# Graphene and 2D dichalcogenides as sensing membranes in superconducting microwave resonators

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**Abstract** Microelectromechanical (MEMS) and nanoelectromechanical (NEMS) devices are among the most sensitive position, force and mass detectors in use today [1]. The effort to further increase the sensitivity of these devices leads to the desire for the lightest of moving parts that still retain suitable mechanical properties. This is a regime in which the thinnest crystals—2D materials like graphene or niobium diselenide—may yield the greatest performance [2]. We report on progress making suspended membrane capacitors out of graphene and other 2D materials. Their ultimate use will be in high frequency RLC circuits, where the large change in system properties due to an external load on the membrane capacitor can be tracked in changes of the RLC resonance. The sensitivity of these devices, and the strength of the electromechanical coupling, can even allow the investigation on the limits of measurement imposed by quantum mechanics and measurement backaction. Integrating these capacitors in superconducting transmission line resonators can allow a drive signal to cool the membranes toward their motional ground state [3]. In this sense, the motion of a large (many atom) system can be said to behave quantum mechanically, which may have application in quantum information science. We have developed a process for making suspended structures that makes use of polymethyl methacrylate (PMMA) and polymethylglutarimide (PMGI) electron beam resists and only solvent-based developers and removers. Electrical connections can be made between two different metal layers, allowing the creation of narrow-gap parallel plate capacitors and air bridges. Suspended regions and support structures can be formed by selectively removing the sacrificial PMGI layer with a step of e-beam/photolithography and development. We propose the use of this fabrication technique for the suspension of membranes of graphene and dichalcogenides for nanomechanical devices operating at low temperatures.

## References

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