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Investigation of perpendicularly magnetized Co_2(Fe,Mn)Si Heusler alloy thin films

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For large capacity magnetoresistive random access memory (MRAM), materials having both high spin polarization and perpendicular magnetic anisotropy are desired. Some Co-based full-Heusler alloys are known as half-metallic materials which have an energy gap at the Fermi level in one spin channel. Recently, some groups reported perpendicular magnetic anisotropy in Co_2FeAl and Co_2FeSi thin films induced by interface magnetic anisotropy.[1, 2] A Half-metallic material with large perpendicular magnetic anisotropy is attractive, although the composition dependence of magnetic anisotropy has not been investigated in detail for Heusler alloys. So the purpose of this study is to investigate composition dependence of magnetic anisotropy in Co_2(Fe,Mn)Si (CFMS) Heusler alloy ultra-thin films.

All films were prepared by using an ultrahigh vacuum sputtering system. A stacking structure is as following; single crystalline MgO (100) substrate/Cr (40 nm)/Pd(10 nm)/Co_2(Fe,Mn)Si (t_{CFMS})/MgO(2 nm)/Ta (5 nm). CFMS layer was deposited at room temperature and annealed at 400°C. Thicknesses of the CFMS layer (t_{CFMS}) were 0.6, 0.8, 1.0 nm. The magnetic properties of the thin films were measured by polar magneto-optical Kerr effect (p-MOKE) and superconducting quantum interference device (SQUID).

Figure 1 shows magnetization curves of (a) Co_2MnSi, (b) Co_2FeSi thin films measured by p-MOKE. The thickness of these samples was 0.6 nm. Both loops shows good squareness. By the results measured by SQUID, we clearly observed perpendicular magnetic anisotropy in both Co_2MnSi and Co_2FeSi. As a result of the film thickness dependence of the magnetization curves, 0.8 nm and 0.6nm-thick Co_2MnSi films and 0.6 nm-thick Co_2FeSi film showed perpendicular magnetic anisotropy and the films whose thickness was thicker than them showed magnetization curves of in-plane easy axis. We will discuss the composition dependence, including $Co_2Fe_{0.5}Mn_{0.5}Si$, and capping layer dependence of magnetic anisotropy for the ultra-thin CFMS films in the presentation.

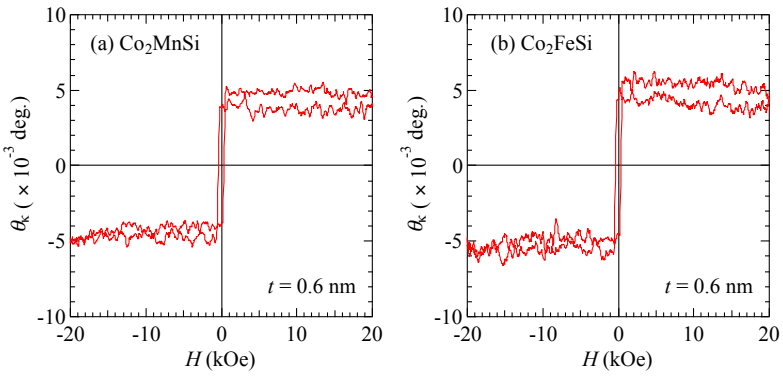

Figure 1: Polar Kerr loops of (a) Co_2MnSi and (b) Co_2FeSi thin films.

References

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