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Book of Abstracts

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EXCITATION OF EXCHANGE MAGNONS IN FERROMAGNETIC FILMS BY PICOSECOND ACOUSTIC PULSES

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We report the experimental and theoretical results on the excitation of exchange magnons in single ferromagnetic films by laser-induced acoustic pulses. In the theoretical calculations, we use simple model based on the system of ordinary differential equations to describe the excitation of spin waves modes. In order to predict optimum condition for the excitation of ultrashort pulses of exchange magnons, we investigate how sequences of acoustic pulses with different duration and periodicity influence the magnetization dynamics.

In optical pump-probe experiments a permanent magnet is used to tilt the magnetization out of the sample plane. The constant effective magnetic field consisting of the external magnetic field, the field of the magnetocrystalline anisotropy, the demagnetizing field and the exchange field is perturbed by the time-dependent magneto-elastic field propagating at the speed of sound. In the experiment, optical pumping results in the excitation of unipolar or bipolar acoustic pulses which propagate across the sample and drive the precessional motion of the magnetization. In addition to that, laser-induced heating alters the direction of the effective magnetic fields thereby inducing spin waves propagating away from the excited region.

Magnetization dynamics was monitored by the magneto-optical Kerr effect in femtosecond time-resolved pump-probe experiments performed on different ferromagnetic films (Fe, Co, Ni and permalloy). Keeping in mind the possibility to generate trains of acoustic pulses periodic by sequences of fs-pump pulses we have performed theoretical calculations for the acoustically induced magnetization dynamics. Excitation of the homogeneous precession (FMR mode) and standing exchange magnons was calculated within the framework of a theoretical model using Landau-Lifshitz-Gilbert (LLG) equation, free boundary conditions for the magnetization and the equations for the propagated elastic strains pulses. Since the influence of the magnetocrystalline anisotropy is expected to be small in polycrystalline films, we neglected it in our calculations. Neglecting the coupling between exchange magnons, we were able to solve LLG equations separately for each mode. We performed simulations for unipolar and bipolar acoustic pulses, analyzed the spectra of acoustic and magnonic excitations and compared them with experimental results obtained with single acoustic pulses. Experiments with sequences of acoustic pulses are underway.

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