Superconducting base elements for brain-like artificial neura network

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Abstract. Increasing energy consumption of computers with von-Neumann architecture rose the necessity of energy efficiency and the radically reduction of the power consumption as a crucial parameter constraining the advance of supercomputers. The promising solution is development of the non-von Neumann computers with brain-like architecture – the Artificial Neural Networks (ANN) based on superconducting elements with two main parts: nonlinear switch similar to the neuron, and linear connecting elements similar to synapse [1]. We present results of design and investigation of artificial neurons, based on superconducting spin valves, and superconducting synapses, based on layered hybrid nanostructures superconductor-ferromagnet.

The superlattices Nb/Co demonstrate change of the superconducting order parameter in thin niobium films due to switching from the parallel to the antiparallel alignment of neighboring ferromagnetic layers. We argue that such superlattices can be used as suitable base elements for superconducting spintronics for ANN engineering [2]. Design of the ANN using that two base elements, artificial neurons and artificial synapses, allows construction of the computer with several orders of magnitude lower energy consumption in comparison with the existing computers based on semiconducting elements.

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References

[1] Frontiers of nanoelectronics: intrinsic Josephson effect and prospects of superconducting spintronics. Anatolie S. Sidorenko, Horst Hahn and Vladimir Krasnov. Beilstein J. Nanotechnol. 2023, 14, 79–82, doi:10.3762/bjnano.14.9

[2] A. Sidorenko (Editor), Functional Nanostructures and Metamaterials for Superconducting Spintronics. Springer, 2018, 279 pages. https://link.springer.com/book/10.1007/978-3-319-90481-8