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Magnetic state of Nb(1-7nm)/$Cu_{30}Ni_{70}$ (6nm) superlattices revealed by Polarized Neutron Reflectometry and SQUID magnetometry

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Abstract. We report results of a magnetic characterization of $[Cu_{30}Ni_{70}(6nm)/Nb(x)]_{20}$ (x=1÷7nm) superlattices using Polarized Neutron Reflectometry (PNR) and SQUID magnetometry. The study has shown that the magnetic moment of the structures growths almost linearly from $H = 0$ to $H_{sat} = 1.3kOe$ which can be interpreted as evidence of antiferromagnetic (AF) coupling of the magnetic moments in neighbouring layers. PNR, however, did not detect any in-plane AF coupling. Taking into account the out-of-plane easy axis of the $Cu_{30}Ni_{70}$ layers, this may mean that only the out-of-plane components of the magnetic moments are AF coupled.

1. Introduction

Hybrid superconducting/ferromagnet (S/F) heterostructures are intensively studied objects due to their interesting and promising properties [1]. At the moment the main research is concentrated on the study of simple S/F bilayers and S/F/S, F/S/F, and S/F/F trilayers (see [2] and references therein). However, we may expect that both superconducting ([3]-[11]) and magnetic ([12]-[14]) properties of a more complex S/F systems, such as $[S/F]_n$ superlattices, will differ from those of their constituent elements (S/F bilayers or S/F/S-, F/S/F -trilayers). A difference between the behaviour of the constituent elements and the superlattice is especially expected when the thicknesses of the layers become comparable with the correlation length of superconductivity, ξ_S, and magnetism, ξ_F, in the respective layers [12]-[15]. In a sense such superlattices can be considered as metamaterials assembled from "atoms" of S/F bilayers.

Our main goal is the design and fabrication of SF metamaterials with unique superconducting and magnetic properties arising from the competition of magnetic and superconducting ordering. As the building blocks of this metamaterial we propose to use Nb/CuNi bilayers investigated in detail before [16]-[19].