Thin $Pd_{0.99}Fe_{0.01}$ films as Josephson barriers in superconducting magnetic memory

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To realize novel elements of superconducting electronics and spintronics based on hybrid nano- and microstructures, we have fabricated and investigated a Josephson magnetic memory based on Josephson superconductor/ferromagnet/superconductor junction (SFS junction) [1,2]. The first successful experiment detecting a perceptible supercurrent in an SFS structure was carried out in 1999 [3]. An application of small external magnetic field changes the magnetization of the ferromagnetic layer that in turn changes the junction critical current I_c, allowing the realization of two distinct states with high and low I_c, corresponding to logical "0" and "1" states, respectively.

It was also demonstrated that multilayered Josephson SIsFS structures, with a tunneling barrier (I) and a thin superconducting layer (s), increase significantly the junction characteristic voltage V_c allowing to achieve high reading frequency [4,5]. In this work, we have realized and studied Nb-Al/AlO_x-Nb-$Pd_{0.99}Fe_{0.01}$-Nb junctions with rectangular shape. The rectangular memory element allows to direct magnetization of magnetic barrier along either long or short side of the F-barrier. Magnetization of F-layer remains at saturation for both orientations and "digital" difference in critical current is reached due to different magnetic fluxes produced by F-layer. This concept allows us to reduce the size of the SFS memory element down to single-domain size of the ferromagnet. In this talk, magnetization hysteresis loops are derived from Josephson magnetometry. Moreover, from the different junction sizes investigated, size-anisotropy effects are studied. Numerical simulations were performed to explain the unusual behavior observed in I_c(H) curves, namely the suppression of maximum critical current.

1. V. V. Bolginov, V. S. Stolyarov, D. S. Sobanin, A. L. Kar-povich, and V. V. Ryazanov, JETP Lett. 95, 366, 2012.

2. V. V. Ryazanov, V. V. Bolginov, D. S. Sobanin, I. V. Vernik, S. K. Tolpygo, A. M. Kadin, and O. A. Mukhanov, Physics Procedia 36, 35, 2012.

3. V. V. Ryazanov, Phys. Usp. 42, 825, 1999.

4. I. V. Vernik, V. V. Bol'ginov, S. V. Bakurskiy, A. A. Golubov, M. Y. Kupriyanov, V. V. Ryazanov, and O. Mukhanov, IEEE Trans. Appl. Supercond. 23, 1701208, 2013.

5. S. V. Bakurskiy, N. V. Klenov, I. I. Soloviev, V. V. Bol'ginov, V. V. Ryazanov, I. V. Vernik, O. A. Mukhanov, M. Kupriyanov, and A. A. Golubov, Appl. Phys. Lett. 102, 192603, 2013.