Magneto-Optical Surface Plasmon Resonance in Ferromagnetic/Noble Metal Superlattices

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Magneto-optical (MO) effect allows to improve a sensitivity in surface plasmon resonance (SPR) biosensor where the MO effect increases at the SPR angle so as that the reflectance falls sharply. In the present work, we have demonstrated a giant enhancement of the magneto-optical surface plasmon resonance (MOSPR) in ferromagnetic Fe/noble (M=Cu, Ag, Au) metal superlattices, Fe_x/M_x, where *x* is the number of atomic-layers, form first-principles calculations. Calculations were carried out by using a full-potential linearized augmented plane wave (FLAPW) method [1], and the diagonal and off-diagonal parts of the absorptive optical conductivity tensor, $\mathrm{Re}(\sigma_{xx})$ and $\omega\mathrm{Im}(\sigma_{yz})$, were estimated by linear response theory. In an optical range (1.6 – 3.3 eV), the $\mathrm{Re}(\sigma_{xx})$ of Fe_xCu_x is much larger than those of Fe_xAu_x and Fe_xAg_x. In Fe_xCu_x, $\mathrm{Re}(\sigma_{xx})$ increases in proportion to the number of *x*. The spectrum $\omega\mathrm{Im}(\sigma_{yz})$ on Fe_xAu_x shows the peak shift from the energy position of 2.0 eV to 2.7 eV and 3.3 eV for *x* =1, 2 and 3, respectively. Assumed the Kretschmann configuration with the 4 × 4 transfer matrix method [2], we have simulated the MOSPR by using gelatin as a sample. The resonance condition in the SPR spectra occurs at an incident angle of 75°, which is in agreement with our previous experiments [3]. On the other hand, the transverse magneto-optical Kerr effect (TMOKE) signal, $\Delta R_{pp}/R_{pp}$, in the resonance condition increases proportionally to the number of *x* in Fe_xM_x. Additionally, a significant enhancement of the TMOKE signal, by 120%, is observed in Fe_3Cu_3, where the enhancement is mainly due to the MO activity [4]. Further discussions will be presented.

Keywords: magneto-optical surface plasmon resonance, first-principles calculations, enhancement

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