SUPERCONDUCTING DEVICES

Transistors go metal

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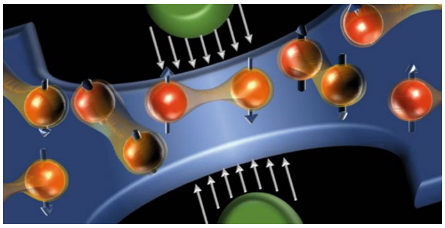

Credit: American Chemical Society

Josephson field-effect transistors are devices in which superconducting source and drain electrodes are used to induce the flow of Cooper pairs (loosely bound pairs of electrons) across a semiconducting channel, and such devices could potentially be used to develop superconducting electronics. In the devices, the charge carrier concentration of the semiconductor can be controlled by an electric field. Replacing this semiconducting channel with a superconducting metal could improve heat dissipation, and also make the devices easier to fabricate. However, electrostatic control of the current flowing through a superconducting metal channel is challenging due to the short screening length of the metal. Federico Paolucci and colleagues at NEST, Istituto Nanoscienze-CNR and SPIN-CNR in Italy now report a fully metallic superconducting field-effect transistor that uses a configuration known as a Dayem bridge and can be fabricated by a one-step electron beam lithography process.

A Dayem bridge is made from a superconducting thin film in which two electrodes are connected via a short constriction. To build their Dayem bridge transistors, the researchers used a superconducting titanium thin film that was fabricated on a commercial silicon wafer and had a constriction that was around 125 nm long and around 300 nm wide. The small size of the transistor leads to reduced parasitic capacitance, which allows side gating electrodes to effectively control the channel current. The devices showed good field-effect characteristics, including complete suppression of the current at a gate voltage of ±8 V, comparable to complementary metal–oxide–semiconductor (CMOS) gate voltages. Furthermore, the devices exhibited a critical temperature (below which the metal exhibits superconductivity) as high as 540 mK, which is a record critical temperature for titanium.

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