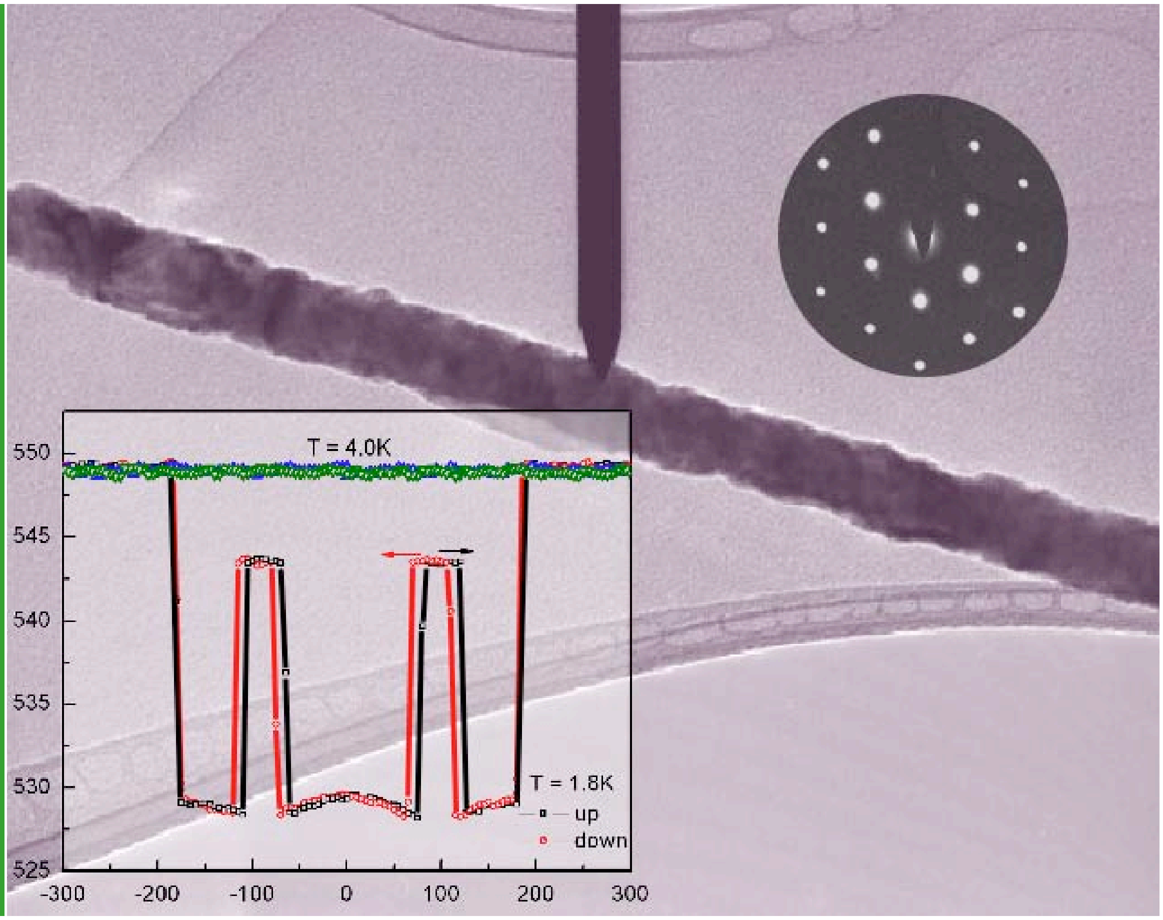
MAGNETIC SWITCH

Penn State MRSEC



Resistance (in ohms) as a function of magnetic field (in Oersted) across a hybrid structure containing both superconducting and ferromagnetic components. The magnetic component is a nickel nanowire 40 nanometers in diameter.

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Ferromagnet-superconductor nanowires
spins in conflict

IRG3

Superconductivity and ferromagnetism both require long-range ordering, but of opposite natures. Superconductivity is a condensation of Cooper pairs with antiparallel spins, whereas ferromagnetism arises from a parallel spin alignment that yields a bulk magnetization. This contrast in spin order generates a host of interesting phenomena arising from proximity effects in hybrid superconductor-ferromagnetic systems.

Penn State researchers Nitesh Kumar, Mingliang Tian, Jinguo Wang and Moses H. W. Chan have sandwiched single-crystal and polycrystalline nickel nanowires 40nm in diameter between bulk tin electrodes to make superconductor-ferromagnet-superconductor hybrids. The magnetoresistance of these structures shows pronounced hysteresis, a magnetic switching behavior that occurs only when the tin electrodes are in the superconducting state. The origin of the extremely sharp transition in resistance at intermediate magnetic fields is currently a mystery, but future work on controlling the switching behavior by tuning the properties of the junction promises to reveal new physics from the interplay of incompatible spin orders across the nanoscale ferromagnet-superconductor interface.