GRAPHENE RESONATORS FOR MECHANICAL SENSING

K. Lai[1], Z. Liu[2], S. Najmaei[2], L. Ma[2], J. Lou[2], P. M. Ajayan[2]

[1]NanoJapan Program, Rice University and Department of Physics, Yale University

[2]Department of Mechanical Engineering & Materials Science, Rice University

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

Kevin Lai*[,1], Zheng Liu[2], Sina Najmaei[2], Lulu Ma[2], Jou Lou[2], Pulickel M. Ajayan[2]

[1]NanoJapan Program, Rice University and Department of Physics, Yale University

[2]Department of Mechanical Engineering & Materials Science, Rice University

*Email: kevin.lai@yale.edu

Resonators: A Valuable Tool

What is a resonator?

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

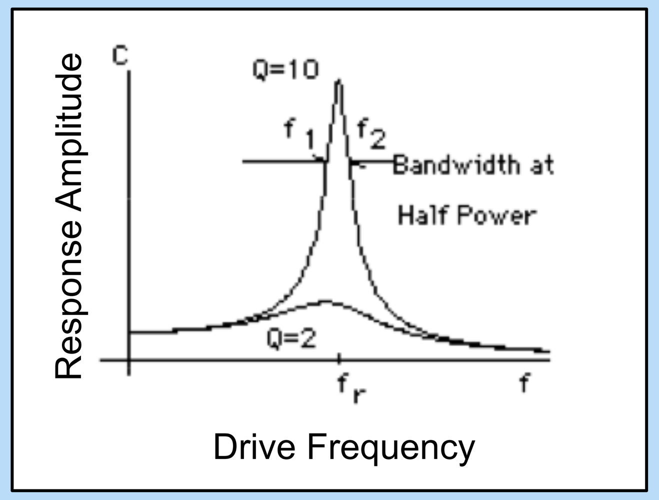


Figure 1: Resonator response at f_r[1]

Resonators are useful for sensing

- Extremely sensitive mass, force, and charge sensors[2]
- Useful for measurement and detection of trace amounts of hazardous chemicals or gases in air

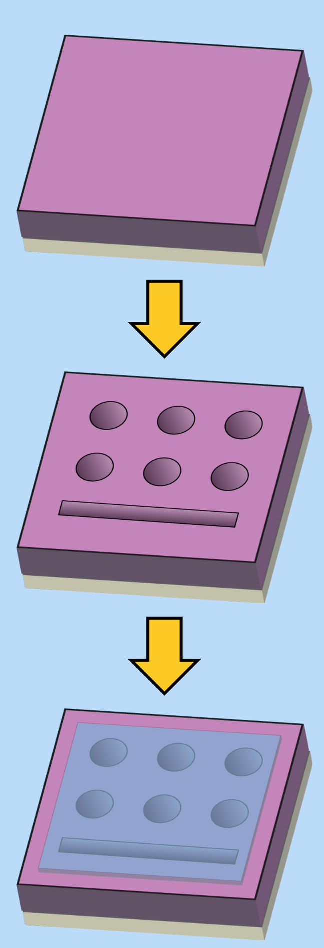
Graphene is well-suited for resonator sensors

- Low mass and high stiffness[3] ➔ high Q factors[4]
- Graphene is at the lower limit of atomic thickness, and smaller resonators function better[5]

