A new path for superconducting graphene

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Whereas a tunable Josephson super-current has been observed in graphene long time ago [1], inducing superconducting properties in graphene remains very challenging. One reason comes from the difficulty to prepare a good interface between graphene and the superconducting metal which is usually deposited on top of the graphene layer. In this work, we developed a new and reliable method to induce superconductivity in graphene by growing graphene on top of a thin Rhenium film.

Scanning tunneling microscopy (STM) studies with atomic resolution reveal large flat terraces of our samples fully covered with graphene and the existence of a moiré superstructure of 2.3nm periodicity, which is typical of graphene on lattice mismatched substrates [2]. The superconducting properties of graphene on Rhenium have been probed by low temperature tunneling spectroscopy performed at 50 mK. We observed a very homogeneous superconducting state below a superconducting transition temperature $T_c \geq 2K$, significantly higher than the critical temperature of bare Rhenium films. The density of states at energy much higher than the superconducting gap reveals features which are position dependent on the moiré pattern, indicating different local coupling strengths of the graphene layer with the Rhenium substrate. We also made more disordered samples with areas partially covered with amorphous carbon. In this situation, a spatial evolution of the superconducting proximity effect shows up between the regions displaying a moiré pattern and the disordered ones. We analyzed this evolution in the framework of mesoscopic superconductivity theories.

The superconducting properties of graphene on Rhenium have been further characterized under a perpendicular magnetic field of a few hundred Gauss. A disordered array of vortices has been observed and the electronic density of states of the vortex core has been obtained. This opens new possibilities in the quest of zero mode states in the vortex core of graphene [3].

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[2] E. Miniussi et al., *PRL* **106**, 216101 (2011)
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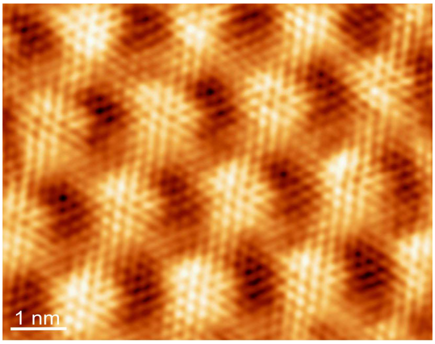

STM image of graphene on Rhenium with atomic resolution on the moiré pattern.