Influence of a change in the domain structure on the Hall effect in CoPt thin films

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Ferromagnetic/heavy metal films, in which skyrmions can be formed, are a promising material for creating memory elements and spintronic devices. When used in electronic devices, one of the most effective ways to detect skyrmions can be the Hall effect. To measure it, a Hall cross structure is formed on the film, and the smaller the size of the cross, the greater will be the contribution of a single skyrmion. Ideally, when the cross is comparable in size to the skyrmion. However, as the size decreases, the influence of the film boundaries increases, which can affect the mobility of the skyrmions or the accuracy of measuring the Hall effect.

To study the effect of a change in the domain structure on the Hall effect, samples containing two Hall crosses 5x5 μm in size were fabricated from the 8 nm thick film containing 10 Co and Pt bilayers (thicknesses of 0.3 and 0.5 nm, respectively). Further, one of the crosses was left unchanged, and the second was cut with the needle of an atomic force microscope (AFM), which reduced the size of the working area to 0.5x0.5 μm. A comparison of the Hall magnetization reversal curves showed that the cuts do not make a significant contribution to the film parameters.

The film magnetization reversal and its effect on the Hall effect were studied using AFM. The sample was initially demagnetized, after which the working area of the cross was successively magnetized by the AFM magnetic needle. The probe moved along a line close to the surface, which locally magnetized the area near this line. During this, a change in the Hall voltage was recorded. Next, the magnetic force microscopy (MFM) image of the domain structure of the working area was scanned; the line was shifted, and the process was repeated — Figs. 1, 2. The processed line is shown in white, the cuts are green. Fig. 3 shows the change in the Hall effect for all passes. As expected, as the magnetized region expands, the change in the Hall voltage increases. There is an anomalous segment where the Hall effect first decreases, but then increases again. Comparison with magnetic images explains this effect. It is due to the spatial inhomogeneity of the magnetic fields generated by the AFM probe.

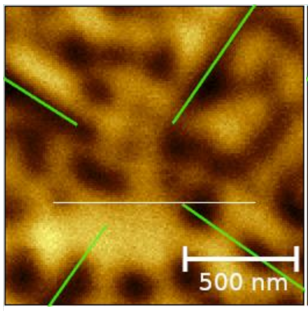

Fig. 1. MFM image on the 18th pass

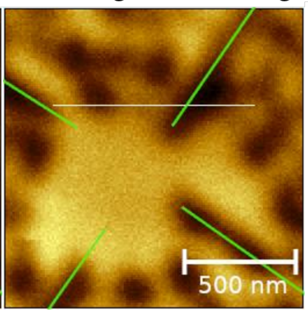

Fig. 2. MFM image on the 50th pass

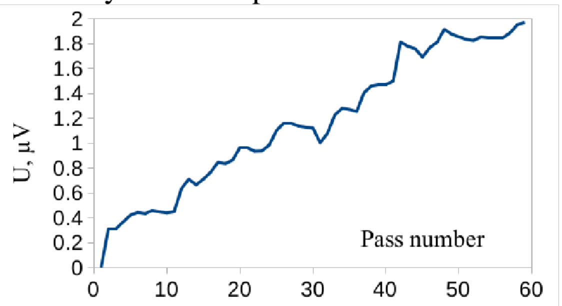

Fig. 3. Hall effect with successive magnetization reversal