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Amplitude and phase of perpendicular standing spin waves via VNA-FMR in sputtered Py/Ta films MARTIN A. SCHOEN, HANS T. NEMBACH, MATHIAS WEILER, JUSTIN M. SHAW, CARL T. BOONE, Electrodynamics Division, National Institute of Standards and Technology, Boulder CO 80305, MIKHAIL KOSTYLEV, School of Physics, The University of Western Australia, Crawley WA 6009, Australia, THOMAS J. SILVA, Electrodynamics Division, National Institute of Standards and Technology, Boulder CO 80305 — The first observation of perpendicular standing spin waves via ferromagnetic resonance in thin films dates back to the mid '50s. However, phase-sensitive, broad-band FMR methods have only recently been developed with sufficient signal-to-noise to examine the dependence of spin-wave phase on mode index. We measured field-swept complex spectra of perpendicular standing spin waves (PSSWs) up to wavenumber 2x10^6 cm^{-1} (30 GHz) in Py/Ta films of different thickness with vector-network-analyzer FMR with coplanar waveguide excitation. The spectra are fitted simultaneously with multiple complex susceptibilities to account for inter-mode interference. The spin-wave stiffness constant D and the pinning-parameter ε are determined from a quadratic fit of the exchange field to the mode number. For all film thickness, ε is indicative of weak pinning. Mode amplitude vs. excitation direction points to a dead layer at the Py/Ta interface. We observe strong inter-mode phase variations, especially for thinner (<100 nm) films. Results are compared to a 1-d electrodynamic model that simultaneously solves the Maxwell and Landau-Lifshitz equations. The observed phase shifts are not expected if substrate conductivity is ignored.

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