Elastic and magnetic dynamics of nano-magnet ordered arrays impulsively excited by sub-ps laser pulses

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Abstract

We report on the first observation of elastic and magnetic dynamics of ordered arrays of permalloy nano-dots excited by low-intensity 120 fs light pulses. The first order of the diffraction pattern, generated by the probe beam in a pump-probe configuration, is used for time-resolved reflectivity and time-resolved magneto-optical Kerr effect measurements. The non-adiabatical absorption of the pump triggers a surface acoustic standing wave in the silicon substrate, detected by the reflected probe signal, with a frequency related to the array wave-vector. The study of the dynamics of steady-state recovery allows to gain detailed information on the elastic properties of the nano-dots/substrate coupled system. The magneto-optical signal exhibits, on the nanosecond time-scale, the signature of the heat-exchange diffusion processes. In addition, a clear oscillation of the magnetic signal, at a frequency close to the frequency of the elastic mode, is unambiguously detected. Finally, the interplay between the elastic and magnetic dynamics are analyzed and interpreted. This work open the way to very important studies on non-equilibrium mechanical, thermodynamical and magnetic properties of nano-scaled systems.