

EuS/Al bilayers for future superconducting spintronics

Elia Strambini, NEST Istituto Nanoscienze-CNR and Scuola Normale Superiore, Pisa, Italy

A renewed interest in studying Ferromagnetic/superconductor structures came with the development of superconducting spintronics[1]. Ferromagnetic insulators (FIs) attached to a superconductor are known to induce triplet superconducting pairing and an exchange energy splitting in the Bardeen-Cooper-Schrieffer (BCS) density of states proportional to the FI magnetization, and penetrating into the superconductor to a depth comparable with the superconducting coherence length. Experiments carried out at the end of 80's have demonstrated that the exchange field of FIs, such as EuS and EuO, can very effectively split the excitation spectrum of an adjacent superconductor (S), such as an Al thin film [2].

We first investigate this long-range magnetic proximity effect in EuS/Al bilayers tunnel coupled to an Al probing layer. The tunnelling spectroscopy of our devices reveals a clear exchange splitting of the BCS peaks strongly correlated to the magnetic domain structure of the EuS, as demonstrated by our microscopic model based on the quasiclassical Green's functions formalism [3].

Secondly, we show a technological application of this hybrid material implementing a spin-valve [4] with a tunnel junction made with a two EuS/Al layers. The high contrast in the tunnelling magnetoresistance (TMR) measured at low temperatures (<1 K) demonstrate the capabilities of this valve for future superconducting electronics. Furthermore, the hard gap and clear intrinsic spin-splitting observed in our tunnelling spectroscopy measurements at zero field indicate that EuS/Al bilayers are an excellent platform for the development of large variety of devices requiring the coexistence of superconducting correlations and built-in spin-splitting exchange fields, as for example in the field of Majorana-based quantum computation.

Bibliography

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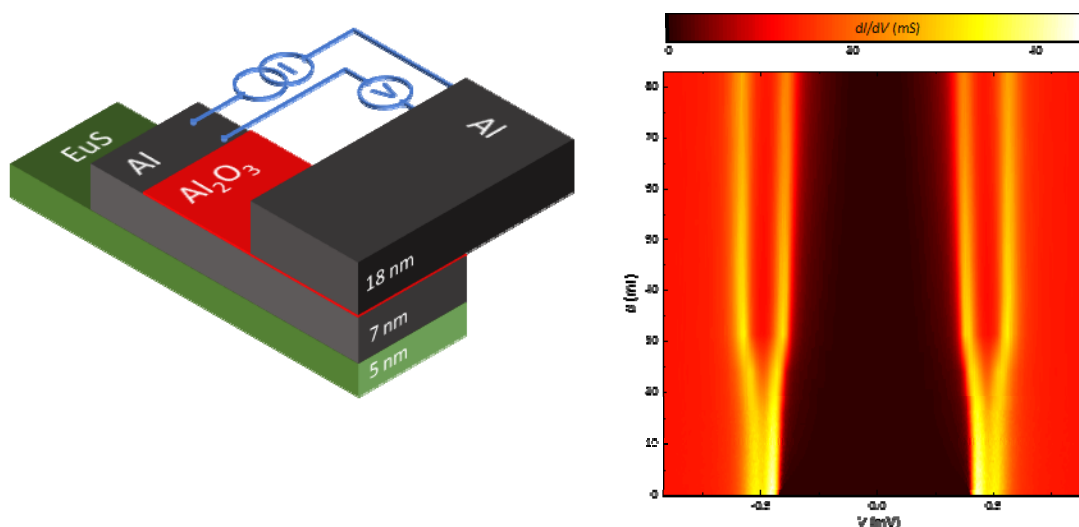


Fig.1 Superconducting tunneling spectroscopy of EuS/Al bilayer vs in-plane magnetic field (B)