DC magnetic field topography by the magnetoplasmonic crystal

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Technological progress sets the direction for the development of modern fundamental and experimental approaches to the study of materials and their adaptation to various applications. One of the rapidly developing directions is the design of magnetic field sensors [1]. Nowadays tasks are aimed for balancing the sensitivity and resolution, and lowering the power consumption. It is also required to lower the price of the magnetic field sensing elements production and miniaturize their dimensions. One of the new approaches for magnetic field sensing is based on the use of magnetoplasmonic crystals (MPlCs) – plasmonic crystals made of noble and ferromagnetic materials [2, 3]. The possibility to enhance magneto-optical response by two orders of magnitude with the use of MPlCs can expand possible applications of magneto-optical effects [4].

A MPlC-based magnetic field sensor that utilize the possibility to enhance the transverse magneto-optical Kerr effect by the excitation of surface plasmon-polaritons (SPPs) can reach the sensitivity up to 10^{-7} Oe [5]. The change of an optical probe position on the MPlC's surface can be used for magnetic field topography.

Here we present the way to tune the magneto-optical response by the change of diffraction grating height and diffraction efficiency preserving the parameters of sputtered layers and the results of the magnetic field topography with the use of permalloy-based MPlCs with the diffraction scheme for SPPs excitation. The used approach is based on the dependence of the magneto-optical response on the of DC magnetic field magnitude codirected with the AC modulating magnetic field. Thus, it is possible to make magnetic field topography by moving the DC field source in the plane of MPlCs (XY) at a distance behind it (Z). As DC magnetic field sources, a wire, a flat planar induction coil with DC current and a set of permanent magnets were used.

The sensitivity to the change of the DC magnetic field in the experimental configuration was 7 mOe with the incident beam focused in a round spot with the diameter of 150 um. The achieved sensitivity and resolution is enough to use the MPlC as an effective probe for magnetic flaw detection.

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