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Optical Detection of Vibrations and Mass Loading of Graphene Mechanical Resonators Compatible with TEM and AFM BENJAMIN ALEMAN, MICHAEL ROUSSEAS, YISHENG YANG, WILL REGAN, FENG WANG, ALEX ZETTL, University of California, Berkeley — We produce arrays of exceptionally clean, suspended graphene mechanical resonators in high-yield using a simple, polymer-free procedure by transferring CVD-graphene to a flexible perforated substrate. The lack of a backing substrate facilitates Transmission Electron Microscopy (TEM) characterization, yet the membranes are still compatible with Atomic Force Microscopy (AFM) studies. We detect mechanical vibrations of resonators through optical interferometry and find excellent agreement with a theoretical model based on the 2D wave equation. We find quality factors of 1.25 μm diameter circular membranes to be as high as Q $\sim$ 800-1000 at room temperature, and observe lifting of mode degeneracies in square membranes. TEM and AFM studies reveal graphene folding, nanoparticle contamination, holes, tears, and other defects that can lead to the observed degeneracy splitting in square membranes. Controlled mass loading is also explored to suppress certain vibrational modes and tune vibrational frequencies for possible high density archival memory applications. The graphene membrane devices reported here open up a host of new possibilities for correlating TEM and AFM studies of an individual graphene membrane to its performance and properties as a mechanical resonator.

[X] Prefer Oral Session
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