Spin dynamics in nanoscale systems

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Spin relaxation processes in metallic structures will be reviewed. It will be shown that the intrinsic Gilbert damping is caused by noise in spin orbit interaction. In ultrathin films the Gilbert damping is affected by interface electron band contributions resulting in an inverse dependence on the film thickness. In multilayer films involving FM/NM and FM/NM/FM structures (FM-ferromagnet, NM-non-magnetic conductor) the spin dynamics becomes affected by non-local spin transport. The precessing magnetization acts as a peristaltic spin pump, which transports the spin momentum away from the FM/NM interface without a net electrical charge allowing one to establish a transfer of information between the magnetic layers separated over thick nonmagnetic metallic spacers. Time Resolved Magneto-Optical Kerr effect (TRMOKE) is an ideal tool to investigate the propagation of spin currents in the magnetic double Fe/Au/Fe(001) structures. The stroboscopic time-resolved measurements (with the time resolution of 1 ps and sub micron spatial resolution) were carried out using a co-planar waveguide which is driven by a CW microwave power synchronized with the fs laser magneto-optical probe and a slotted transmission line driven by ps magnetic pulses. These studies were further augmented by FMR measurements using the magnetic single layer Fe/Au,Ag(001) structures. With increasing thickness of Au and Ag a part of the accumulated spin momentum in the Au and Ag layers relaxes to the lattice and that leads to an increased interface Gilbert damping in the Fe layer. The quantitative analysis of TRMOKE and FMR data using the spin diffusion theory allowed one to determine the momentum and spin flip relaxation time constants in the crystalline Au and Ag spacers. The spin diffusion length in Au and Ag was found to be of 35 and 280 nm, respectively.
The crystalline Fe/Au,Ag/Fe/Au(001) nano-structures were prepared by Molecular Beam Epitaxy (MBE) technique using 4x6 reconstructed GaAs(001) substrates.

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