Accurate Backbone Curve for Ultrathin NEMS with Geometric Imperfection

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The electromechanical properties of the doubly clamped graphene resonators deviate from the flat rectangular plate as the former possesses ripples and wrinkles [1] that are sometimes orders of magnitude larger than the thickness of the graphene. Apart from these, fabrication process also introduces imperfection in the graphene sheet such as resist residues. Due to aforementioned imperfections [2] the nonlinear properties of graphene resonator deviate from theoretical predictions. In this work, we report an initial weak softening behaviour of graphene resonators for small vibration amplitudes. However, for large vibration amplitudes the device show strong hardening behaviour [3]. The initial softening behaviour can be explained by incorporating the effect of geometric imperfection in quadratic nonlinearity.

References

[1] S. Deng and V. Berry," *Mater. Today*, vol. 19, no. 4, pp. 197–212, May 2016.
[2] M. Amabili, *J. Sound Vib.*, vol. 291, no. 3–5, pp. 539–565, Apr. 2006.
[3] "Nonlinear Vibrations and Stability of Shells and Plates," *Cambridge University Press*.

Figures

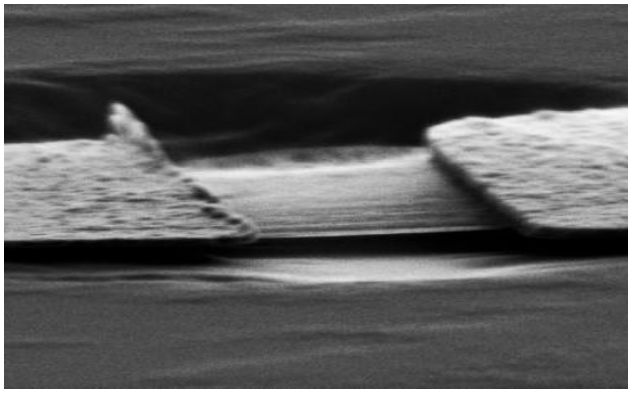

Figure 1: SEM image of suspended graphene device with ripples.

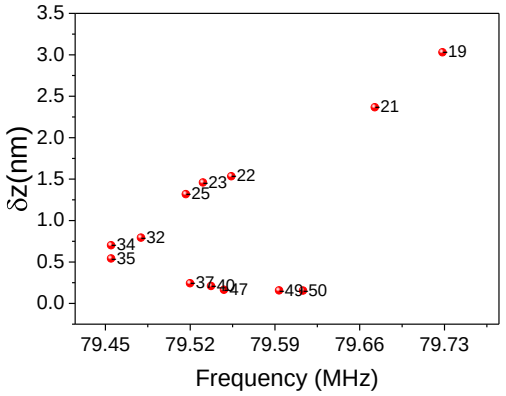

Figure 2: Back-bone curve extracted from frequency response of graphene resonator at different drive levels. The numbers against the points in the graph indicate the ac source-drain voltage applied in mV.