Closed cavity resonator formed by suspended large monolayer graphene-based membrane

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The attractive small mass density, mechanical and electrical properties promise the application of graphene acoustic sensors. Some graphene-based membrane sensors have been made and applied successfully to condenser microphones, loudspeakers, ultrasonic radio and acoustic resonators.[1-6] For sensing low frequency, large area graphene membranes around a few millimeters' diameter should be used. However, the millimeter scale membranes are much more difficult to be suspended or clamped fully over the cavity due to the larger membranes' diameter to thickness aspect ratio. In this work, large area monolayer graphene-based closed cavity resonator (Fig.1) has been fabricated. The diameter of the graphene-based membrane is 3.5mm, which is designed for sensing signal within acoustic frequency range. The diameter to thickness aspect ratio of graphene-based membrane is around 7,000.

The graphene-based closed cavity resonator has been formed by transferring an ultra-large monolayer graphene-based membrane over 3.5mm diameter circular closed cavity with 220µm depth. The graphene-based membrane includes mono-layer graphene and 500nm Poly (methyl methacrylate) film. A modified and simplified graphene dry transfer method using the Kapton tape supporting frame has been used in this work. Membrane's static deformation is 97nm. The membrane's static deformation aspect ratio (suspended membrane diameter over the membrane deformation) is around 36,000. The fabrication process, the dynamic deformation measurement details and the Raman Spectra of the suspended graphene-based membrane will be presented. Furthermore, the graphene-based closed cavity resonator has been actuated mechanically, electro-

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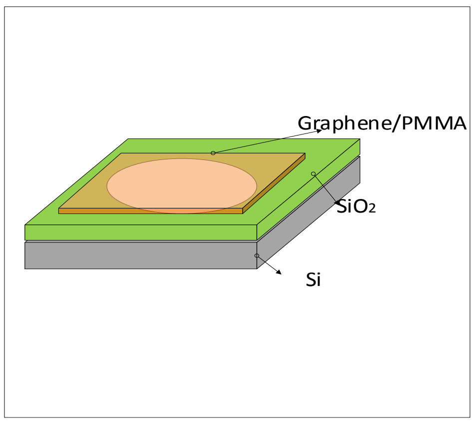
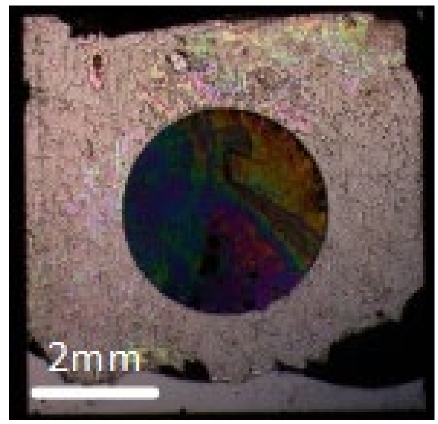
thermally and acoustically. The dynamic behavior of the membrane suspended over the closed cavity is shown in Fig.2. The second nodal mode has been observed to dominate the graphene-based membrane's resonance with a resonant frequency of around 11 kHz. Further details on the dynamic behavior of the graphene-based closed cavity resonator will be discussed.





(a) (b)

Fig.1: The schematic (a) and the optical image (b) of the graphene-based membrane closed cavity resonator

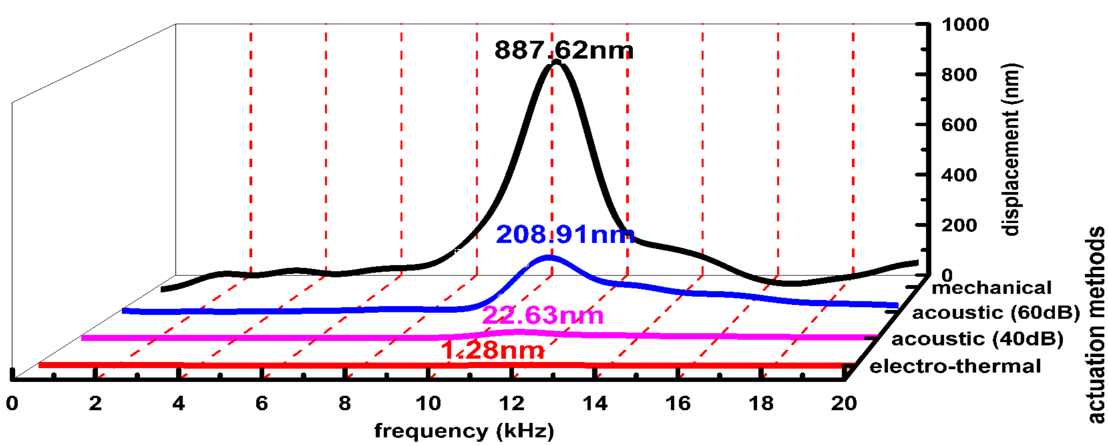


Fig.2: The frequency response of the monolayer graphene based closed cavity resonator actuated by different method