固体ゲート MgO/Pd/Co 構造における磁性の電界効果

Electric field effect on magnetism in MgO/Pd/Co structure with solid-state gate

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Electric field (EF) control of magnetic properties has been intensively studied. Recently, we have reported that the possibility that the proximity-induced magnetic moment in Pd thin film deposited on Co is tunable using an ionic liquid (IL) gating [1]. Although an EF was applied to the Pd surface, to completely rule out the possibility of the EF effect in the diffused Co atoms to the surface is difficult because the Pd layer is thin. In addition to this, redox reactions have been often discussed when an IL is used. In this study, we examine the electric field effect on magnetism in all-solid-state system, in which the charging effect is expected to be dominant. To detect the change in the magnetic properties, various experimental methods including an element-specific measurements (X-ray absorption spectroscopy (XAS) and X-ray magnetic circular dichroism (XMCD)) are carried out.

The layers consisted of Ta(8.3 nm)/Pt(2.0)/HfO_2(50)/MgO(2.0)/Pd(0.9)/Co(0.6)/Pt(2.0) was deposited from the substrate (GaAs) side by rf sputtering and atomic layer deposition. An EF is applied to the surface of Pd through the HfO_2/MgO insulating bilayer in a back-gating configuration. The perpendicular component of the magnetic moment $m_\perp$, which is measured using a superconducting quantum interference magnetometer, is confirmed to be dependent on EF as shown in Fig. 1. If the EF-induced change in $m_\perp$ observed here takes place at the bottom-surface Pd atoms, that per one modulated electron is determined to be 1.5±0.3μ_B per Pd atom, which nearly agrees with the Slater-Pauling relation as well as our previous result obtained in the IL sample [1]. XAS and XMCD spectra for the Co L-edges shows almost no dependence on EF, suggesting that the induced-moment in Pd is the main contributor for the change in the total magnetic moment in the present system, although further careful analysis may be needed.

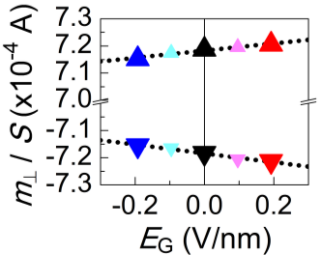

Fig. 1 The dependence of the saturated perpendicular magnetic moment per area ($m_\perp/S$) on the gate EF (E_G). ▲(▼) symbol corresponds to the result for the upward (downward) magnetization.

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