P-3

Asymmetric Magnetization Reversal in Exchange-Biased Single Layer

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When a ferromagnet (FM) in contact with an antiferromagnet (AFM) is cooled through the Néel point of the AFM under an applied magnetic field, the hysteresis loop of the FM is shifted from the origin along the magnetic field-cooled axis by an amount known as the exchange-bias field H_E [1]. One of intriguing phenomena related with exchange bias effect is asymmetric magnetization reversal in both branches of a hysteresis loop as recently observed in a variety of systems composing of a FM and an AFM [2,3]. However, the exact mechanism and underlying physics of this asymmetric reversal are still unclear. So far, most of studies on asymmetric magnetization reversal behavior have been devoted to the exchange-biased system of *bilayered* structure having layer-by-layer contact between a FM and an AFM. Here, we present asymmetric magnetization reversal behavior in a new kind of exchange-bias system, i.e., field-cooled MnAs film, where exchange bias effect is existed *in the same single layer* having a stripe-like structure consisted of the FM α-MnAs and the AFM β-MnAs. Time-resolved domain observation reveals that the magnetization reverses with a sequence of discrete jumps of saw-tooth type domain under an applied field parallel to the field-cooling direction, while the magnetization reversal takes place via a sudden single jump under an applied field antiparallel to the field-cooling direction, as clearly seen in Fig. 1. The asymmetric magnetization reversal in the MnAs system is ascribed to the fluctuation of the local exchange-bias field, induced by the local non-uniformity of the volume fraction of two phases. The saw-tooth domain shape is found to be independent of an applied field direction with respect to the field-cooled orientation, which is explained based on a simple model considering large magnetic anisotropy energy and small saturation magnetization.

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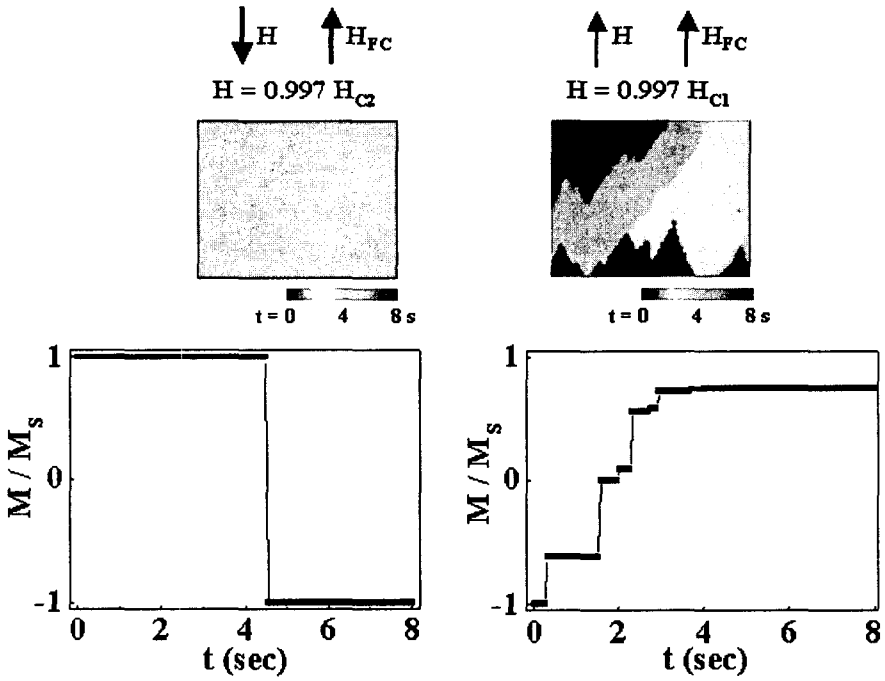

FIG. 1. The domain reversal patterns and magnetization reversal curves in both field directions in the field-cooled MnAs film at T = 26 °C.