ANTIFERROMAGNETIC DOMAINS IN MULTILAYERS: A COMPARATIVE PNR STUDY

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Antiferromagnetically (AF) coupled metallic multilayers (ML) have received much attention in recent years due to their relevance in fundamental science and magnetic recording technology alike. Reflectometric methods like polarized neutron reflectometry (PNR) and synchrotron Mössbauer reflectometry (SMR) are capable of investigating the plane-perpendicular and lateral magnetic structure of MLs. Previously, a variety of domain formation and transformation phenomena was found and systematically studied in a strongly AF-coupled Fe/Cr multilayer by SMR and PNR. In particular, a spontaneous growth of the domains in a magnetic field decreasing from saturation (ripening) and a further explosion-like growth of the ripened domains on passing the bulk-spin-flop (BSF) transition (coarsening) was established. The pattern both of the ripened and the coarsened domains was found to be erased only in a field considerably higher than the apparent saturation field of the Fe layers, a phenomenon referred to as the *supersaturation domain memory effect* (SDME). So far the microscopic reason of SDME remained unclear. In this contribution we present a comparative PNR study performed on two strongly AF-coupled Fe/Cr multilayers of different shape of their magnetic hysteresis curves. We will show that a lateral distribution of the layer-layer coupling rather than the magnetic structure of the Cr spacer layer is responsible for SDME.

The epitaxial samples 1 and 2 were prepared by MBE and sputtering, respectively. The S-like shape of the magnetization hysteresis curve of Sample 1 was characteristic for a broad distribution of the coupling strength and/or for a strong biquadratic coupling. Conversely, Sample 2 showed a well-defined saturation field in both easy and hard direction of the fourfold in-plane anisotropy.

We investigated the details of domain coarsening and possible SDME on Sample 2 by time-of-flight PNR at the REMUR reflectometer at the IBR-2 pulsed reactor of the Joint Institute for Nuclear Research in Dubna using a position-sensitive detector. The domain transformations were traced by momentum-space measurements around the structurally forbidden 1/2 Bragg peak.

In spite of its differently shaped magnetization loop, also Sample 2 showed the domain coarsening previously observed on Sample 1, albeit at a different level. However, the external field at which the original small-domain state is restored was found to be different for the two samples. In contrast to Sample 1, where the application of an unexpectedly high field above apparent saturation was necessary, for Sample 2 the small-domain state was restored exactly at the saturation field derived from the magnetization loop.

An obvious explanation of the SDME could be connected to the memory of the exchange spring of the Cr spacer. However, in view of the similarity of the Cr layer thicknesses of both samples, the above results strongly indicate that the SDME of Sample 1 was caused by the broad lateral distribution of the saturation field. Indeed, on releasing the applied magnetic field from a value slightly above the apparent saturation field, the tiny fraction of the still not saturated regions acted as seeds for the large domain growth. Lacking a comparably broad distribution of the interlayer coupling, no SDME was manifested on Sample 2.