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Development of three-configurational surface magneto-optical Kerr effect measurements system for *in situ* study of ultrathin magnetic films

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초박막 자성체의 실시간 자화 벡터 연구를 위한 3-축 표면자기광학 측정 장치 개발

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I. INTRODUCTION

The surface magneto-optical Kerr effect (SMOKE) has become an important tool in the study of magnetism in ultrathin film due to its easy implementation and power as a surface sensitive *in situ* characterization under ultrahigh vacuum (UHV). A vectorial SMOKE system with three probing axes is highly desired to study magnetic anisotropies and spin reorientation transition in the ultrathin limit. We have developed a special SMOKE setup which is capable of 3-configurational measurements during the deposition without the transport of sample.

II. SYSTEM DESCRIPTION

In order to realize a simultaneous measurement and deposition at the same position, a spherical main chamber was fabricated with a diameter of 400 mm. A base pressure of 5×10^{-11} Torr is typically obtained after 48-hrs. bakeout at 150 ℃. The sample manipulator was mounted on a rotary base with fine XYZ motions to align a sample at the center of the chamber, and the holder was made of non-magnetic material not to perturb the optical alignments during measurement. Deposition rates for Co and Pd were 0.78 and 1.0 Å/min with UHV compatible evaporator, respectively. To obtain the clean surface of substrate before deposition, sputter-cleaning procedure by ion gun was repeated with a subsequent annealing at 500 ℃.

Fig. 1 shows the main chamber specially designed for three set of SMOKE setups which are mutually orthogonal to each other, which enable 3-dimensional vectorial studies of magnetism in ultrathin film. Three setups are called the 'polar', '1st longitudinal', and '2nd longitudinal' configuration, respectively, considering the scattering plane and substrate normal direction with respect to the direction of an applied field. For the applied field, single set of electromagnets was inserted to the vacuum chamber using a deep pocket of 4 inch diameter. Maximum field of 2.0 kOe was obtained with a pole gap of 29 mm, for all the measuring geometries. We can obtain the magneto-optical property with submonolayer sensitivity through phase modulation method using photoelastic modulator with frequency of 50 kHz and crystal polarziers of Glan Taylor type with extinction ratio better than 10^{-5}.

III. RESULTS AND DISCUSSION

Using this system, we have carried out *in situ* 3-configurational SMOKE measurements of ultrathin Co films

grown on Pd(111), glass, and 200 Å Pd/glass substrates. In fig. 2, 3-axis SMOKE measurements are demonstrated for a Co film of 150 Å, grown on glass substrate with Pd buffer layer of 200 Å. From the loops, one can obtain saturation, remanence, and coercivity values which provide rich information about thin film magnetism with vectorial analysis. The hysteresis loops are clearly identified from all the configurations with sensitivity of 0.001°. Mixed anisotropy behaviors of Co film grown on these substrates may have some relation with the coexistent phase proposed by Millev *et al.*[1]

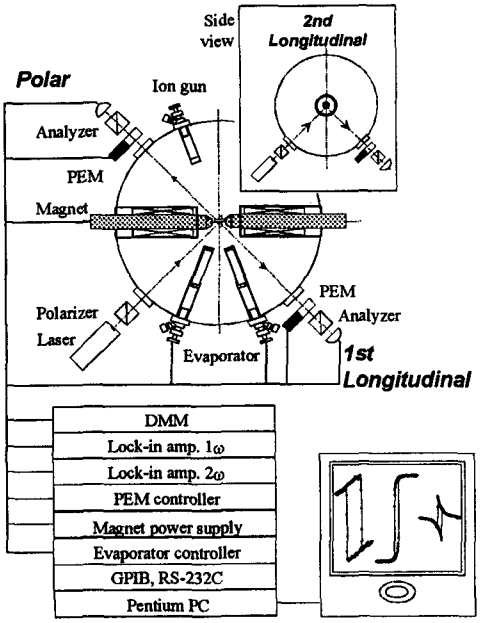

Fig. 1. Schematic diagram of 3-configurational SMOKE measurement system. Incident angle is 45° for all the configurations.

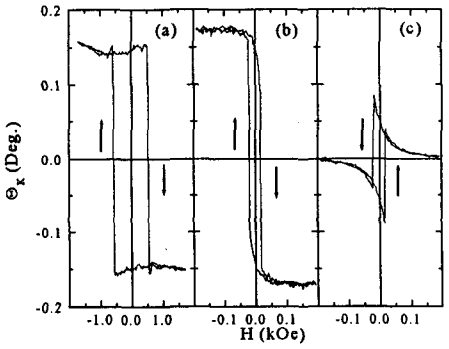

Fig. 2. SMOKE hysteresis loops of 150- Å Co/200- Å Pd/glass measured with (a) the polar, (b) the 1st longitudinal, and (c) the 2nd longitudinal configurations.

IV.ACKNOWLEDGEMENT

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V. REFERENCES

[1] Y. T. Millev, H. P. Oepen, and J. Kirschner, Phys. Rev. B. 57, 5848 (1998).