

Heusler ferrimagnetic multilayer with perpendicular magnetic anisotropy

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Nanometer ferromagnets have been widely used in storage media, non-volatile memory, and logic devices based on spintronics, where the magnetization is manipulated by magnetic field, spin-polarized current, and electric field. As demanded by cell minimization, ferromagnets employed for information storage experienced a transition from in-plane to perpendicular magnetization in last decades to overcome the thermal fluctuation as cell lateral size minimization [1]. Beyond the stability requested for individual cells, the static magnetic interaction between neighboring magnetic units becomes critically important as the density increasing. Ferrimagnetic or antiferromagnetic materials were proposed as recording media, owing to the fact that the distance between ferrimagnetic especially antiferromagnetic islands can be drastically reduced without fearing of the information stored on one island affecting that of neighboring islands compared to ferromagnets [2]. We fabricated a new ferromagnetic multilayers (MLs) with perpendicular magnetic anisotropy (PMA) using $\text{Mn}_{62}\text{Ga}_{38}$ (MnGa) and $\text{Co}_{50}\text{Fe}_{23.7}\text{Al}_{26.3}$ (CFA). The MnGa and CFA alloys used for MLs are $L1_0$ ordered PMA ferrimagnet and cubic soft ferromagnet, respectively, ensuring that the magnetic parameters of MLs formed with [MnGa/CFA] are highly flexible. The MLs formed with [MnGa (t_{MnGa}) / CFA (t_{CFA})] units exhibit widely tunable magnetic properties, with M_s and K_u^{eff} varying from 0 to 400 emu/cm^3 , and from -2 (in-plane magnetization) to 8 Merg/cm^3 (out-of-plane magnetization), as shown in Fig. 1. At the compensation points, where the antiparallel aligned magnetizations of MnGa and CFA have same magnitude, the MLs are compensated ferrimagnets exhibiting zero M_s with PMA, which is a potential candidate for light-induced ultrafast spintronics applications [3].

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[1] D. Weller *et al.* IEEE Trans. Magn. 36, 10 (2000). [2] E. E. Fullerton *et al.* Appl. Phys. Lett. 77, 3806 (2000).

[3] Q. L. Ma *et al.*, Sci. Rep. (to be published, 2015).

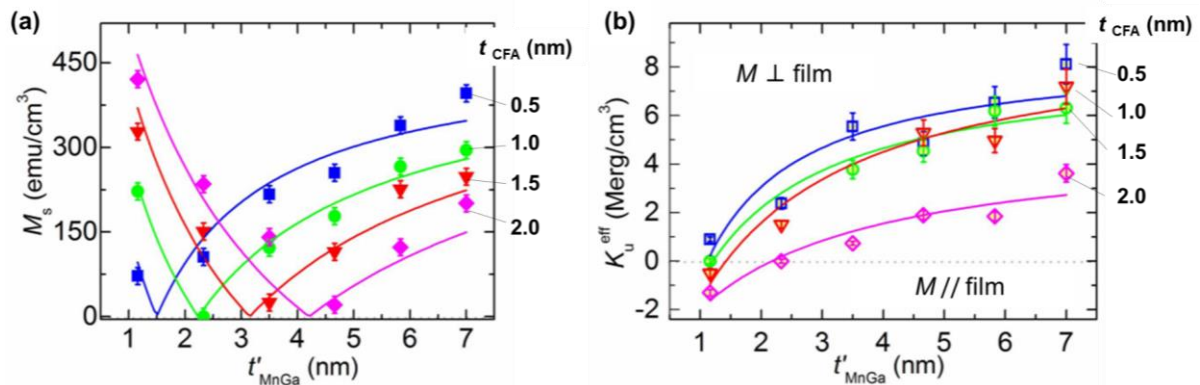


Fig. 1 (a) Magnetization and (b) effective PMA constant for the [MnGa /CFA]₅/MnGa multilayer epitaxial films grown on Cr-buffered MgO (001) single-crystalline substrate using UHV-sputtering. The t_{CFA} is the thickness of CFA layer, and t'_{MnGa} is the effective MnGa layer thickness per CFA layer.