NEMS structures for graphene mechanical properties

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Abstract

The extremely low areal density and high strength of graphene monolayers make the material very attractive for mechanical nanoelectromechanical systems (NEMS) resonators. Highly sensitive sensors for mass, force and displacement can be fabricated using suspended graphene mechanical resonators. In addition since graphene may be readily functionalized these sensors may be designed to selectively sense specific molecular species. In this presentation we report our method for preparing substrates with suitably patterned array of holes or depressions, across which chemical vapour deposition (CVD) grown graphene may be transferred. Graphene membrane drum resonators varying in size from 1μm to 40μm in diameter have been produced in this way. Raman microscopy has been used to confirm the layer number of the transferred films and scanned probe microscopy (atomic force microscopy (AFM) and scanning Kelvin probe microscopy (SKPM)) have been carried out to test the correct assignment of layer number for the graphene and to test for the strain in the deposited films. AFM has been used to map the force-deflection curves across the surface of several drums, allowing a value for Youngs modulus for the suspended graphene to be derived. The mechanical resonant properties of the drums have also been determined in a system where the substrate is mounted on a piezoelectric vibrator. More detailed properties of the mechanical resonator are deduced by measurements made with a scanned near-field microwave microscope. A key issue for the application of these drums is to optimize the mechanical quality factor Q as this parameter determines the sensitivity for force, mass of displacement detection. Currently Q values observed in air are around 500, already sufficient to provide sub-piconewton force measurements using near-field microwave system.

References

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Figures

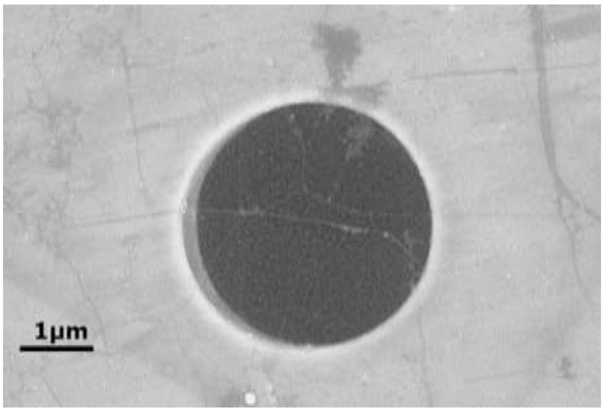

Figure 1: SEM image of graphene drum resonator with diameter ~5μm.