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Magnetic properties of Ni, Fe, Co nanowires synthesized using porous Al2O3 matrices

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The magnetic properties of one-dimensional ferromagnetic nanostructures with diameters in the nanometer range and macrolengths are actively studied and many scientific works are devoted to them due to their non-trivial magnetic behavior due to strong uniaxial shape anisotropy [1]. These nanostructures are a promising material for creating a new kind of magnetic memory, due to the dense manufacturing technology and independent shape anisotropy, these nanostructures can solve the problem of creating a new kind of magnetic memory. In turn, shape anisotropy can be controlled by changes in the geometry of nanostructures. Size effects play an important role in nanostructures, which have a significant impact on their magnetic properties. Studies have shown that such ferromagnetic structures can be used as nanoagents in biomedical applications [2], such as the fight against cancer using hyperthermia and mechanical destruction of tumors, targeted drug delivery, MRI contrast agents. There are many methods for synthesizing various one-dimensional nanostructures [3]. One of them is the method of electrodeposition into porous matrices of aluminum oxide, in which the deposited nanostructures repeat the shape of the pores in the matrix. Under controlled conditions, anodizing aluminum can produce a self-organizing hexagonal ordered array of nano-sized pores [4]. The parameters of porous matrices, such as their porosity, pore diameter and length, and the distance to neighboring pores, can be precisely controlled, which means that the parameters of synthesized ferromagnetic nanostructures can also be controlled, which is why such matrices are attractive for use as membranes.
In this work, ferromagnetic Ni, Fe, Co nanowires were synthesized using porous aluminum oxide matrices as a membrane. Porous matrices of aluminum oxide were obtained under identical conditions in potentiostatic mode with a voltage of 31 V using oxalic acid, to eliminate the influence of differences in the shape of nanowires when comparing them. Nanowires were synthesized by electrochemical deposition in a potentiostatic mode. The morphological and magnetic properties were studied, and X-ray phase analysis of the resulting Ni, Fe, Co nanowires was carried out. Magnetic properties of Co nanowire arrays showed distinctive results compared to Ni, Fe nanowires. Co nanowires showed lower coercivity when the external magnetic field is directed along the long axis of the nanowires compared to Ni, Fe nanowire arrays, and strong interaction fields were observed in Co nanowire arrays, according to FORC research results.

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Primary author: SOBIROV, Mukhammad (Far Eastern Federal University, Institute of High Technology and Advanced Materials)

Co-authors: Prof. OGNEV, Aleksei (Far Eastern Federal University, Institute of High Technology and Advanced Materials); Dr SAMARDAK, Aleksei (Far Eastern Federal University, Institute of High Technology and Advanced Materials); Prof. SAMARDAK, Alexander (Far Eastern Federal University, Institute of High Technology and Advanced Materials); ROGACHEV, Kirill (Far Eastern Federal University, Institute of High Technology and Advanced Materials)

Presenter: SOBIROV, Mukhammad (Far Eastern Federal University, Institute of High Technology and Advanced Materials)

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