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Nonlinear Magneto-Optical Studies in Magnetic Superlattices and Magnetic Nano Structures

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Linear magneto-optical effect has been known to provide plenty of information on electronic structures of bulk magnetic materials. On the other hand, nonlinear magneto-optical effect, or magnetically-induced nonlinear-optical response, provides information on interplay between crystallographic and magnetic properties of surfaces and interfaces.

We studied linear magneto-optical spectra of artificial superlattices consisting of a few atomic layers of Fe and Au, K. Sato, E. Takeda, M. Akita, M. Yamaguchi, K. Takanashi, S. Mitani, H. Fujimori, Y. Suzuki: Appl. Phys. 86 (1999) 4985 and those of Co and Ru, M. Yamaguchi, K. Takanashi, K. Himi, K. Hayata, K. Sato and H. Fujimori: J. Magn. Magn. Mater. 239 (2002) 255 from which it was elucidated that magneto-optical spectra can be interpreted in terms of band structures peculiar to these superstructures.

We also studied magnetically induced second harmonic generation (MSHG), which is one of nonlinear magneto-optical effect, on Fe/Au superstructures. We found anisotropic pattern in the polar plot second harmonic signals that reflects the symmetry of the substrate. K. Sato, A. Kodama, M. Miyamoto, A.V. Petukhov, K. Takanashi, S. Mitani, H. Fujimori, Kirilyuk and Th. Rasing: Phys. Rev. B64 (2001) 184427. We also found the anisotropic pattern shows a drastic change under the reversal of the magnetic field. From this study it has been clarified that not only electric dipole term but also electric quadrupole term is necessary to understand the MSHG anisotropy. In addition we found large nonlinear Kerr rotation in these materials, the largest of which amounts to 31 degrees in Fe(1.75ML)/Au(1.75ML) superstructure.

Recently we have successfully fabricated buried magnetic structures of permalloy dot array of 300 nmx100 nm in area and 100 nm in depth using electron beam lithography and damascene technique. K. Sato, Y. Morishita and T. Ishibashi: The 26th Annual Conference on Magnetics in Japan, Tokyo, Sept. 17-Sept. 20, 2002. MSHG shows clear anisotropic pattern with prominent

magnetic response.

First part of this talk will be dedicated to brief introduction of physical basis of nonlinear magneto-optical effect and second part experimental data of MSHG on Fe/Au superlattices with theoretical interpretation and the last part fabrication technique of magnetic nano-structure and its MSHG observation.

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