Tunable superconductivity in graphene based hybrid devices

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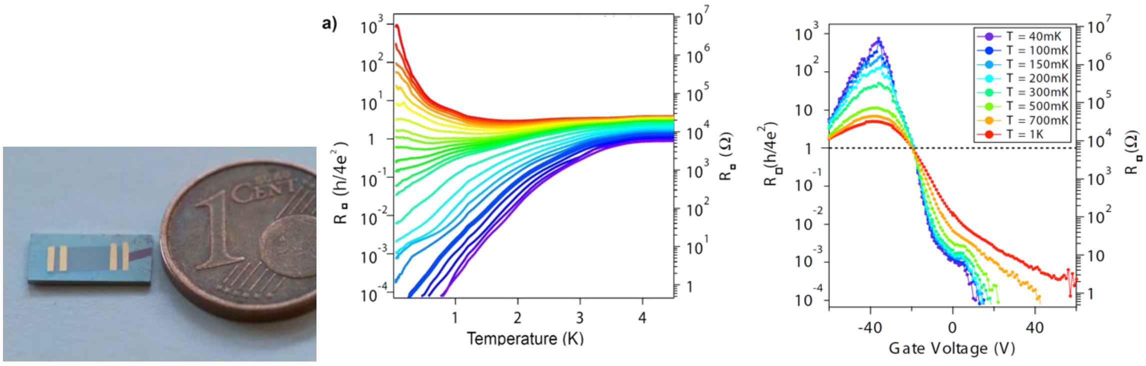
The easily accessible 2D electron gas in graphene provides an ideal platform on which to tune, via application of an electrostatic gate, the coupling between electronically ordered dopants deposited on its surface. I will present recent experimental studies on electrostatically tuned superconducting transition in graphene sheets decorated with tin nanoparticles. The transition towards superconducting state is due to percolation of superconductivity induced by proximity effect within the nanoparticules random array. Depending of the disorder within the graphene layer, superconductivity show different characteristics and significant variations. In case of low disorder exfoliated graphene, the superconducting state results from a Berezinski-Kosterlitz-Thouless transition which leads to an homogeneous 2D superconducting state [1]. In case of disordered Graphene (CVD-grown),we show that upon changes in carrier density (+/-7.10^{12} cm^{-2}, applying a gate voltage), a transition from a superconducting to a truly insulating state can be induced. [2]. An intermediate metallic regime is also present at the transition showing sheet resistivity of the order of the resistance quantum h/4e^2. We interpret this transition within the framework of granular superconductivity found in Josephson junction arrays. The intense positive magnetoresistance observed for fields below the critical field of tin nanoparticles is a signature of the localization of Cooper pairs.

This hybrid system appears to be an original platform to investigate the current understanding of the physics of the superconductor-insulator quantum phase transition and offer a original starting material for the realization of superconducting weak links.

[1] B. M. Kessler et al., Phys. Rev. Lett. 104,047001 (2010).

[2] A. Allain et al., http://arxiv.org/abs/1109.6910.



Superconducting Metal-insulating transition induced in Tin doped Graphene : Left, micrograph of a typical sample, showing the macroscopic CVD-grown Graphene Sheet, Center :resistance-temperature curves at different gate voltages (gate step 5V) Right : Field effect at different temperature,showing the universal resistance at the transition.