

Off-axis electron holography of magnetization reversal in patterned spin valves

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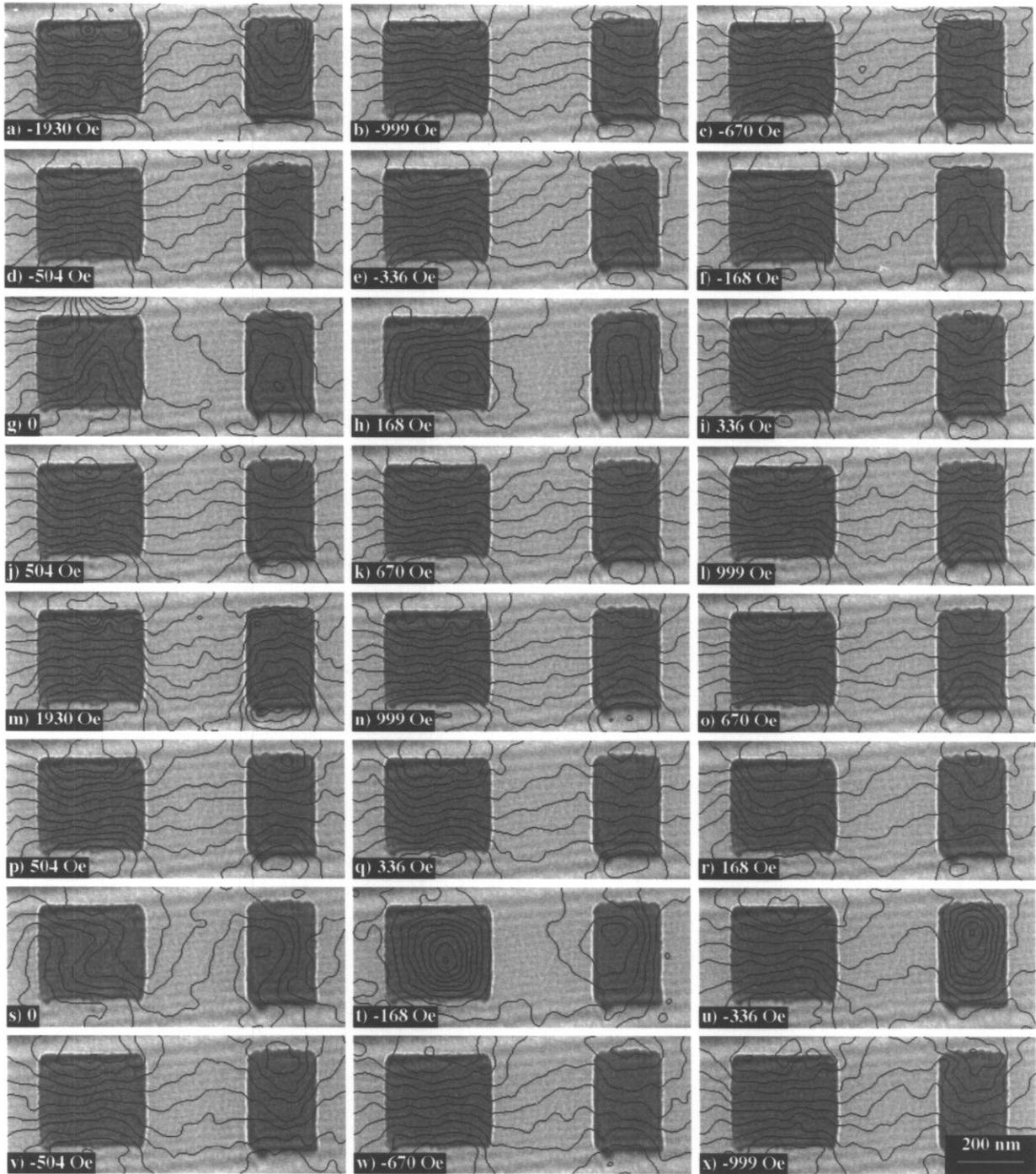
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An understanding of magnetization reversal in submicron-sized magnetic elements is essential for novel magnetic information storage applications [1]. Here, we apply off-axis electron holography [2] in the transmission electron microscope (TEM) to study the magnetic properties of patterned rectangular $\text{Co}_{10\text{nm}}/\text{Au}_{5\text{nm}}/\text{Ni}_{10\text{nm}}$ spin valve elements prepared on self-supporting 55-nm-thick Si_3N_4 membranes using electron-beam lithography and lift-off processes. Holograms were recorded at 200 kV using a Philips CM200-FEG TEM equipped with an electrostatic biprism. A Lorentz minilens allowed images to be obtained with the objective lens switched off and the sample in almost field-free conditions. The objective lens could then be excited slightly and the sample tilted in order to apply known in-plane magnetic fields and follow magnetization processes *in situ*.

Figure 1 shows the magnetic contributions to the phases of holograms of two patterned rectangles, recorded over a complete hysteresis cycle. The contours follow lines of constant magnetization, and their separation is proportional to the magnetic field strength integrated in the incident beam direction. Although it is difficult to separate the contributions to the magnetization from the Co and the Ni, the ranges of applied fields over which solenoidal domain configurations exist are smaller than those seen for similar rectangles of pure Co [3]. This result may be explained by the fact that the Co in the spin valve is influenced by the presence of the Ni, which has wider domain walls than those of Co and is thus less likely to support complicated domain structures. An examination of elements of different shapes, as well as a comparison of experimental data with micromagnetic calculations, are now required [4].

References

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←→ Direction of applied field

FIG. 1 - Magnetic contributions to phases of off-axis electron holograms of patterned spin valves (275×210 and 275×330 nm in size) during a complete magnetization reversal cycle, with applied in-plane fields indicated. Mean inner potential contribution has been subtracted from each image to leave magnetic contribution of primary interest. Contours lie parallel to lines of constant magnetization (contour spacing of 0.11π radians is proportional to magnetic field strength integrated in beam direction). Reference holograms were used to remove artifacts caused by irregularities in image/recording system. Biprism voltage was 100 V.