垂直磁化 (Mn-Cr)AlGe / W 積層膜における電流誘起磁化反転

Current Induced Magnetization Switching in Perpendicularly Magnetized (Mn-Cr)AlGe/W Bilayer Samples

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(Mn-Cr)AlGe is an intermetallic compound showing the C38 phase that is a pseudo-two-dimensional tetragonal crystal structure exhibiting uniaxial magnetocrystalline anisotropy for the *c*-axis direction[1, 2]. Previous studies demonstrated magnetic properties in (001)-textured films onto thermally oxidized silicon substrates, *i.e.*, a perpendicular magnetization, large magnetocrystalline anisotropy energy (K_u: 7×10^5 J/m^3), small saturation magnetization ($M_s \sim 300$ kA/m)[3], and small Gilbert damping constant (α: 0.0012)[4]. In addition, those magnetic properties can be achieved in a few-nanometer-thick samples with room temperature deposition process and post-annealing at 400 °C using a furnace[5]. The film fabrication process is a merit from an application point of view because of its compatibility with silicon-device fabrication technologies.

In this study, we investigated current induced magnetization switching (CIMS) of the (Mn-Cr)AlGe films layered with a tungsten (W) layer which would be a spin-current source. The layered samples were fabricated onto thermally oxidized silicon substrates with a stacking structure consisting of Ta 3 nm | W 0.3 nm | CoFeBTa 1 nm | MgO 10 nm | Mg 0.8 nm | (Mn-Cr)AlGe *t*| W 5 nm | MgO 0.8 nm | Ta 1 nm (from bottom to top). The film composition of (Mn-Cr)AlGe was $(Mn_{0.77}Cr_{0.23})Al_{1.06}Ge_{0.94}$ (at.%), and the layer thicknesses (t) were 5, 7, 10, 15 and 20 nm.

From magnetization curve measurements, perpendicular magnetization with high squareness ratio (> 0.9) was observed for t = 7 nm and larger samples. The samples were patterned into 5- or 10-μm-width Hall-bar shapes. CIMS measurements were carried out at room temperature. The applied current range was ± 50 mA with a pulse width of 100 μsecond. An in-plane magnetic field (H_x) of 1 kOe was applied during the measurements along the current pulse direction. The CIMS was observed at around 20 mA in a 7 nm-thick sample for both positive and negative current polarity. The corresponding current density value is about 2×10^{11} A/m^2 with an assumption that the current flew equally both in the (Mn-Cr)AlGe and the W layers. Magneto-optical Kerr (MOKE) microscope imaging with the electric probing was also carried out. From the MOKE images, the magnetization reversal process is suggested to be dominated by nucleation of reversed magnetic grains with distributed magnetocrystalline anisotropy. The details will be discussed in the presentation.

This work was partly supported by KAKENHI (JP20K05296) and a Cooperative Research Program (No. 21G417) of the CRDAM-IMR, Tohoku Univ.

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