Graphene based quantum superconducting circuits

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Devices based on the control of quantum states will revolutionize information and communications technologies. Several implementations of the quantum bit (Qubit), i.e. the building block for systems targeting quantum-enabled functionalities, were already demonstrated. Approaches based on all-superconducting materials provide the most advanced solid-state platform to date but they must rely on magnetic effects for control and operation, which is not an industry standard for devices and might induce unwanted interaction between different elements of the circuit. We report the integration of graphene in the key element of superconducting circuits: the Josephson junction. The field effect enables the junction to gain electrical tunability, a breakthrough for control and future integration. This has recently been implemented in superconducting qubits[1,2,3]. The poster will show how to incorporate a graphene Josephson junction in a superconducting microwave resonator whose resonance frequency can thus be modified by a gate voltage. It will especially focus on the critical current engineering which is directly related to the non-linearity of the system. One might want especially high critical current for some applications. We investigated the use of Ti/Al contacts on graphene as well as MoGe and Ta/MoGe. The position of the junction in the resonator is an important parameter as well because of the spatial dependence of the microwave intensity.

References

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[3] Kroll, J.G., Uilhoorn, W., van der Enden, K.L. *et al.*, *Nat Commun*, 9 (2018) 4615.
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Figures

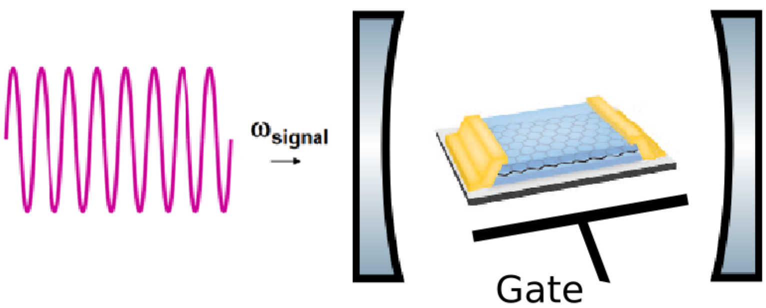

Figure 1: Graphene heterostructure contacted with a superconductor in a resonator geometry. By applying a gate voltage on graphene, the inductance of the junction is modified and thus the resonance frequency of the cavity as well.
Graphene heterostructure picture taken from [4].