Room temperature growth of ultrathin ordered Mn-Ga films

○K. Z. Suzuki, R. Ranjbar, A. Sugihara, T. Miyazaki, and S. Mizukami
WPI Advanced Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan

$L1_0$-MnGa alloy films have a large perpendicular magnetic anisotropy and small damping constant[1] and it is potentially attractive for Spin-transfer-torque magnetoresistive random access memory (STT-MRAM) applications. Growth of ultrathin Mn-Ga films, whose thickness is usually less than 3 nm, is required for STT-switching, whereas it has been difficult.[2-5] Here we demonstrate the growth of ultrathin MnGa films with thickness down to 1 nm by using paramagnetic CoGa buffer layer having CsCl-type crystal structure. All the samples were prepared by a ultrahigh vacuum (UHV) magnetron sputtering system.

The sample stacking structure is MgO(001) substrate/Cr (40 nm)/CoGa (30 nm)/MnGa (t_{MnGa}=1-5)/Mg (0.4) /MgO (5). The Cr and CoGa buffer layers were deposited at room temperature and subsequently annealed at 700 and 500°C, respectively. The MnGa layer was deposited on the CoGa buffer layer at room temperature and not annealed. The out-of-plane polar Kerr loops for these films are shown in Fig. 1. The loops with squareness close to unity are observed even at t_{MnGa}= 1 nm.[6] Figure 2 shows a cross-sectional image of CoGa/MnGa/MgO layers measured by a high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM). The atomically flat interfaces and well-ordered crystalline structure of the MnGa layer was observed.[7] These results indicate that the CoGa buffer layer is a promising candidate for growth of ultrathin film of Mn-based alloys. We will also discuss the spin-dependent transport properties.

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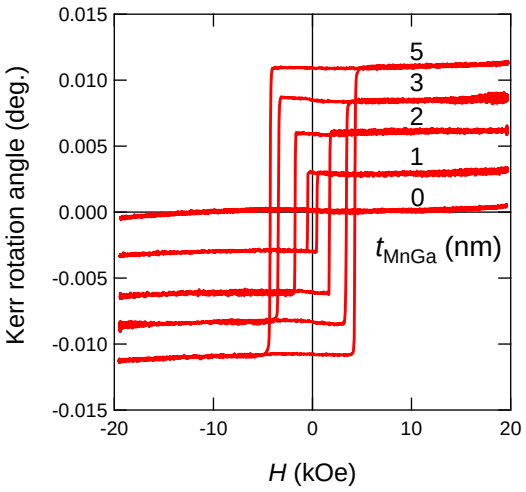

Fig. 1 Out-of-plane hysteresis curves for the ultrathin MnGa films with different thickness measured by polar magneto-optical Kerr effect.

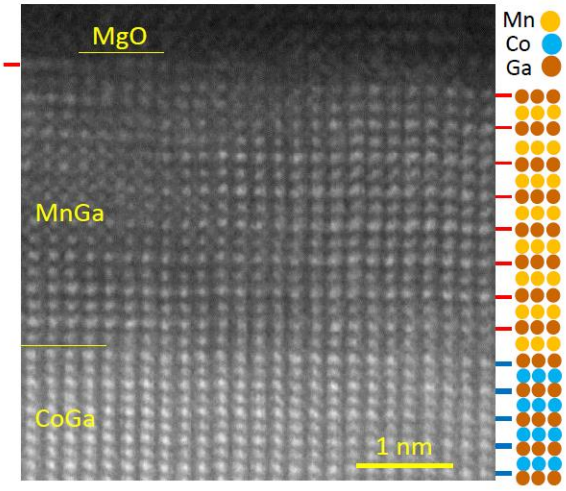

Fig.2 The cross-sectional HAADF-STEM image of the CoGa/MnGa/MgO layers. Right cartoon is the schematic for the corresponding to the atomic structures.

Reference

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