REENTRANT SUPERCONDUCTIVITY IN SUPERCONDUCTOR/FERROMAGNETIC–ALLOY BILAYERS

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We studied the Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) like state established due to the proximity effect in superconducting Nb/$Cu_{41}Ni_{59}$ bilayers. Using a special wedge-type deposition technique, series of 20-35 samples could be fabricated by magnetron sputtering during one run. The layer thickness of only a few nanometers, the composition of the alloy, and the quality of interfaces were controlled by Rutherford backscattering spectrometry, high resolution transmission electron microscopy, and Auger spectroscopy. The magnetic properties of the ferromagnetic alloy layer were characterized with superconducting quantum interference device (SQUID) magnetometry. These studies yield precise information about the thickness, and demonstrate the homogeneity of the alloy composition and magnetic properties along the sample series. The dependencies of the critical temperature on the Nb and $Cu_{41}Ni_{59}$ layer thickness, $T_c(d_S)$ and $T_c(d_F)$, were investigated for constant thickness d_F of the magnetic alloy layer and d_S of the superconducting layer, respectively. All types of non-monotonic behaviors of T_c versus d_F predicted by the theory could be realized experimentally: from reentrant superconducting behavior with a broad extinction region to a slight suppression of superconductivity with a shallow minimum. Even a double extinction of superconductivity was observed, giving evidence for the multiple reentrant behavior predicted by theory. All critical temperature curves were fitted with suitable sets of parameters. Then, $T_c(d_F)$ diagrams of a hypothetical F/S/F spin-switch core structure were calculated using these parameters. Finally, superconducting spin-switch fabrication issues are discussed in detail in view of the achieved results.

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