Imaging in-plane 90° magnetization switching in (Ga,Mn)As

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The in-plane 90-degree (90°) magnetization switching in a (Ga,Mn)As epitaxial layer (x = 0.02, $T_C \approx$ 50 K) is studied using a home-made magneto-optical (MO) microscope. A small contrast between two different 90° domains caused by magnetic birefringence (MB) [1] is enhanced by image processing. Two consecutive 90° switchings are captured at temperature regimes below and above the half-value of the Curie temperature, namely, at 10K and 30 K. The dynamics are not the same for the first and the second switching, reflecting the influence of the ⟨110⟩ uniaxial anisotropy and spin-dependent pinning sites [2]. At 10K, the first switching that passes via the relatively-easy uniaxial (REU) axis (the [1−10] axis) is dominated by smooth 90° domain wall (DW) motion (Fig.1,left), whereas the second switching that passes via the relatively-hard uniaxial (RHU) axis (the [110] axis) occurs through nucleation and coalescence of 90° domains together with the DW motion (Fig.1, middle). Similarly, at 30K, the first switching is initiated by nucleations and their rapid expansion, whereas the second switching is dominated by relatively slow DW motion (data not shown). The extracted DW velocity is analyzed by employing a thermally-activated depinning and flow models (Fig.1, right) [3]. The values of derived parameters, namely, the activation volume and DW mobility are found to be (28 nm)^3 and 0.35 nm s^{-1} Oe at 10 K, respectively [4].

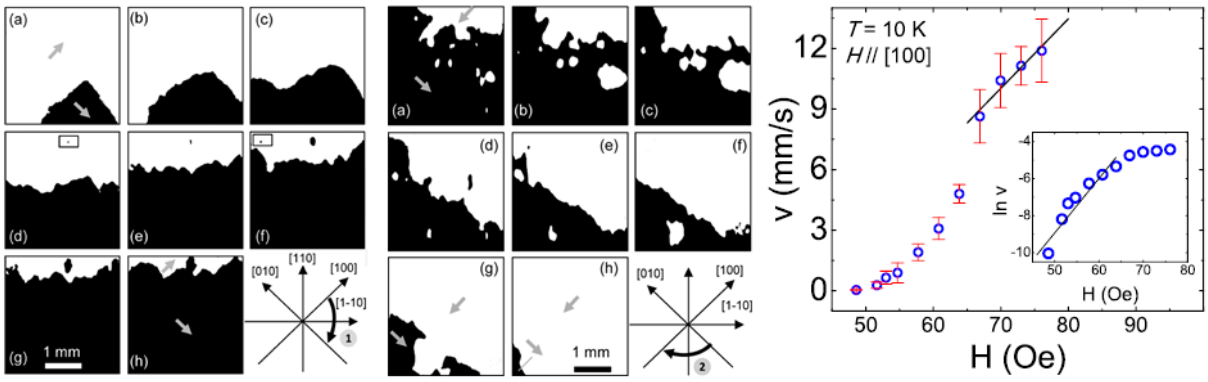

Fig.1: Successive MO domain images acquired at 10 K for the first 90° magnetization switching (left graph) and the second 90° magnetization switching (middle graph). The lag time between the successive images is 0.2 s. Right graph is the DW velocity as a function of magnetic field obtained for the first 90° switching at 10 K. In the linear plot, solid lines represent fits to the high-field velocities. In the semilogarithmic plot (insets), solid lines are linear fits to the low-field region.

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