Abstract Submitted
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Phase-sensitive detection of both inductive and non-inductive ac voltages in ferromagnetic resonance[1] MATHIAS WEILER, JUSTIN M. SHAW, HANS T. NEMBACH, MARTIN A. SCHOEN, CARL T. BOONE, THOMAS J. SILVA, Electromagnetics Division, National Institute of Standards and Technology, Boulder, CO 80305 — Spin pumping causes significant damping in ultrathin ferromagnetic/normal metal (NM) multilayers via spin-current generation of both dc and ac character in the NM system. While the nonlinear dc component has been investigated in detail by utilization of the inverse spin Hall effect (iSHE) in NMs, much less is known about the linear ac component that is presumably much larger in the small-excitation limit. We measured generated ac voltages in a wide variety of Permalloy/NM multilayers via vector-network-analyzer ferromagnetic resonance. We employ a custom, impedance-matched, broadband microwave coupler that features a ferromagnetic thin film reference resonator to accurately compare ac voltage amplitudes and phases between varieties of multilayers. By use of the fact that inductive and ac iSHE signals are phase-shifted by $\pi/2$, we find that inductive signals are major contributors in all investigated samples. It is only by comparison of the phase and amplitude of the recorded ac voltages between multiple samples that we can extract the non-inductive contributions due to spin-currents. Voltages due to the ac iSHE in Permalloy(10nm)/platinum(5nm) bilayers are weaker than inductive signals, in agreement with calculations based upon recent theoretical predictions.

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