# EuS Interfaces for Low Temperature Spintronics

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Abstract

Magnetic insulators (MI) carry magnetic moment without charge dissipation, which is beneficial for both spintronic technologies and proximity effect-mediated material engineering, especially at cryogenic temperatures. Yet, their practical use is hindered by the lack of MI compounds which can be deposited as thin films on top of Si/SiOx substrates and then processed with typical lithography methods.
I will illustrate the advantages of introducing interfaces of the MI compound EuS in low temperature spintronic and superconducting devices.
First, I will present a characterization of the magnonic properties of EuS films at low temperature (2K). In devices comprising heavy metal/EuS interfaces, we observe that spin signals can be injected and propagate through the EuS films by the spin Seebeck effect. Moreover, ferromagnetic resonance measurements of the EuS films reveal a Gilbert damping of 10-3 at 2K in polycrystalline films, pointing to the possibility of exploiting EuS interfaces for coherent low temperature magnonics [1]. Finally, I will illustrate the introduction of EuS/Al electrodes in vertical EuS/Al/AlOx/Al Josephson junctions. The proximity effect induces a sharp spin-splitting of the density of states of the Al electrode in contact with the EuS film, clearly observed in the tunnelling spectroscopy of the junctions [2]. At the same time, we observe that the superconducting gap is well defined for reasonable temperature and in-plane magnetic field ranges. The I-V characteristics of the more transparent junctions reveal the presence of in-gap superconducting transport processes, such as the Josephson effect and multiple Andreev reflections. Fittings of the dI/dV of the junctions demonstrate how the EuS interfacial exchange field affects such processes.
The presented
experiments do not rely neither on the growth of epitaxial EuS interfaces nor on a careful control of their thickness, an important advantage for the design of MI-interface based cryogenic devices.

References

[1] M. Xochitl Aguilar-Pujol, S. Catalano et al., Phys. Rev. B 108 (2023) 224420
[2] Hijano, A. et al. Phys. Rev. Res. 3, (2021) 023131

Figures

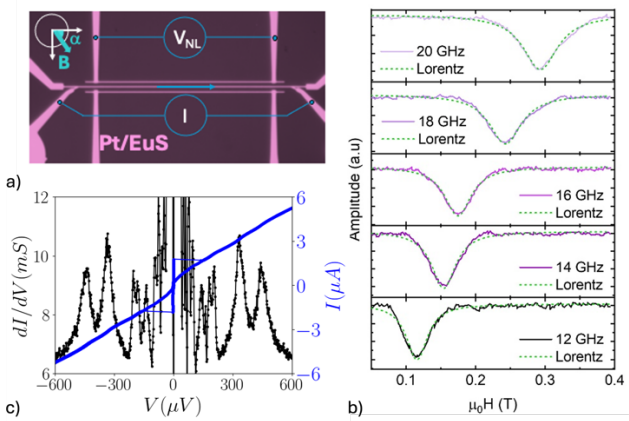


**Figure 1:** a) a Pt/EuS device used to detect the spin Seebeck effect; b) FMR spectra of polycrystalline EuS films at T = 2K; c) *I-V* characteristics (blue line) and *dI/dV* spectroscopy (black line) of a vertical EuS/Al/AlOx/Al junction, showing Josephson effect and MAR resonances.