Nucleation of Superconducting Domains in Thin s-layers of S-F/N-sIS Josephson Devices

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Abstract — In this work we study theoretically the properties of S-F/N-sIS tunnel devices in the frame of the Usadel formalism. We demonstrate that in the S-F/N-sIS device it is possible to achieve its separation into two regions which have positive and negative critical current densities. We prove by numerical calculations that this separation is accompanied by a new phenomenon, namely the violation of a spatial uniformity of the superconductive film and its decomposition into domains with an order parameter phase difference equal to π. The effect is sensitive to thickness of the s layer and widths of F and N films in the direction along the sIS interface. We found that in the crossover regime the S-F/N-sIS device may have two metastable states and can be switched between these states by current induced in the s film. Finally, the state of the system can be nondestructively read by current injected through the S electrodes.

Keywords (Index Terms) — Superconductivity, ferromagnetism, electronics, Josephson Junction, hybrid structures, memory.