THERMAL EFFECTS AND HEAT FLOW IN GRAPHENE JOSEPHSON JUNCTIONS: PROSPECTS FOR ULTRA-SENSITIVE BOLOMETERS

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A bolometer is a device for measuring the power of incident electromagnetic radiation via the heating of a material. In order to reach a high sensitivity, the absorbing material or device should have a low heat capacity and a weak heat conductance to its surroundings. One promising candidate for ultra-sensitive bolometry is graphene [1], where the electronic heat capacity is tiny and weakly connected to the lattice via electron–phonon coupling.

We have studied graphene Josephson junctions (superconductor–graphene–superconductor, SGS) at low temperatures (10–800 mK) to determine which thermal conduction mechanism is responsible for the relaxation of the electron temperature of the system. The junction is heated with a finite dc bias voltage and the temperature of the electrons is extracted from the voltage of the superconducting gap $\Delta(T)$ and from the superconducting-to-normal transition of the junction at the critical temperature T_c. We find that in our samples with Ti/Al contacts ($T_\mathrm{c} < 1$ K) thermalization in the presence of self-heating occurs via out-diffusion of hot electrons through the leads. In bolometer applications, this can be prevented by using a contact material with a higher T_c, e.g. Nb or MoRe.

The main obstacle for graphene bolometers has been that its resistance does not depend on temperature, and read-out should be carried out by other means, e.g. critical current, thermal noise or Josephson inductance. We propose a novel scheme, where dual-gated bilayer graphene is used to open a gap and create a strong temperature dependence in device resistance.

[1] A. C. Ferrari *et al.*, Nanoscale 7 (2015) 4587.