Structural, magnetic and superconducting characterization of the CuNi/Nb bilayers of the S/F type using Polarized Neutron Reflectometry and complementary techniques

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Abstract

Structural, magnetic, and superconducting properties of S/F bilayers $Nb/Cu_{40}Ni_{60}$ deposited on silicon substrate have been characterized using Polarized Neutron Reflectometry and complementary techniques. The study allowed to determine real thicknesses of the S and F layers as well as the r.m.s. roughness of the S/F interfaces. The latter does not exceed 1 nm, showing the high quality of the S/F interface. Using SQUID and a mutual inductance setup we determined the superconducting transition temperatures of the samples, which are in agreement with the literature data. Using of PNR for the single S layer allowed to determine the screening length λ of the superconducting layer, λ = 120 nm. This value is higher than the London penetration depth for pure niobium which may indicate that the superconductor is in the dirty limit. PNR and SQUID studies of magnetic properties of the CuNi layer have shown the presence of ferromagnetism in all investigated samples.

Keywords: proximity effects, superconductors, ferromagnets, polarized neutron reflectometry

1. Introduction

A proximity of a superconductor (S) and a ferromagnet (F) leads to appearance of a great number of intriguing phenomena, such as spatial oscillation of electron density of states, π type S/F/S Josephson junctions, F/S/F spin valves, etc. (see reviews [1,2]). The interaction