Hybrid nanostructures superconductor-ferromagnet for superconducting spintronics

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Abstract. The work is devoted to the study of the processes of formation of multilayer nanostructures, their vacuum deposition, and the manufacture of a novel functional element of spintronics - superconducting spin valve, which is a multilayer structure consisting of ferromagnetic cobalt nanolayers separated by superconductor niobium films. Multilayer nanostructures are fabricated by magnetron sputtering on (111) silicon substrates at a temperature of 300K. The prototypes of the superconducting spin valve are prepared from multilayer nanostructures by the method of sharp focus reactive ion etching (FIB). Modeling was carried out using molecular dynamics methods.

1. Introduction

Multilayer hybrid superconductor / ferromagnet nanostructures are the basic element of quantum electronics - spintronics, based on electron spin transport. Unlike conventional semiconductor electronics, superconducting spintronics consume a minimum of energy and has a high response rate. [1,2]. However, practice shows that the creation of multilayer superconductor-ferromagnet nanostructures with the required properties is an extraordinarily complex process, therefore, commonly, it is not possible to create an "ideal" nanosystem. The structure of real nanosystems is far from ideal one. In particular, it can be noted that the surface separating the various nanolayers of the system is not perfectly flat. The surface has noticeable irregularities that penetrating into the layers being in contact. Also, there is a mutual penetration of one contacting layer atoms into another due to the interdiffusion of the layer's elements. Therefore, the layer interface has a certain, non-zero thickness. It should be noted that the atomic structure of each layer does not form an ideal single crystal, but a system of polycrystals is formed. In this regard, complex theoretical and experimental studies of such multilayer nanostructures are highly relevant.

The aim of the work was the experimental and simulation study of the influence on these nanosystems main technological parameters: temperature, concentration, and spatial distribution of deposited atoms over the nanosystem surface, and on the atomic structure and morphology of the fabricated nanosystem.

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