

# Cr-concentration dependence of perpendicular magnetic anisotropy in Cu<sub>2</sub>Sb-type (Mn-Cr)AlGe films

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The Cu<sub>2</sub>Sb-type MnAlGe is a material exhibiting uniaxial magnetocrystalline anisotropy and relatively small saturation magnetization.<sup>1,2)</sup> Such a material is attractive for application of the free layer in magnetic tunnel junctions (MTJs) used in spin transfer torque switching type magnetoresistive random access memories (MRAMs). The perpendicular magnetic anisotropy energy ( $K_u$ ), of MnAlGe is about  $5 \times 10^6$  erg/cm<sup>3</sup> in bulk<sup>1)</sup> and epitaxially grown film<sup>2)</sup> samples, which should be improved for the giga-bit-class MRAM application. According to literatures,<sup>3)</sup> the substitution of Cr for the Mn site in MnAlGe enhances the magnetization and the ferromagnetic Curie temperature, which may also change the anisotropy of the material. Another feature of the MnAlGe is preferred crystallographic orientation to the [001] direction for film samples,<sup>4)</sup> which is suitable for application of MgO-based MTJs with (001) orientation.

In this work, crystal structures and magnetic properties of poly-crystalline (Mn-Cr)AlGe films were investigated. All samples were fabricated onto thermally oxidized Si substrates using ultra-high vacuum magnetron sputtering system. The stacking structure is Sub. | (Mn-Cr)AlGe 100 nm | MgO 2 nm | Ta 3 nm. All layers were deposited at room temperature, and after depositing the MgO | Ta capping layers, annealing was carried out using a vacuum furnace. Four series of samples were prepared with different Cr concentrations in the range of 0 to 0.45 in the stoichiometry.

The (001)-textured structure was confirmed for all samples by x-ray diffraction profiles. Fig. 1 shows magnetization curves measured at room temperature for Mn<sub>1.07</sub>Al<sub>0.88</sub>Ge<sub>1.05</sub> and (Mn<sub>0.76</sub>Cr<sub>0.28</sub>)Al<sub>0.94</sub>Ge<sub>1.06</sub> films. Both samples exhibit perpendicular magnetization, and the saturation magnetization and  $K_u$  are enhanced by the Cr substitution. Results for other Cr concentration samples and possible origin for the enhancement of  $K_u$  will be discussed in the presentation.

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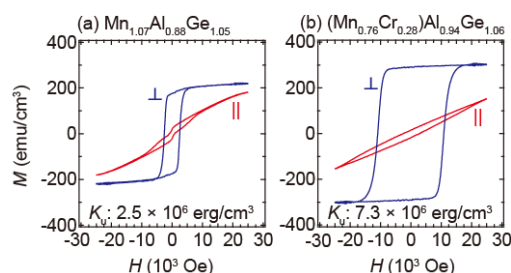


Fig. 1 Magnetization curves of (a) Mn<sub>1.07</sub>Al<sub>0.88</sub>Ge<sub>1.05</sub> and (b) (Mn<sub>0.76</sub>Cr<sub>0.28</sub>)Al<sub>0.94</sub>Ge<sub>1.06</sub> films.