PURE MAGNETO OPTIC DIFFRACTION BY AN ARRAY OF PERIODIC DOMAINS

J.L. Costa-Krämer, R.J. Ortega-Hertogs, S. Melle, C. Guerrero and F. Briones

Instituto de Microelectrónica de Madrid, CNM-CSIC, Isaac Newton 8, PTM, 28760 Tres Cantos, Madrid, España

On an array of periodic magnetic elements, reflected light polarized in the plane of incidence, or (00) beam, shows intensity changes directly proportional to the changes of the average magnetization within the elements perpendicular to the plane of incidence (transverse MO Kerr configuration). The amplitude of these changes are of the order of 0.1-1% for Fe, Co, Ni varying as well as a function of light wavelength and angle of incidence. Moreover, the intensity of different diffraction order beams (m,n) contains also information about the elements magnetization distribution as a Fourier transform of both optical and magnetic periodic distributions [1,2]. In this work we show that it is possible to observe pure MO diffraction by a totally flat and optically homogeneous magnetic surface in which an array of ordered domains is artificially induced. At magnetic saturation diffracted light is zero, while at selected magnetic field values, where the magnetization breaks into an array of ordered periodic domains, diffracted beams appear at angles corresponding to the domain periodicity. This magneto optical switch effect is reported for the first time to our knowledge.

Samples are microfabricated by optical lithography on polycrystalline Co sputtered on glass. First, a continuous layer, 60nm thick, is grown. This thickness guarantees optical opacity for the light used in the experiments, a 633nm wavelength 1.5 mW laser. Secondly, an array of 120nm thick Co stripes is deposited and patterned on top of the previous layer, using standard lift-off technique. Different samples with varying width and inter stripe spacings in the 2-50 μm range are fabricated. MO experiments are performed on the light beam reflected both from the patterned side and from the flat side. When an alternating magnetic field is applied perpendicular to the stripes long axis, marked differences are found in the MO signal corresponding to front and back reflection,as shown in Fig. 1 a and b for a structure with 6 μm period and 3 μm interstripe spacing. These differences correspond to a range of fields where magnetic domains on the continuous film are created with an antiparallel orientation to the overall magnetization. At the same time, the appearance of diffracted beams at this range of fields is observed for light impinging on the flat side of the samples. The intensity of those beams is switched ON and OFF in phase with the the applied low amplitude ac field as expected and shown on fig. 2. The diffraction angle corresponds to the artificially induced domain periodicity.
In summary, light diffraction by an array of ordered domains at a flat surface is reported. This effect could be useful for magneto optical switches.

References:

[1] D. Jaque, J.I. Martín, G. Armelles, J.L. Costa-Krämer., F. Brioens and J.L. Vicent, Nanopatterning effects on magnetic anisotropy of epitaxial Fe(001) squares. Jor. of Appl. Phys. 91 (2002) 382-388

[2] P. García- Mochales, J.L. Costa-Krämer, G. Armelles, F. Briones, D. Jaque, J.I. Martín and J.L. Vicent . Simulations and experiments on Magneto-optical diffraction by an array of epitaxial Fe (001) microsquares. Applied Physic Letters, submitted..

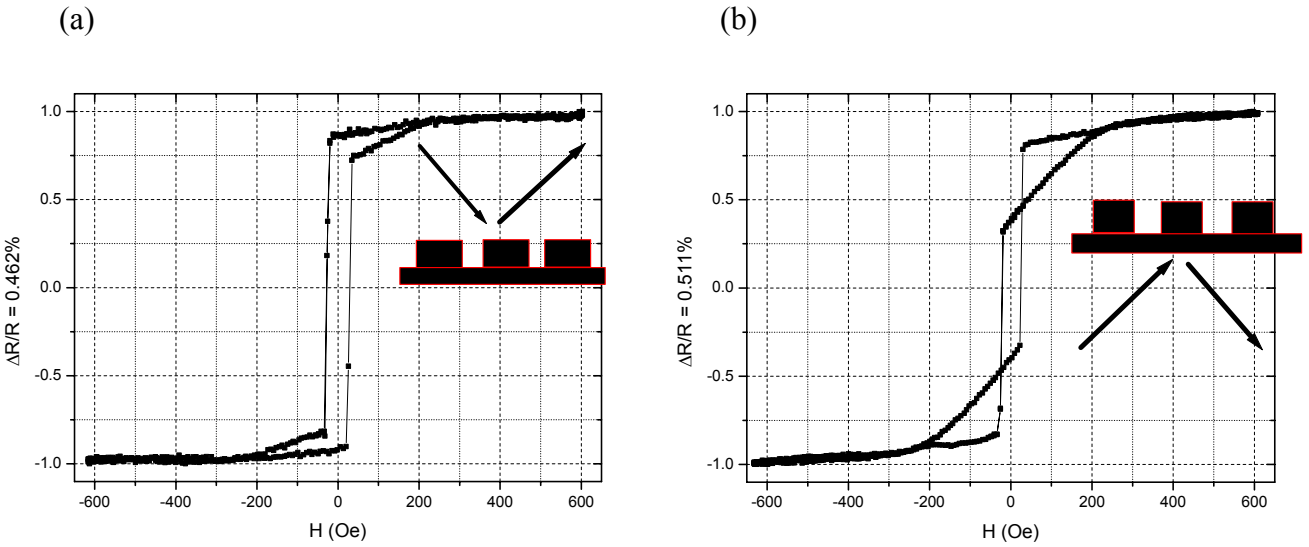

Figure 1: Hysteresis loops for a structure consisting of a continuous Co film with an array of Co stripes on top when the light is shined from (a) the patterned side, and (b) the flat side. The insets show the magneto optical measurement configuration (see text)

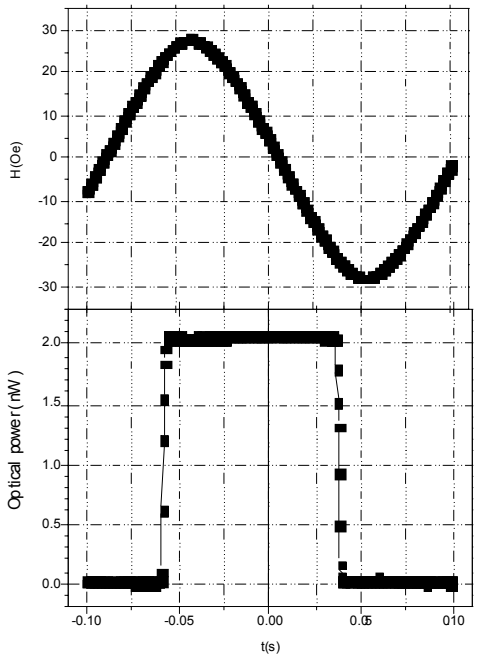

Figure 2: Applied field and variation of the diffracted light at an angular position corresponding to the stripe array periodicity when light is shined from the flat side of the structure.