Imaging magnetisation processes in $Fe_{78}Si_9B_{13}$ thin films with perpendicular anisotropy by magnetic force microscopy.

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$Fe_{78}Si_9B_{13}$ thin films prepared by rf sputtering on Si_3N_4 substrates are characterised by a dense stripe domain configuration [1], originating from internal stresses that can be progressively released by means of relaxation thermal treatments. Fig. 1a shows typical transcritical loops of a 230 nm thick film submitted to annealing at three different temperatures. The magnetisation of the film is organised into parallel stripes tilted upwards and downwards, as shown in Fig. 1b for the sample annealed at 225 °C at the magnetic remanence after a saturating field has been applied along the vertical direction. By exploiting a recently developed field-dependent MFM technique [2] coupled with a novel analysis of the acquired data, we have been able to investigate the field evolution of the magnetisation during reversal and rotation. In particular, the field-dependence of the MFM contrast is suitably analysed to investigate the magnetisation reversal during hysteresis loops and the alignment of the stripes along different directions during rotation processes. An example of a stripes rotation process investigated by MFM is shown in Fig. 1(c,d). From hysteresis loops and field-dependent MFM analysis, a correlation between the anisotropy field responsible for the stripes domain configuration and a threshold field that must be overcome to induce stripes rotation is experimentally assessed (Fig. 1(e)). The detailed field evolution of the magnetisation in the stripes is investigated by direct comparison of vector measurements made by VSM and field-dependent MFM, as a function of the magnetic anisotropy of the FeSiB samples. The origin of the threshold field, whose amplitude is independent on the field direction in the sample plane, is discussed as well.

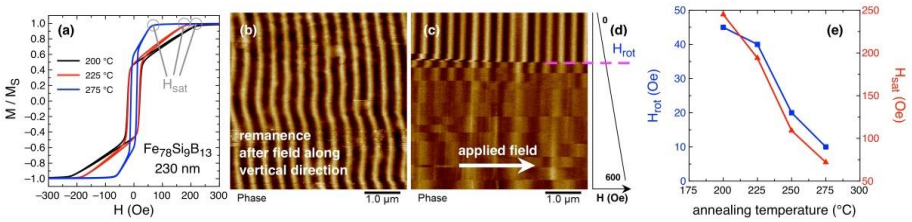

Figure 1. (a) Hysteresis loops. (b) Example of stripe domain configuration at the magnetic remanence. (c,d) Evolution of the stripe configuration for increasing applied fields along the horizontal direction. (e) Anisotropy field and rotation field threshold vs. annealing temperature.

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