Temperature Dependence of Spin Pumping in Y3Fe5O12/Pt, Ni81Fe19/Pt and SnTe/Ni81Fe19 Thin Films

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Magnons (quanta of spin waves) are collective excitations in magnetic material and allow information processing without transferring charge [1]. Such no-charge-based devices are in great demand owing to information transfer without Joule heat loss. One of the crucial components of a magnonic device is the detection of a magnon signal by transferring it to an electrical signal. One prominent way to accomplish the goal of electric detection of magnon spin current is via a method called spin pumping [2] using inverse spin hall effect (ISHE) phenomena. When the heavy metal (e.g. Pt) or topological material is interfaced with the magnetic materials (FM), the spin current can be injected into the HM from FM via spin pumping. Precessing magnetic material transfer angular momentum from the FM to the FM/HM interface via coupling of the local magnetic moments of the FM with the conduction electrons of the HM. Recently, it has been reported via ferromagnetic resonance experiments that induced spin currents can be amplified instead of suppresses by adding a strong spin-orbit coupled spin sink layers in a superconductor/ferromagnet hybrid structure [3] and is key for superconducting spintronics. Therefore, it is essential to study the low-temperature spin pumping in Pt and topological materials, such as SnTe. We report broadband spin-wave spectroscopy and spin pumping experiments on $Y_3Fe_5O_{12}$/Pt, $Ni_{81}Fe_{19}$ (with Pt thickness varied from 7 nm to 75 nm), and SnTe/ $Ni_{81}Fe_{19}$ bilayer thin films for temperatures ranging from 300 K to 4 K. We observed a systematic shift in ferromagnetic resonance fields, amplitude, and linewidths as a function of frequency and temperature. For the in-plane and out-of-plane directions of the magnetic field, we observed distinct modes at lower temperatures. The spin mixing conductance, spin current density, and spin hall angle values showed strong temperature dependence. Our findings are key for the usage of Pt and SnTe as spin sink layers for the superconducting spintronics applications.

References:

[1] A. V. Chumak, et al., Nature physics 11, 453 (2015)
[2] Y. Tserkovnyak, A. Brataas, and G. E. Bauer, Physical review letters 88, 117601 (2002)
[3] Jeon, KR., Ciccarelli, C., Ferguson, A.J. et al., Nature Mater 17, 499–503 (2018).

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