Superconductive-graphene hybrid devices

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Abstract

In a superconductor-insulator-superconductor (SIS) junction we can have both tunnelling of quasiparticles (above the superconductor gap 2Δ) or tunnelling of Cooper pairs at zero voltage, called Josepshon supercurrent. The width of the insulator layer must be very thin so that we can have a tunnelling current. We can also change the insulator layer by a normal metal of a given width. In this case, the Cooper pairs can survive inside the normal metal over a large length scale – what is called proximity effect – provided that the normal metal shows several properties like phase coherence and time reversal symmetry [1][2]. Although these properties were not clearly present in graphene [3], recent studies showed that the Cooper pairs could survive over distances up to 500nm [2].

Our purpose was to induce superconductivity in graphene by proximity effect. We used a SiO_2 substrate and, as superconductor contacts, we prepared W-based deposits by Focused Ion Beam Induced Deposition (FIBID) using Ga^+ ions, whose critical temperature is around 5K [4]. The ion beam can damage the graphene in an unrepairable way and the only solution is to prepare the device in a first step and deposit the graphene over it. We have used both CVD graphene and exfoliated graphene. The former must be grown on top of a copper substrate and then transferred to the device; whereas the latter can be deposited directly on top of the device using PDMS gel [5].

References

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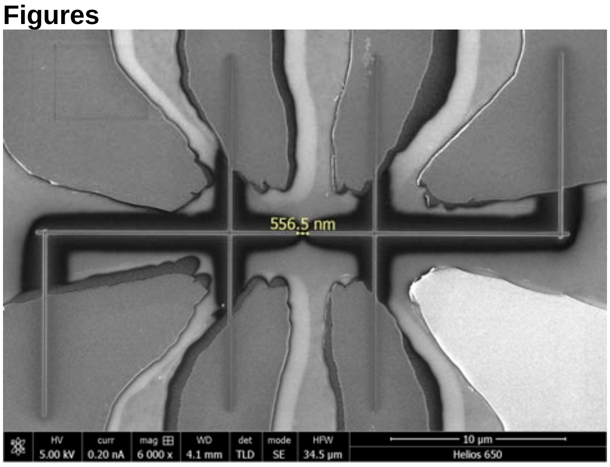
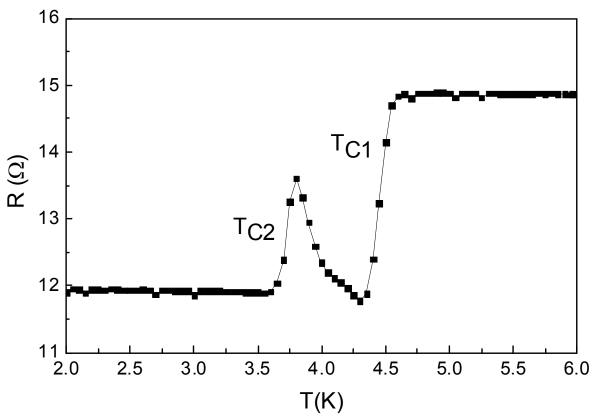
Figures





Left. Device ready for graphene transfer. The separation between the superconductor contacts is around 500nm. Right. Resistance versus temperature in a sample with CVD graphene. We can observe two critical temperatures: T_{C1} at 4.5K, which corresponds to the critical temperature of the W deposits; and T_{C2} at 3.75K, which corresponds to the superconducting transition induced on the graphene layer.