverse spin-hall effect signal vs. Pt thickness, we were able to evidence two different lengthscales for the spin-current profile generated or absorbed at the interfaces [2]. The first lenghscale, extracted from FMR analyses and of the order of 2 nm, represents a typical interface length characteristic of a spin memory loss at the Co/Pt and Co/Cu/Pt interfaces. This represent a typical region of spin-current dissipation by which almost 60-70 % of the total current generated is lost before conversion in bulk Pt. The second lengthscale, roughly equal to 3.4 nm, like determined by Inverse Spin Hall Effect (ISHE) transverse voltage measurement, is more characteristic of the spin-diffusion length of the bulk Pt that governs a part of the spin-to-charge conversion efficiency by ISHE. After careful analyses, we determined a spin-hall angle of 5.6 % for Pt and an intrinsic spin hall conductivity of 3200 $(\text{Ohm.cm})^{-1}$ for our corresponding Pt resistivity [2]. In the end, I will focus on the physical description of our experiments within a derived Valet-Fert model describing the spin transport/relaxation in a diffusive approach and using relevant boundary conditions for spin-pumping (constant spin accumulation in the ferromagnet). The origin of the spin-memory loss and spin-current discontinuity, also proposed in a very recent work [3], will be explained in terms of atomic intermixing at interfaces or possible Rashba-split states at Co/Pt interfaces.

[1] Y. Tserkovnyak et al., Rev. Mod. Phys. 77, 1375 (2005) and references therein.
[2] J. C. Rojas-Sanchez et al., Phys. Rev. Lett. 112 106602 (2014)
[3] Liu Yi et al., Phys. Rev. Lett. 113, 207202 (2014)