

DIRECT NANOSCALE MAGNETIC PATTERNING IN FEAL ALLOYS BY MEANS OF ION IRRADIATION

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Fe₆₀Al₄₀ (at. %) alloys show an interesting combination of magnetic and structural properties, where atomically ordered Fe₆₀Al₄₀ (B2-structure) is paramagnetic at room temperature, whereas disorder Fe₆₀Al₄₀ (i.e., atomically intermixed, A2-structure) becomes ferromagnetic [1]. The transformation from paramagnetic B2-phase to the ferromagnetic A2-phase can be accomplished by means of homogeneous ion irradiation procedures. The irradiation induced transformation depends on the irradiation dose and the type of ions [2]. Furthermore, local ion irradiation procedures (i.e., focused ion beam or ion irradiation through masks) have been also used in order to fabricate periodic arrays of ferromagnetic structures embedded in a paramagnetic matrix [3]. Patterned polymer layers defined by electron beam lithography and porous alumina templates were used as masks. While the e-beam lithography allows for a careful design of the patterns, alumina templates lead to fast processing of very large areas. Importantly, due to the low fluences used, this method does not induce any roughening of the surface, leading to topographically featureless magnetic dots. The fabricated entities exhibit a range of magnetic properties depending on the size and shape, which were investigated by means of magneto-optical Kerr effect magnetometry, while the local character of the induced ferromagnetism was examined by magnetic force microscopy. The smallest dots (sub-50 nm in size) exhibit coercivities in the range of $H_C \sim 500$ Oe and a large squareness, $M_R/M_S \sim 1$ (see Fig. 1). Interestingly, when the patterned sheets are annealed at sufficiently high temperatures, the ferromagnetic properties are removed due to the annealing-induced atomic reordering. Hence, these methods may lead to a novel type of patterned recording media free from tribological and exchange coupling effects. Moreover, these approaches can be easily extrapolated to a variety of other systems exhibiting disorder-induced magnetism.

[1] J. Nogués et al., *Phys. Rev. B* **74**, 024407 (2006)

[2] J. Fassbender et al., *Phys. Rev. B* **77**, 174430 (2008)

[3] E. Menéndez et al., (2008) submitted

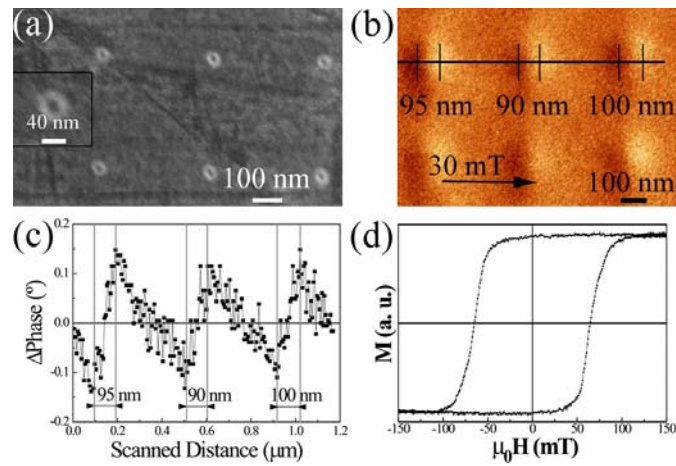


Figure 1. Sub-50 nm magnetic patterning by FIB. (a) SEM image obtained using secondary electrons of an array of circular dots, patterned by FIB. The inset in (a) shows an enlarged image of one of these entities. (b) MFM image of the circular dots taken in $\mu_0 H = 30$ mT after saturation; (c) Phase profile line scan analysis at the position indicated in (b) and (d) MOKE hysteresis loop corresponding to these ferromagnetic features.