Magnetic properties of silicide nanoparticles ion-beam-synthesized in the external magnetic field

G.G. Gumarov[1], A.I. Gumarov[2], V.Yu. Petukhov[1], N.R. Khabibullina[1], V.F. Valeev[1]

[1]*Zavoisky Physical-Technical Institute, Kazan, 420029, Russia*
[2]*Kazan State University, 420008, Russia*
gumarov@kfti.knc.ru

It has been shown that ion-beam synthesis in the external magnetic field leads to the formation of anisotropic ferromagnetic silicide films [1]. The synthesized films exhibit a high value of the effective saturation magnetization and the pronounced in-plane anisotropy. Earlier [2], the anisotropy of these films has been investigated by radio-frequency autodyne method. The goal of this work is to study the nature of magnetic anisotropy in the films ion-beam-synthesized in the applied magnetic field.

Iron ions with energy of 40 keV were implanted into the (111) single-crystal silicon wafers at room temperature. The implantation dose was $3 \cdot 10^{17}$ cm^{-2}, the ion current density being 5 $\mu A/cm^2$. During implantation a magnetic field H_i of 500 Oe was applied parallel to the plane of the substrate. Samples were investigated by X-ray diffraction (XRD), fluxgate magnetometry, L-band ferromagnetic resonance (FMR) and conversion electron Moessbauer spectroscopy (CEMS).

XRD at grazing angles and CEMS indicate that the synthesized films contain two phases: FeSi and ferromagnetic Fe_3Si. Easy magnetization axes in the plane of the films were observed depending on the orientation of the field H_i regarding to the crystal axes of the substrate. FMR and fluxgate magnetometry measurements also confirm the appearance of in-plane anisotropy. Using the three-dimensional Stoner-Wohlfarth model we showed that the observed in-plane magnetic anisotropy is the result of superposition of the threefold magnetocrystalline and the induced uniaxial anisotropies. The mechanisms of the induced anisotropy appearance are discussed.

Acknowledgements: The work was supported by the Grant of Presidium of RAS №01/09.

References:

1. G. G. Gumarov, V.Yu. Petukhov, I.B. Khaibullin, E.P. Zheglov, E.N. Dulov, N.G. Ivoilov. Abstracts of the International Conference “Modern development of magnetic resonance” Kazan, Russia, 2004.- P.247.
2. Gumarov G.G., Petukhov V.Yu., Zhikharev V.A., Valeev V.F., Khaibullin R.I. Nuclear Instruments and Methods in Physics Research B 267 (2009) 1600–1603.