On Chip Acoustic Actuation for Linear Excitation of 2D NEMS

Marsha M. Parmar[1]
M. Faizan[1], P. X.-L. Feng[2], L. G. Villanueva[1]

[1]*Advanced NEMS Group, Ecole Polytechnique Federale de Lausanne (EPFL), CH-1015, Lausanne,Switzerland.*
[2]*Department of Electrical Engineering and Computer Science, Case school of Engineering, Case Western Reserve University, Cleveland, OH 44106,USA.*

Contact@E-mail (marsha.parmar@epfl.ch)

Abstract

In this paper we compare the dissipation mechanism of suspended graphene sheet using electrostatic and acoustic actuation techniques. Acoustic actuation is achieved at device level through patterning of Aluminum nitride (AlN) thin film at wafer scale. The graphene sheet was transferred on the chip using viscoelastic dry transfer method [1]. The SEM image of suspended graphene nanoresonator is shown in Fig.1. The AlN piezo stack is partially visible at the bottom of the image. The multilayer graphene sheet is suspended over 10μm-diameter circular cavity. The graphene NEMS was first actuated electrically using highly doped silicon as back-gate. The frequency response curves for increasing drives is shown in Fig.2a. To illustrate the effect of nonlinear damping [2] associated with electrostatic actuation[3], we divide output amplitude with forcing amplitude and plot the frequency sweeps for various increasing drives. Due to the effect of damping on amplitude, the curves do not lie on top of each other as shown. However, when actuated through the on-chip piezoelectric stack, the various frequency response curves lie on top of each other indicating a linear damped system as shown in Fig.2b. We also report the acoustic actuation technique to be less dissipative. Our study will be important in better understanding of dissipation and decoherence mechanism for studying the quantum aspects of 2D NEMS.

References

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Figures

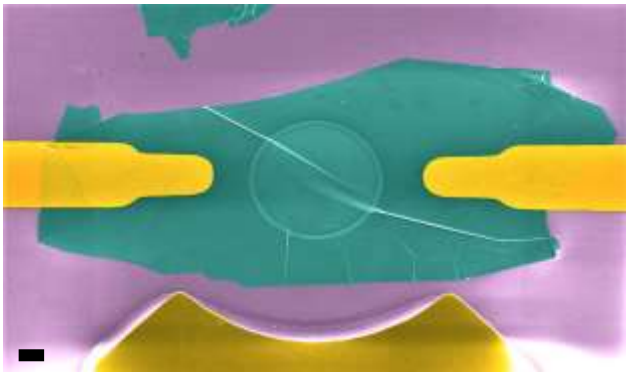

Figure 1: SEM image (false colors) of suspended multilayer graphene sheet on 10um circular cavity. The AlN piezo-stack is also visible at the bottom of the image. The scale bar is 2um.

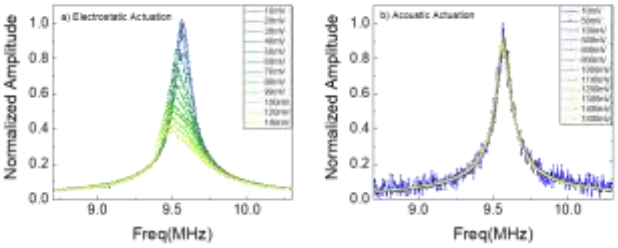

Figure 2: Frequency sweeps for a) Electrostatic and b) Acoustic actuation of graphene membrane as a function of increasing ac drive force. The y-axis denotes output amplitude divided by the driving amplitude.