# Active hybrid devices based on physisorbed elements on Graphene: from tunable superconducting transitions to neural network bio-applications

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Abstract:

Graphene provides an ideal 2D gas of Dirac Fermions, which is directly exposed to the environment. Therefore it provides an ideal platform on which to tune, via application of an electrostatic gate, the electronic coupling between ordered adsorbates deposited on its surface via the control of density and sign of charge carriers. This situation is particularly interesting when the network of adsorbates are actively interacting between each other and can induce some long range electronic order within the underlying graphene substrate, such as superconducting correlations [1]. To demonstrate this concept, we have measured arrays of superconducting clusters physisorbed on Graphene capable to induce via the proximity effect a gate-tunable superconducting transition. We have experimentally studied the case of macroscopic graphene decorated with an array of superconducting tin clusters [2], which induce via percolation of proximity effect a global but tunable 2D superconducting state. By adjusting the graphene disorder and its charge carrier density on one side , the geometrical order, cluster size and density of the superconducting dot network on the other side, the superconducting state can exhibit very different behaviors, allowing to test different regimes and quantum phase transition from a granular superconductor to either metallic or insulating states, leading to a bosonic-type gate-controlled quantum phase transition [3]. I will show recent experimental results involving three sets of triangular arrays sparsely distributed on graphene, in which superconductivity is destroyed for a critical gate value that we attribute to the effect of quantum fluctuations of the phase giving rise to an intermediate metallic state [4].

Finally I will give another example of organized elements on graphene involving the interaction of in-situ grown neurons onto graphene [5], showing that electrical activity of neural cells can be probed with sub-cell accuracy.

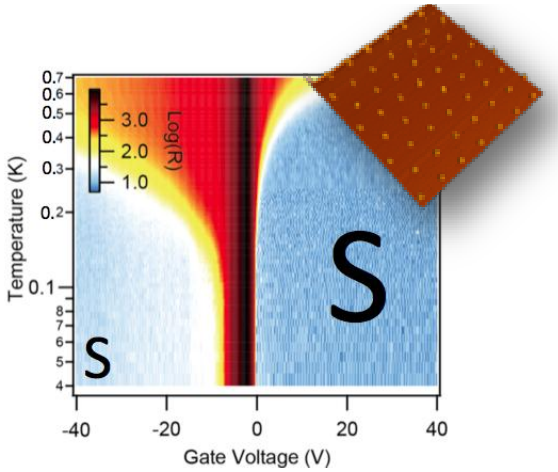


*Figure : Low temperature phase diagram of superconducting transition triangular array of Tin dots decorating graphene inset AFM micrograph of the corresponding sample (scan size 10 microns).*

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