V International Conference on Microelectronics and Computer Science

ICMCS-2007

NANO Symposium-
Humboldt Kolleg
"NANO-2007"

Alexander von Humboldt Stiftung/Foundation

Nanoscale Phenomena – Fundamentals and Applications

NANO-2007

Abstract book

September 20-22, 2007

Chisinau, Moldova

Enhancement of complex decay length in S-(FNF)-S Josephson junctions.

T. Yu. Karminskaya*, M. Yu. Kupriyanov*, A.A. Golubov**, A.S. Sidorenko***, V.V. Ryazanov****

**Institute of Nuclear Physics Moscow State University, Moscow, 119992, Russia.*
***Faculty of Science and Technology, University of Twente, 7500 AE Enschede, The Netherlands*
**** Institute of Electronic Engineering & Industrial Technologies ASM, Kishinev 2028, Moldova*
*****Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, 142432. Russia*

In the last few years there were considerable efforts focus on searching of a ferromagnetic material suitable for fabrication of superconductor (S) - ferromagnetic (F) - superconductor (S) Josephson junctions for small scale applications. The analysis of existing experimental data have shown that the value of exchange energy H of ferromagnet materials used in these structures scales in between 850 Kч2300 K. As a result an effective decay length ($\xi_{F1}\approx 1{,}2\div 4{,}6$ nm) and a period of oscillations ($\xi_{F2}\approx 0{,}3\div 2$ nm) of thickness dependence of a junction critical current I_C turns out to be much smaller compare to decay length $\xi_N\approx 10\div 100$ nm of I_C in similar SNS structures. These small values of ξ_{F1} and ξ_{F2} make difficult the fabrication of SFS junctions with reproducible parameters. In this study we have shown that all this difficulties can be overcome in S-(FNF)-S Josephson junctions in the geometry providing the supercurrent flow in the direction parallel to FN interfaces. In the frame of Usadel equations we have demonstrated that the interaction between F and N films may result in considerable increase of ξ_{F1} and ξ_{F2} up to the scale of ξ_N. We also have studied the dependence of the critical current of the structure on the value of exchange energies H_1 and H_2 in the bottom and upper F films. It is shown that the transition from parallel to anti parallel orientations of F films magnetization results ether in transition from 0 to π states or in essential increase of the value of the critical current. The possibilities of experimental realization of this type of junctions briefly discussed. This work has been supported by RFBR project 06-02-90865_Мол.

Extraordinary behavior in external magnetic field of SIFS Josephson junctions with the inhomogeneous transparency of S/F interface.

M.Yu. Kupriyanov*, N.G. Pugach*, M.M. Khapaev*, A.V. Vedyayev*, E.B. Goldobin**, D. Koelle**, R. Kleiner**

* *M. V. Lomonosov Moscow State University, Moscow, Russia.*
** *Physikalisches Institut-Experimentalphysik II, Universitat Tubingen, Germany*

It is well known that the value of a critical current I_C of any traditional Josephson junctions is suppressed in external magnetic field H independently on in "0" or "π" are they in the ground state. In particular, if the size of a one dimensional junction is smaller than Josephson penetration depth λ_J and its critical current density $J_C(y)$ is uniform in the direction perpendicular to the current flow, then the $I_C(H)$ curve has the special form known as Fraunhofer pattern. The uniformity of $J_C(y)$ is an important factor. Its violation results in the strong modification of the Fraunhofer curve. In recent experiments with SFS and SIFS junctions the lack of uniformity of $J_C(y)$ had been achieved by making a step like changes of the thickness of the ferromagnetic (F) or normal layer inside a junction.

We model this step by supposing that one of S/F interfaces of a structure possesses a step like change of its transparency. In the framework of the Usadel equations we have shown that at certain thickness of F-layer the inhomogenuety of the transparency leads to a formation of a nonuniform point contact inside the structure. This may lead to the dependence of the junction critical current on external magnetic field essentially different from the Fraunhofer pattern typically observed in usual Josephson contacts. Namely, the value of critical current grows up with the increase of magnetic field achieving the maximum value in the field of the order of a second critical magnetic field of superconducting electrodes.

This work has been supported by RFBR project 06-02-90865_Мол.