Cobalt concentration dependence of magnetic properties in epitaxial $(Mn_{1-x}Co_x)_2VAl$ Heusler thin films

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A ferrimagnetic full-Heusler alloy Mn_2VAl, which becomes half-metal in $L2_1$-ordered structure, is a promising candidate of spin injector because of both high spin polarization and low magnetization. By substituting Co atoms for Mn atoms partially, magnetization decreases depending on Co concentration. In particular, $(Mn_{0.5}Co_{0.5})_2VAl$ becomes fully-compensated antiferromagnet with keeping half-metallic character [1, 2]. As mentioned above, series of $(Mn_{1-x}Co_x)_2VAl$ alloy is an interesting half-metal, however, magnetic properties in thin films have not been reported. In this study, we characterized crystalline structures and magnetic properties of $L2_1$-ordered $(Mn_{1-x}Co_x)_2VAl$ epitaxial thin films.

Three series of 50-nm-thick $(Mn_{1-x}Co_x)_2VAl$ (x = 0, 0.2, 0.4) thin films were deposited on MgO (001) substrate with substrate heating, T_s = 600°C and were capped by 3-nm-thick Ta. All films were deposited by UHV magnetron sputtering. The crystalline structures, magnetic properties, elemental magnetic characters, and magnetic damping constant were measured by XRD, SQUID, XMCD, and FMR, respectively.

Fig. 1 shows x dependence of $B2$ and $L2_1$ order parameter. We obtained films with highly-ordered crystalline structure in each composition. Lattice constant of the films linearly decreased with increasing x and was close to the bulk value. Fig. 2 shows x dependence of saturation magnetization. A dotted line in Fig. 2 is magnetization calculated from Slater-Pauling rule. $(Mn_{1-x}Co_x)_2VAl$ films, which possess magnetization values close to the theoretical ones, were successfully fabricated. We have experimentally demonstrated that magnetization in $(Mn_{1-x}Co_x)_2VAl$ can be controlled by Co concentration.

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[1] I. Galanakis *et al*., Phys. Rev. B **75**, 092407 (2007).

[2] B. Deka *et al*., J. Alloy. Compd., **662**, 510-515 (2016).

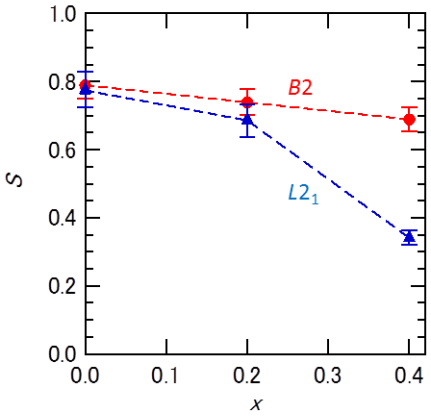

Fig. 1 x dependence of order parameter, S.

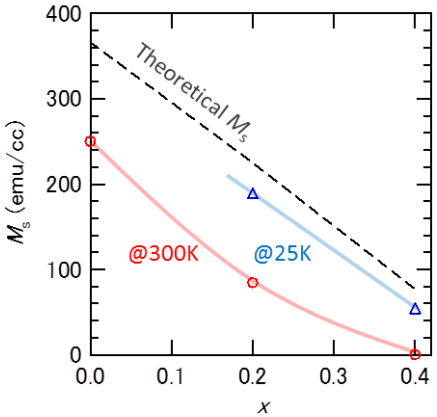

Fig. 2 x dependence of saturation magnetization, M_s.