THE EXPERIMENTAL OBSERVATION OF STRAIN-PHOTON COUPLING FOR MAGNETOSTRICTIVE MAGNETICS

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A new emerging branch of spintronics – strain-magnetooptics has been created due to a direct observation of correlation between magnetoelastic properties and absorption of unpolarized light in the infrared range in $CoFe_2O_4$ single crystals with high magnetostriction.

The interaction between strain and spin has received intensive attention in the scientific community due to its abundant physical phenomena and huge technological impact. For example, straintronics demonstrates a fundamentally new way to control electronics at the nanoscale [1]. The straintronics` materials usually explore the change of their magnetostrictive properties via magnetic-field-induced mechanical deformations. On the other hand, optical reflection and absorption in magnetics are also sensitive to magnetic field and stresses [2]. To explore the coupling between straintronics and optics, we studied the influence of magnetic field on the magnetooptical properties of a ferrimagnetic $CoFe_2O_4$ possessing high magnetostriction constants (about 6×10^{-4}) at room temperature.

The $CoFe_2O_4$ single crystals were grown by the floating zone melting with radiation heating. The magnetostrictive, magnetic and optical properties were measured for (001) oriented plate-shaped samples with in-plane typical dimensions of 10×10 mm^2 and thickness of d = 400 μm in a magnetic field up to 4 kOe applied in-plane to the crystal surface.

The direct correlation between the magnetoreflection and magnetotransmission of natural light in the IR range with magnetostriction of a magnetic was shown for the single-crystal of $CoFe_2O_4$ [3, 4]. This correlation is confirmed by the similarity of the field behavior of effects at different orientations of magnetization with respect to crystal axes. The mechanisms of magnetotransmission, magnetoreflection of light and magnetorefractive effect in spinel connected with the magnetic-field-induced mechanical deformation of spinel crystal were revealed. It was also shown that the effect of the magnetic field on the optical properties of spinel is indirect: the magnetic field strongly affects the crystal lattice, which in turn leads to the changes in the absorption and reflection spectra. The contribution of traditional Faraday rotation on the magnetotransmission effect in the IR range is quite small [5].

The revealed mechanism of new infrared magnetooptical effects in magnetostrictive magnetics paves the way towards new area called as a strain-magneto-optics.

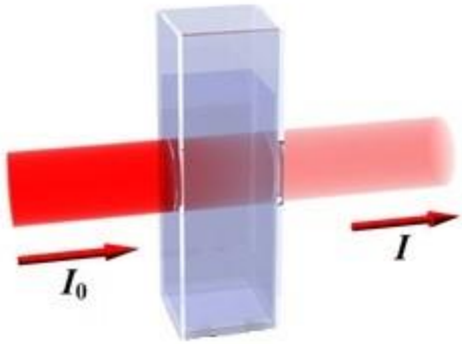

Fig. 1. The field dependences of magnetostriction (top), magnetotransmission (left bottom) and magnetoreflection (right bottom) of light at wavelength 3 mkm for the ferrite crystal at room temperature.

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