BEILSTEIN JOURNAL OF NANOTECHNOLOGY

Periodic Co/Nb pseudo spin valve for cryogenic memory

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Letter

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Keywords:
cryogenic computing; neutron scattering; spin valve; superconducting spintronics

Beilstein J. Nanotechnol. **2019,** *10,* 833–839.
doi:10.3762/bjnano.10.83

Received: 29 November 2018
Accepted: 18 March 2019
Published: 09 April 2019

Associate Editor: P. Leiderer

Abstract

We present a study of magnetic structures with controllable effective exchange energy for Josephson switches and memory applications. As a basis for a weak link we propose to use a periodic structure composed of ferromagnetic (F) layers spaced by thin superconductors (s). Our calculations based on the Usadel equations show that switching from parallel (P) to antiparallel (AP) alignment of neighboring F layers can lead to a significant enhancement of the critical current through the junction. To control the magnetic alignment we propose to use a periodic system whose unit cell is a pseudo spin valve of structure F_1/s/F_2/s where F_1 and F_2 are two magnetic layers having different coercive fields. In order to check the feasibility of controllable switching between AP and P states through the whole periodic structure, we prepared a superlattice [Co(1.5 nm)/Nb(8 nm)/Co(2.5 nm)/Nb(8 nm)]$_6$ between two superconducting layers of Nb(25 nm). Neutron scattering and magnetometry data showed that parallel and antiparallel alignment can be controlled with a magnetic field of only several tens of Oersted.

Findings

Superconductor digital devices have attracted growing attention due to their unique energy efficiency and performance [1], and also due to compatibility with a number of quantum and neuromorphic computers under development [2-4]. However the lack of cryogenic memory elements (including synapses) with sufficiently fast switching between stable states and suffi-