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Low temperature resistive elements integrated into superconductive NbN nanowires produced under ion beam irradiation

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Traditional lift-off technique of Ti-Au resistive elements deposition has a number of disadvantages: relatively large sizes of the elements, a large number of technological operations required for sputtering.

New methods for the fabrication of integrated resistive functional nanoelements based on superconducting thin NbN films have been developed at the NRC "Kurchatov Institute" for the creation of cryoelectronic devices for various applications, due to controlled changes in the chemical composition and modification of the properties of nanomaterials under ion beam irradiation.

These methods have the following advantages: low number of necessary technological operations; the possibility of creating integrated elements of small size (<100 nm); by controlling the size of the irradiated region, the radiation dose and the beam composition, various functional elements (resistors, capacitances, inductances) can be created.

To create the resistors ultrathin NbN films with thickness of 5 nm, obtained by cathode sputtering on SiO_2 substrates were used. Formation of structures for electrical measurements was performed by electron lithography and plasma-chemical etching.

Modification of NbN films was performed by composite 0.1-4 keV ion beam of H^+ and OH^- ions, through the open windows in the PMMA mask of the required geometry.

In this paper, integrated resistors were built into low-temperature superconducting current lines of NbN with different resistances in the range 1 Ω-1 MΩ. The different values of resistivity was obtained by varying the geometry of irradiated area integrated into the superconductive line.

Irradiation based technique to form integrated resistive elements can be used during different design cryogenic circuit production.

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