Cu_2Sb 型(Mn-Cr)AlGe 薄膜における垂直磁気異方性：Mg 界面層の効果

Perpendicular magnetic anisotropy in Cu_2Sb-typye (Mn-Cr)AlGe films: Mg-interface layer effect

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MnAlGe is an intermetallic compound showing the Cu_2Sb-type crystal structure, which is also a ferromagnet with relatively small saturation magnetization, M_s (~ 250 emu/cm^3), exhibiting uniaxial magnetocrystalline anisotropy energy, K_u, of about 5×10^5 J/m^3 at room temperature[1]. In a previous study, we successfully enhanced K_u of MnAlGe films by substituting a part of Mn atoms for Cr[2]. Although relatively large K_u (~ 7×10^5 J/m^3[2]) with small M_s is of interest for magnetoresistive random access memory application, the layer thickness of 100 nm in the previous study was too thick. To fabricate thinner (Mn-Cr)AlGe films, the existence of a few-nanometer-thick dead layer around the MgO-interfaces was a problem [3]. Thus, in this study, Mg-interface layer effect was investigated to solve the problem.

Film samples were fabricated onto thermally oxidized silicon substrates using an ultrahigh-vacuum-compatible magnetron sputtering machine. The stacking structure was as follows: Sub. | under layers | MgO 1.5 nm | (Mn-Cr)AlGe t_{MCAG} | Mg t_{Mg} | MgO 1.5 nm | Ta 3 nm, where the thickness of Mg-interface layer, t_{Mg}, was changed in the range of 0 to 7 nm. The layer thickness of (Mn-Cr)AlGe, t_{MCAG}, was changed from 3 to 30 nm. Post-annealing was carried out using a vacuum furnace at 400 °C. Magnetization curves of samples were measured by using a vibrating-sample magnetometer. The crystal structures were characterized using cross-sectional high-angle annular dark field scanning transmission electron microscope images.

From the magnetization measurements, the t_{Mg} dependence of remanent magnetization values per sample area, M_r/A, was evaluated for samples with t_{MCAG} of 10 nm. The M_r/A exhibited the maximum value around t_{Mg} of 3 – 4 nm. The magnetic dead layer thickness was evaluated from the t_{MCAG} dependence of M_r/A, and it was 2.1 nm for t_{Mg}= 3nm, which is smaller than that of 3.5 nm for a no-Mg sample. With the optimum t_{Mg}, perpendicular magnetization was maintained down to the t_{MCAG} of 3 nm.

The results with the Mg-interface layer for the bottom interface, the t_{MCAG} dependence of K_u and crystal structures especially around the interfaces will also be discussed in the presentation.

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