Moscow International Symposium on Magnetism

1 – 5 July 2017

Book of Abstracts

M.V. Lomonosov Moscow State University, Faculty of Physics

Main Topics

Spintronics and Magnetotransport
Magnetophotonics
High Frequency Properties and Metamaterials
Magnetic Nanostructures and Low Dimensional Magnetism
Soft and Hard Magnetic Materials
Magnetic Shape-memory Alloys and Magnetocaloric Effect
Magnetic Semiconductors and Oxides
Multiferroics
Magnetism and Superconductivity
Magnetic Soft Matter
Magnetism in Biology and Medicine
Study of Magnetism using X-rays and Neutrons
Theory
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ULTRA-THIN $Pd_{(1-X)}Fe_X$ FILMS SYNTHESIS AND STUDIES OF THEIR COMPOSITION, MORPHOLOGY, STRUCTURAL AND MAGNETIC PROPERTIES

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Palladium iron (PdFe) alloy is the unique class of ferromagnetic materials. A small, even less than 1 at.%, amount of Fe atoms in palladium matrix induces ferromagnetism (FM) [1]. Iron atoms substituting for palladium in the crystal lattice create strong polarization and produce overlapping polaron clouds of 4d-electrons. Concentartion of iron controls principal ferromagnetic properties of these materials. Thin films of $Pd_{1-x}Fe_x$ are attractable for practical applications in cryogenic memory elements.

Ultrathin $Pd_{1-x}Fe_x$ (x=0.01-0.1) films were deposited by molecular beam epitaxy (MBE, SPECS) and magnetron sputtering (MS, BESTEC) techniques under ultra-high vacuum conditions (3×10^{-10} mbar in the MBE chamber, and 5×10^{-9} mbar of the residual gas pressure in the MS chamber). Magnesium oxide (MgO) and silicon single crystals were used as the substrates for MBE and MS depositions, respectively.

SPECS Er-LEED-3000-D setup was used for investigating crystal structures of the substrates and the films. Surface morphology was studied by scanning electron (SEM, Carl Zeiss Merlin) and atomic force (AFM, Bruker Dimention FastScan) microscopies. Elemental composition and atomic concentration of the films were measured by X-Ray photoelectron spectroscopy (XPS, SPECS). Thickness of the deposited films was controlled with the stylus profilometer Dektak XT (Bruker). Magnetic properties were studied by means of the vibrating sample magnetometry technique with Quantum Design PPMS-9. An X-band Bruker ESP300 electron spin resonance spectrometer (ESR) was used for ferromagnetic resonance (FMR) measurements.

Cubic magnetic anisotropy with tetragonal distortion was found for the films with iron concentrations of $x > 0.015$, that were epitaxially grown by MBE. In contrast, films deposited by MS revealed isotropic in-plane magnetic properties. It was found that the magnetization and Curie temperature of the films were growing monotonically while increasing the iron concentration. Coercive fields for the films deposited by MBE were several times smaller compared to the films obtained by MS technique. Magnetic measurements at low temperatures ($T = 5$ K) show coercive field of about 7 Oe for the epitaxial films of $Pd_{1-x}Fe_x$ with x=0.01-0.08.

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[1] G.J. Nieuwenhuys, *Adv. Phys.*, **24** (1975) 515.