

Observation of non-collinear antiferromagnetic domain structure in epitaxial Mn_3Sn thin films

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Non-collinear antiferromagnetic $D0_{19}\text{-Mn}_3\text{Sn}$ has recently attracted increasing attention in spintronics owing to its topologically nontrivial phenomena despite the vanishingly small net magnetization [1-2]. Magneto-optical Kerr effect (MOKE) provides a powerful tool to study the spatial and dynamical properties of such systems, and has been utilized for bulk Mn_3Sn samples [3-5]. In this study, we observe domain structures of $(1\bar{1}00)$ -oriented Mn_3Sn thin films with various compositions using MOKE, and discuss on the reversal process and its consequences.

We deposit stacks consisting of W (2 nm)/Ta (3 nm)/ $\text{Mn}_{3+x}\text{Sn}_{1-x}$ (30 nm)/MgO (1.3 nm)/Ru (1 nm) on MgO(110) substrate by DC/RF magnetron sputtering, followed by annealing at 600 °C for an hour. Within a certain composition x range, $(1\bar{1}00)$ -oriented epitaxial $D0_{19}\text{-Mn}_3\text{Sn}$ is formed with the Kagome plane aligned perpendicular to the film plane [6]. Polar MOKE measurement indicates a clear hysteresis loop as shown in Fig. 1. Domain images under external magnetic field with the MOKE microscopy are shown in Fig. 2, where the labels of A to D correspond to the points indicated in Fig. 1. We find that the reversal starts with a nucleation of domains dispersed in the film, followed by an anisotropic propagation of domain wall. We also find that the amplitude of the Kerr rotation angle (~ 10 mdeg. in Fig. 1) varies with the composition of Mn-Sn, and the result is consistent with the reversible area revealed from the domain observation. Furthermore, the structural analysis indicates that the observed composition dependence can be attributed to formations of grains with different crystalline phases or crystallographic orientations.

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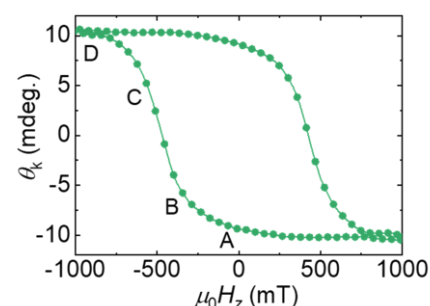


Fig.1 Out-of-plane magnetic field H_z dependence of Kerr rotation angle θ_K

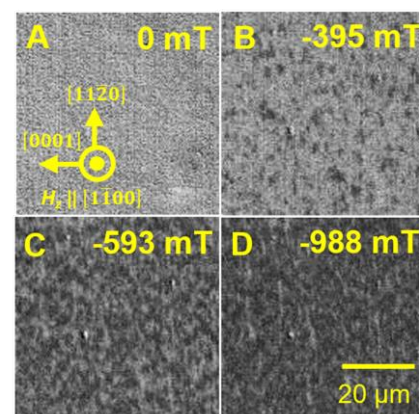


Fig.2 MOKE images obtained in the decreasing-field process from 1 T to -1 T