

Supplementary Material to the article

“Nonthermal photoinduced reduction of the coercive field in thin epitaxial films of the $L1_0$ -phase FePt and FePt_{0.84}Rh_{0.16}”

A. Sample synthesis and preparation. Thin epitaxial films with FePt and FePt_{0.84}Rh_{0.16} compositions were obtained by magnetron sputtering of targets of the film compositions onto MgO substrates with (001) orientation, “epi-polished” surface quality grade and a roughness of less than 0.5 nm (Crystal GmbH, Germany). The base pressure in the synthesis chamber (SPECS, Germany) was no worse than 10^{-9} bar. Pure argon of the 6N grade was used as a plasma-forming gas; its pressure in the process of film deposition was $3 \cdot 10^{-3}$ mbar. The chemically ordered $L1_0$ -phase with the tetragonal symmetry was formed during vacuum annealing at 650 °C for 2 h. The thickness of the deposited films was 20 nm. The appearance of the (001) maximum in the X-ray diffraction pattern of the FePt film (Fig. S1) indicates the formation of a structure with tetragonal symmetry and the c axis orientation along the normal to the film plane. The diffraction pattern of the FePt_{0.84}Rh_{0.16} film has a similar structure. The films are continuous and have a roughness of ~ 1 nm according to the atomic force microscopy data.

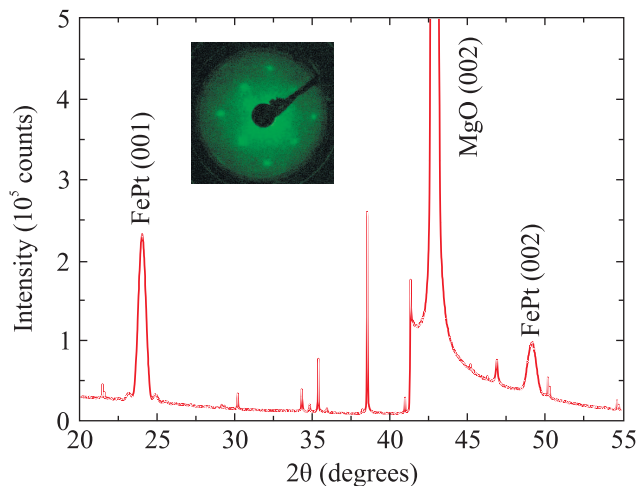


Fig. S1. X-ray diffraction pattern of a thin FePt film (20 nm) on a single-crystal MgO (001) substrate, $T = 300$ K. Source – Cu- $K\alpha$, diffractometer Bruker D8 Advance, equipped with an Euler cradle, measurement configuration – Bragg–Brentano

B. Experimental setup. The layout of the experimental setup for studying the time-resolved magneto-optical Kerr effect is shown in Fig. S2. The setup is based on a Coherent Legend Elite USP femtosecond laser with an emission wavelength of 800 nm, a pulse duration of 35 fs, and a basic pulse repetition rate of 1 kHz. The synchronization and delay generator allows to arbitrarily decrease the pulse repetition rate.

The experiments were performed following the “pump-probe” approach. The output laser pulse is divided in amplitude by a thin-film beamsplitter BS into the pump and the probe pulses. In the experiments presented in the article, the second harmonic radiation with a wavelength of 400 nm was used for the pump that was obtained using a nonlinear BBO-crystal with a thickness of 140 μm . The variation of the optical path difference between the pump and the probe pulses makes it possible to study the dynamics of the optical properties of the sample, covering the range of delays from the time preceding the pump pulse, during the pulse, and after it. The Physik Instrumente C-663.2S linear translator with a scanning range of 30 cm makes it possible to study the temporal dynamics of the measured values up to 2 ns delay relative to the pump pulse with a minimum step of 0.67 fs.

The magnetization of the sample manifests itself in the angle of rotation of the plane of polarization (Kerr angle) of the probing radiation upon reflection from it. With a good accuracy, the Kerr angle is proportional to the magnetization [A. K. Zvezdin, V. A. Kotov, Modern magneto-optics and magneto-optical materials, CRC Press, Boca Raton (1997)]. The described experiments were carried out in the polar geometry, when the magnetization

vector is perpendicular to the reflecting surface. The angle of incidence of the probing light on the sample was 57 degrees and was limited by the size of resistive electromagnet. Continuous thin films of the $L1_0$ -phase of the FePt compound and similar ones usually possess a stripe domain structure with the domain magnetizations directed along the normal to the film. The overall magnetization reversal occurs due to the domain wall motion. Therefore, in the described experiments, the magnetization component perpendicular to the film was measured.

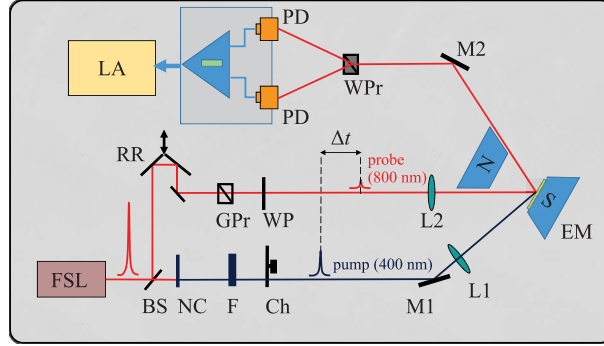


Fig. S2. Experimental setup for pump-probe type studies (FSL – femtosecond laser, BS – beamsplitter, NC – nonlinear crystal, F – blue filter, Ch – chopper, RR – corner delay line reflector, GPr – Glan prism, WP is a half-wave phase plate, M1 is a mirror, M2 is a mirror, L1 is a lens, L2 is a lens, EM is an electromagnet, WPr is a Wollaston prism, PD is a photodiode, LA is a lock-in amplifier)

To fine-tune the probe beam polarization, a combination of a broadband half-wave retardation plate and a Glan prism was used. The latter provides a high degree of polarization within the entire fairly wide spectrum of femtosecond pulses (32 nm at half maximum for a pulse duration of 35 fs and a central wavelength of 800 nm).

The pump and the probe beams are focused at the sample surface into the overlapping spots using the fused silica lenses. The effective diameters of the pump and probe spots at the film surface were 300 and 50 μm , respectively. The samples were fixed near one of the poles of a resistive electromagnet. The maximum generated magnetic field is 0.6 T.

The probe light reflected from the sample passes the Wollaston prism that splits it into two orthogonally polarized components. At an angle of 45 degrees between the polarization plane and the axis of the polarizer, the intensities of the components are equal. These intensities are detected by silicon photodiodes, which are insensitive to light polarization. The rotation of the polarization plane leads to a change in a difference between the outputs of these photodiodes and, thus, allows us to study the evolution of the polarization of the probe light reflected from the samples and, accordingly, the magnetization of the samples. Next, the difference signal of a detector is fed to the input of the lock-in amplifier (SR7270 from Ametek, USA). Detection can be performed both at the laser pulse repetition rate and at a half-frequency if the change in the Kerr angle is measured, rather than the angle itself, and the pump light is modulated. So, when measuring the dependence of the saturation magnetization on time (Fig. 2 of the main manuscript), an optical obturator (a chopper) was placed in the pump channel, blocking every second pulse. This modulator was absent in the pump channel when measuring the hysteresis curves shown in Fig. 3 of the main part of the article. All measurements of the time-resolved magneto-optical Kerr effect were carried out at room temperature.