GRAPHENE RESONATORS FOR MECHANICAL SENSING

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Graphene’s high conductivity and strength make it an excellent material for sensitive yet robust measurement devices. In particular, graphene resonators have been shown to have high quality (Q) factors, showing promise for use in force detection. However, in part due to the difficulty in creating large pieces of graphene, previously built graphene resonators have used graphene components that are only tens of microns across at most. Improvements in graphene growth have allowed for the creation of much larger graphene sheets, which can be incorporated in novel devices. Here, we fabricate large graphene resonators using standard photolithographic methods. Large resonators should exhibit unique traits, such as a different detection range due to decreased resonant frequencies. We test various electric and mechanical properties of the resonators.
Graphene Resonators for Mechanical Sensing

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Resonators: A Valuable Tool

What is a resonator?
- Large response to a small driving force at precise resonant frequencies (fr)
- High quality (Q) factor makes the response at fr relatively larger, leading to better signal to noise ratios

Resonators are useful for sensing
- Extremely sensitive mass, force, and charge sensors
- Useful for measurement and detection of trace amounts of hazardous chemicals or gases in air

Graphene is well-suited for resonator sensors
- Low mass and high stiffness => high Q factors
- Graphene is at the lower limit of atomic thickness, and smaller resonators function better

Goal
To harness the exceptional properties of graphene for use as resonator sensors, particularly for sound and gas detection

Successful Fabrication of Drum and Trench Resonators

1. Si sample initially coated with SiO2
2. Etch holes using Reactive Ion Etch (RIE)
3. Transfer graphene

Sound Detection
- Sound waves used to actuate drums movement
- Drum motion measured as changes in capacitance
- Useful as extremely small microphones and as sound sensors for graphene-based circuits

Testing Effects of Gas on Graphene
- Suspended graphene has a large surface area for interacting with its environment
- Graphene has very high charge mobility, which will give good signals in conductance measurements
- Compare changes in conductance after gas adsorption for non-suspended and suspended graphene

Future Experiments for Resonators in Sound Detection and Gas Adsorption

Figure 1: 20 micron diameter drum resonators
Figure 2: 6 by 16 micron trench resonators
Figure 3: Proposed sound measurement setup
Figure 4: Preliminary IV curve for trench resonator

References
[1] PHYS 201b lab handout, Yale University