16th International Workshop on Low Temperature Detectors
20 24 July 2015

Role of the Andreev current in bolometers and calorimeters based on tunnel junctions

Main author:

FAIVRE Timothé

Co-authors:

Faivre Timothé, Low Temperature Laboratory, Department of Applied Physics, Aalto University.

Golubev Dmitry S., Low Temperature Laboratory, Department of Applied Physics, Aalto University, P. O. Box 13500, FI-00076 AALTO, Finland

Pekola Jukka P., Low Temperature Laboratory, Department of Applied Physics, Aalto University, P. O. Box 13500, FI-00076 AALTO, Finland

Viisanen Klaara L., Low Temperature Laboratory, Department of Applied Physics, Aalto University, P. O. Box 13500, FI-00076 AALTO, Finland

We discuss aluminium based tunnel junctions for calorimetry. Our rf-transmission readout of a Normal metal - Insulator - Superconductor (NIS) tunnel junction provides currently 10 μK / \sqrt{Hz} sensitivity with a bandwidth of 10 MHz below 100 mK, with promise for ultralow-energy calorimetry [1]. Ultimately, the performance of such a device is limited by the leakage through the junction. This problem is well known in the context of NIS solid state coolers. Our work [2] establishes the role of the disorder enhanced Andreev reflection in the leakage of a low impedance NIS tunnel junction. We demonstrate experimentally that this effect provides a method to measure electronic temperature, specifically at temperatures below 200 mK when aluminium is used. The Andreev thermometer has some advantages over conventional quasiparticle thermometers: for instance, it does not dissipate or conduct heat and its reading does not saturate until at lower temperatures. Preliminary measurements demonstrate a constant noise equivalent temperature of 20 μK / \sqrt{Hz}. While the quasiparticle conductance saturates at around 150 mK, the Andreev thermometer in the same device saturates only at 85mK, and even then due to spurious heat load. Operation at lower temperatures leads to an improvement in the predicted energy resolution and noise equivalent power.

[1] S. Gasparinetti, K.L. Viisanen, O.P. Saira, T. Faivre, M. Arzeo, M. Meschke, and J.P. Pekola, Phys. Rev. Applied 3, 014007 (2015).
[2] T. Faivre, D.S. Golubev and J.P. Pekola , Appl. Phys. Lett. 106, 182602 (2015).