Goal

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

Size and Shape-Independent Resonator Fabrication



1. Si sample initially coated with SiO_2
2. Etch holes using Reactive Ion Etch (RIE)
3. Transfer graphene

Successful Fabrication of Drum and Trench Resonators

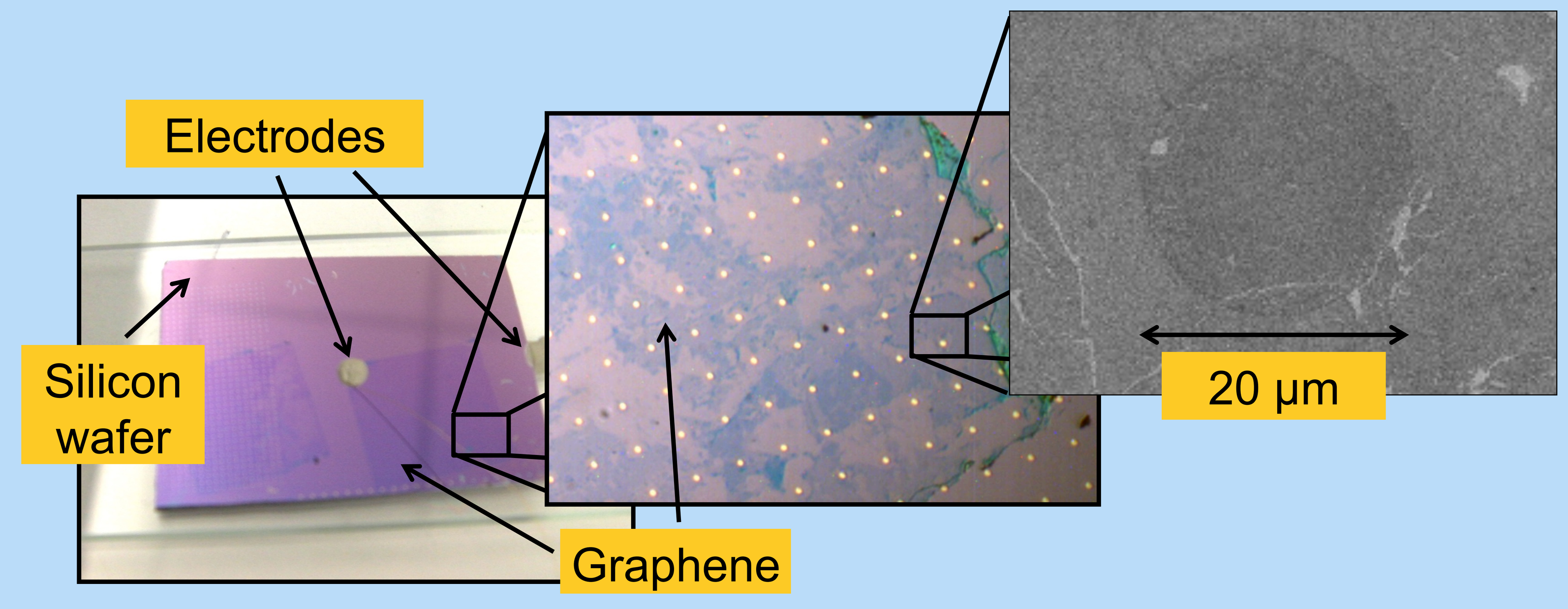


Figure 1: 20 micron diameter drum resonators

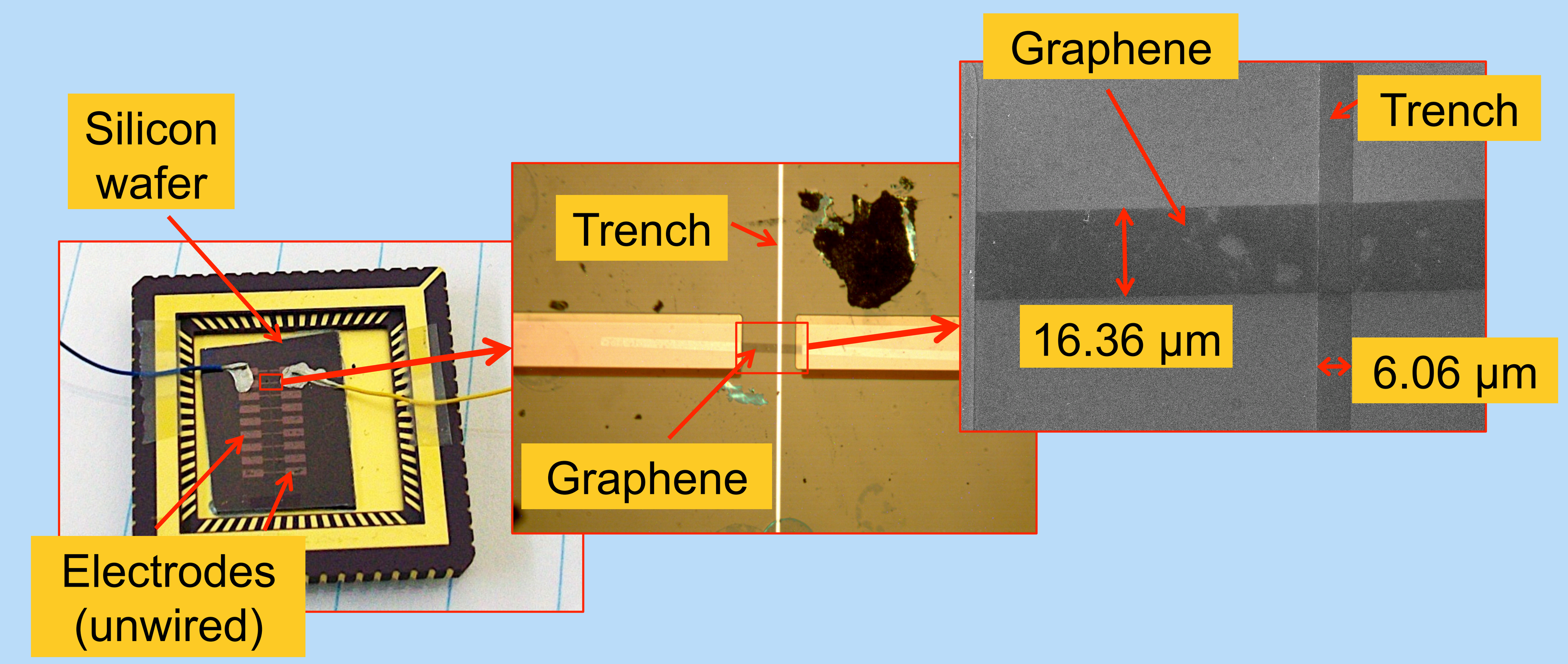


Figure 2: 6 by 16 micron trench resonators

Future Experiments for Resonators in Sound Detection and Gas Adsorption

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

