Increase of magnetic anisotropy energy in Au/Co/Au nanostructure by localized surface plasmon resonance

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1. Introduction

Magneto-plasmonics has attracted much interest in recent years. There have been some reports that large magneto-optical effect is observed at the resonant wavelength of the surface plasmon [1]. Although it is well known that surface plasmon excitation plays a role in enhancing the magneto-optical effect, it is unclear whether surface plasmon excitation causes any change in the magnetic anisotropy of magnetic materials. In this study, we evaluate the in-plane magnetic anisotropy energy of Au/Co/Au nanostructures via localized surface plasmon resonance (LSPR).

2. Experimental procedure

We fabricated nanometer sized square patterns onto an ITO substrate using electron beam lithography. Afterwards, thin films were fabricated on the ITO substrate. The stacking structure of the thin films is as follows: ITO substrate / Cr (5 nm) / Au (30 nm) / Co (6 nm) / Au (30 nm). Cr layer was initially deposited by thermal evaporation. Then, Au and Co layers were deposited using electron beam evaporation. Finally, through the liftoff process, Au/Co/Au nanostructures were fabricated. The dimension of each nanostructure was 170 nm × 170 nm with a periodicity of 310 nm in the x and y directions. Optical properties were characterized by measuring transmittance spectra using a UV-visible spectrometer. The magnetic properties were characterized via a polar magneto-optical Kerr effect (P-MOKE) measurement system at room temperature. In this P-MOKE measurement system, light illuminated the sample surface after passing through a polarizer and a PEM. The polarization axis of the polarizer was oriented at an angle of 45 degrees with respect to the plane of incidence. The plane of incidence was set parallel to the side of sample surface. The incident angle was fixed at about 5 degrees with respect to the surface normal of the sample. The magnetic field was applied perpendicular to the sample plane and ranged from 20k to -20k Gauss.

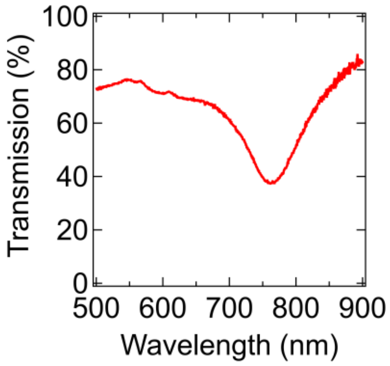

Fig.1 Transmission spectra of Au/Co/Au nanostructure.

3. Result

Figure 1 shows the transmittance spectra of the fabricated nanostructure in the visible region. The polarization axis of the incident light was oriented 45 degrees with respect to the side of the thin film plane. Since a clear absorption peak was observed at the wavelength (λ) of 760 nm, we confirmed that LSPR was excited in the Au/Co/Au nanostructure.

Figure 2 shows the P-MOKE loops of the Au/Co/Au nanostructure for different excitation wavelengths, λ = 500 nm and 750 nm. From the P-MOKE loop, we observe a saturation magnetic field increase in the Au/Co/Au nanostructure when changing the wavelength of incident light from λ = 500 nm to 750 nm. This result indicates that in-plane magnetic anisotropy energy is increased by localized surface plasmon excitation.

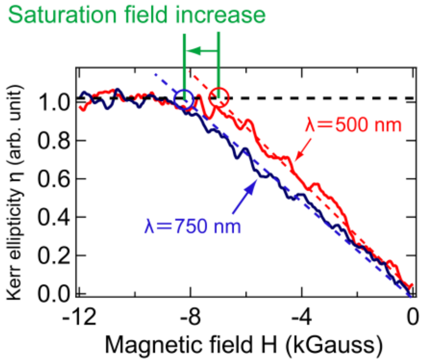

Fig.2 Polar Kerr loop of Au/Co/Au nanostructure for wavelengths: 500 nm and 750 nm.

4. Conclusion

We have experimentally observed significant increase of magnetic field saturation in our Au/Co/Au nanostructure. This result demonstrates that localized surface plasmon excitation induce the in-plane magnetic anisotropy energy increase.

Reference

[1] D. Sander, et al., J. Phys. D: Appl. Phys. **50** (2017) 363001.