Ion-beam-induced magnetic transformation of metastable fcc iron-nickel films grown on Si(100) substrates

Michal Horký[1, 2, 3], Jan Hulva[2], Jonáš Gloss[2], Peter Varga[2, 3], Michael Schmid[2], and Michal Urbánek[1, 3]

[1]*Brno University of Technology, Technická 2896/2, Brno 616 69, Czech Republic*
[2]*Vienna University of Technology, 1040 Vienna, Austria*
[3]*CEITEC BUT, 616 00 Brno, Czech Republic*

Ultrathin fcc Fe films on Cu(100) have been studied for their unique capability of magnetic (paramagnetic to ferromagnetic) and structural (fcc to bcc) transformation upon ion beam irradiation. However, pure fcc Fe films undergo a spontaneous transformation when their thickness exceeds 10 ML (2 nm) [1]. We have shown that it is possible to grow fcc transformable $Fe_{78}Ni_{22}$ films on Cu(100) single crystal without a limit in thickness [2].

Because single crystals are expensive and inconvenient for industrial applications, we investigate growth of Fe-Ni films on Si(100).

We present a study of deposition and transformation of 22 (4 nm) and 44 ML (8 nm) thick $Fe_{78}Ni_{22}$ films grown on Si(100) substrates. The growth of fcc paramagnetic $Fe_{78}Ni_{22}$ films directly on Si(100) substrate is impossible because of the lattice mismatch. Hence it is necessary to grow an epitaxial Cu(100) buffer layer [3]. Prepared films were transformed by irradiation with 2 keV Ar+ ion beam and the results of the transformation results were observed by Low Energy Electron Diffraction (LEED) and Surface Magneto-Optical Kerr Effect (SMOKE). The possibility of direct focused ion beam writing of ferromagnetic elements embedded in a paramagnetic thin film makes these $Fe_{78}Ni_{22}$/Cu(100)/Si(100) films an ideal candidate for the fabrication of magnetic nanostructures.

[1] J. Thomassen, et al., Phys. Rev. Lett. 69, 3831 (1992).

[2] J. Gloss, et al., Appl. Phys. Lett. 103, 262405 (2013).

[3] I. Hashim, et al., Appl. Phys. Lett. 63, 2833-2835 (1993).