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Nanoscale memory elements based on the superconductor-ferromagnet proximity effect and spin-transfer torque magnetization switching

BURM BAEK, NIST - Boulder

Superconducting-ferromagnetic hybrid devices have potential for a practical memory technology compatible with superconducting logic circuits and may help realize energy-efficient, high-performance superconducting computers. We have developed Josephson junction devices with pseudo-spin-valve barriers [1]. We observed changes in Josephson critical current depending on the magnetization state of the barrier (parallel or anti-parallel) through the superconductor-ferromagnet proximity effect. This effect persists to nanoscale devices in contrast to the remanent field effect. In nanopillar devices [2], the magnetization states of the pseudo-spin-valve barriers could also be switched with applied bias currents at 4 K, which is consistent with the spin-transfer torque effect in analogous room-temperature spin valve devices. These results demonstrate devices that combine major superconducting and spintronic effects for scalable read and write of memory states, respectively. Further challenges and proposals towards practical devices will also be discussed.

In collaboration with: William Rippard, NIST Boulder, Matthew Pufall, NIST Boulder, Stephen Russek, NIST-Boulder, Michael Schneider, NIST Boulder, Samuel Benz, NIST Boulder, Horst Rogalla, NIST-Boulder, Paul Dresselhaus, NIST - Boulder

[1]B. Baek et al., Nat. Commun. 5, 3888, (2014).
[2]B. Baek et al., Phys. Rev. Appl. 3, 011001 (2015).