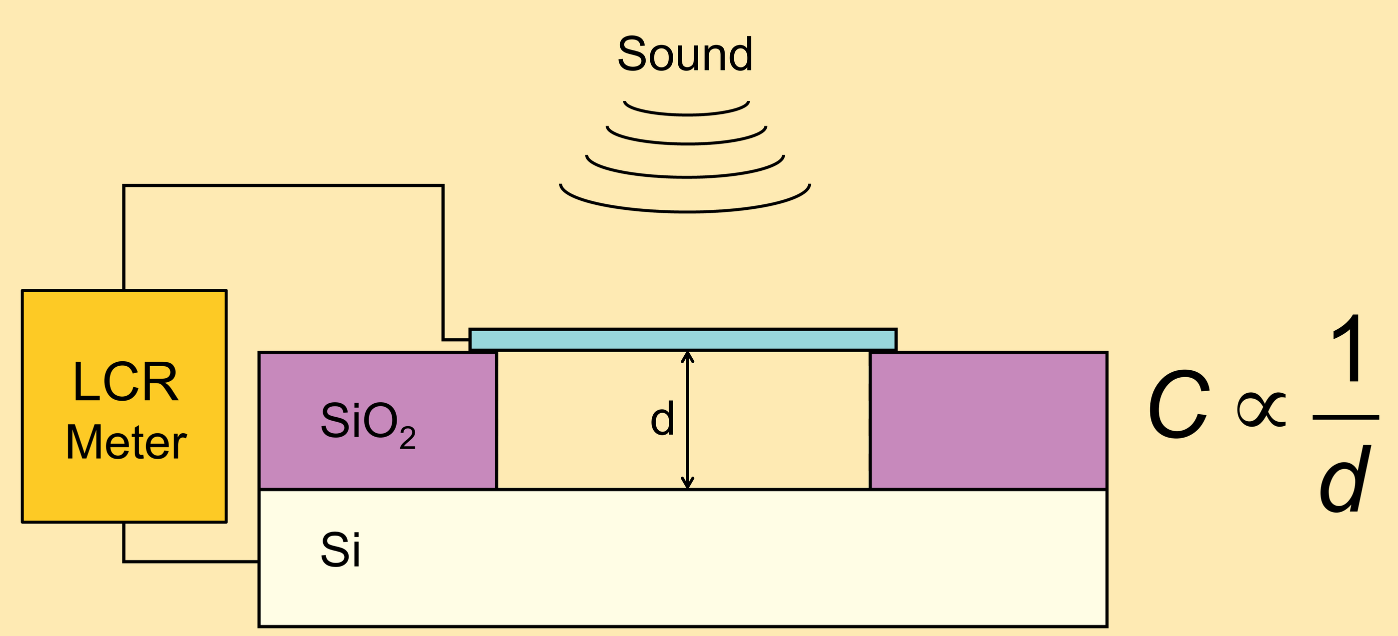


Figure 3: Proposed sound measurement setup

Testing Effects of Gas on Graphene

- Suspended graphene has a large surface area for interacting with its environment
- Graphene has very high charge mobility[6], which will give good signals in conductance measurements
- Compare changes in conductance after gas adsorption for non-suspended and suspended graphene

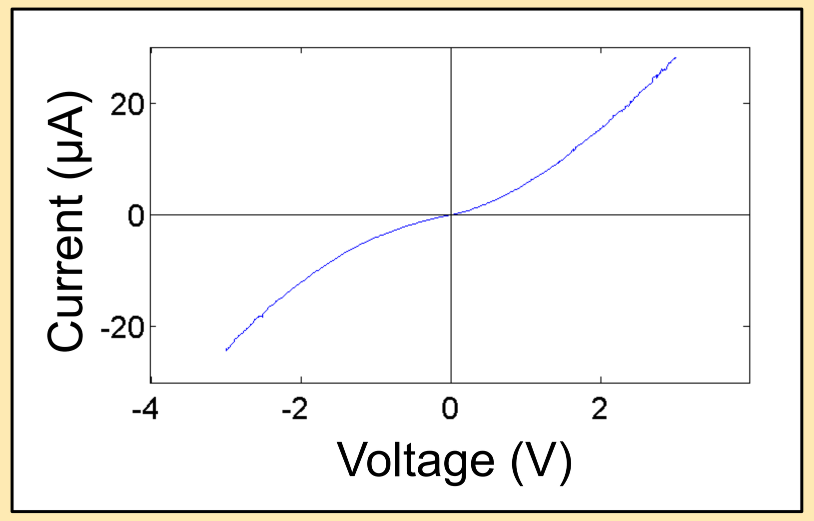


Figure 4: Preliminary IV curve for trench resonator

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