Linfield College

Graphene as Gas Detector

Christina Bibler, Kyel Lambert, Dr. M.S. Crosser
Linfield College, McMinnville, OR

Motivation-Gas Detector

A solid state gas detector is a device whose electrical properties change under the influence of a gas. Ideally, gas detectors are sensitive to small amounts of gas, while also having low electrical noise. Graphene, a single atomic sheet of graphite, shows great promise as a gas detector. We report early progress in developing such a device.

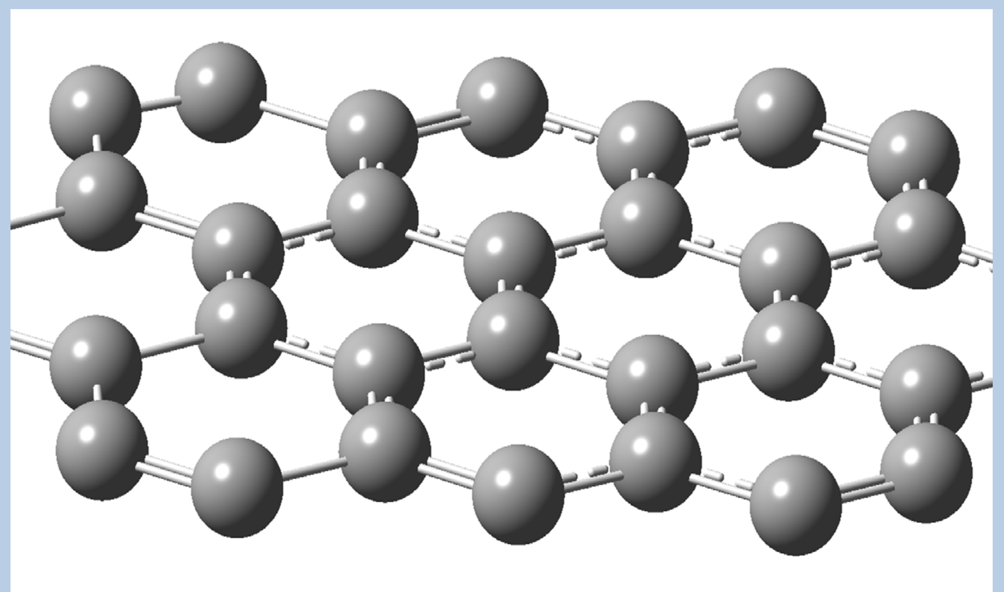

Figure 1. Atomic structure of graphene

Graphite is a form of carbon that is structured as sheets of hexagonal lattices stacked on top of each other. The bonds between sheets are weak, which makes the layers easy to separate. In the past few years, researchers have learned how to separate these layers and to make devices from a single layer of graphite, called graphene [1].

With a graphene device we can measure the resistance across the flake. When a gas becomes adsorbed onto the graphene, this resistance profile will change. Because graphene is a single atomic layer, it is more sensitive than similar bulk gas detectors. More importantly, graphene itself has few defects and so produces very little noise in its measurements.

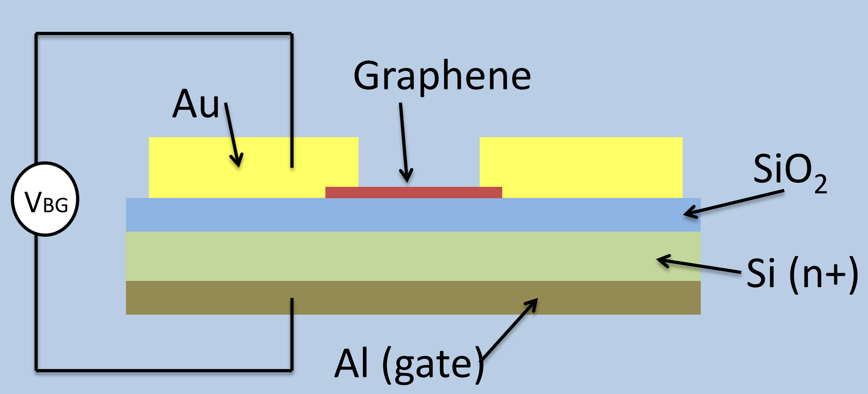

Figure 2. Schematic – Device side view

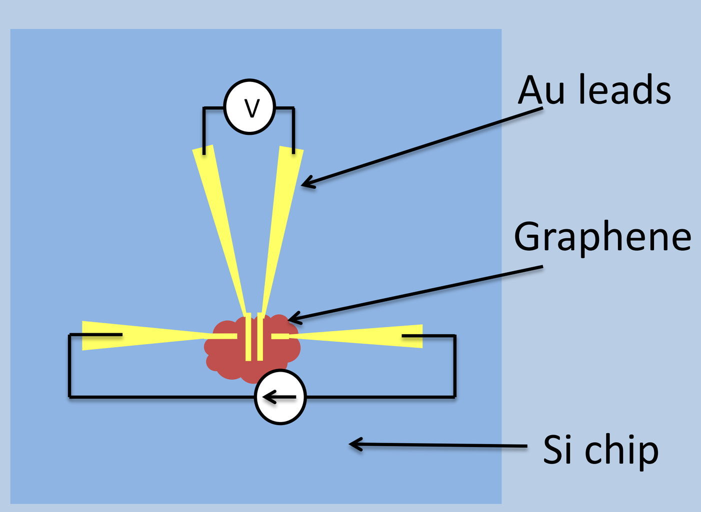

Figure 3. Schematic – top view (graphene leads)

Experimental Methods

Figure 6. Graphene and graphite on tape during mechanical exfoliation.

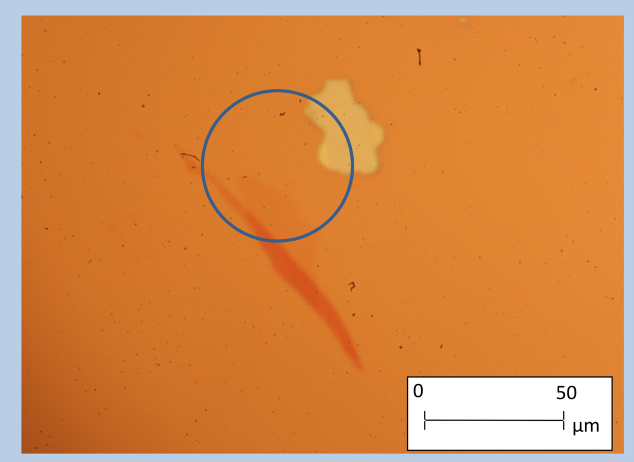

Figure 7. Graphene is then deposited onto silicon. (highlighted by circle)

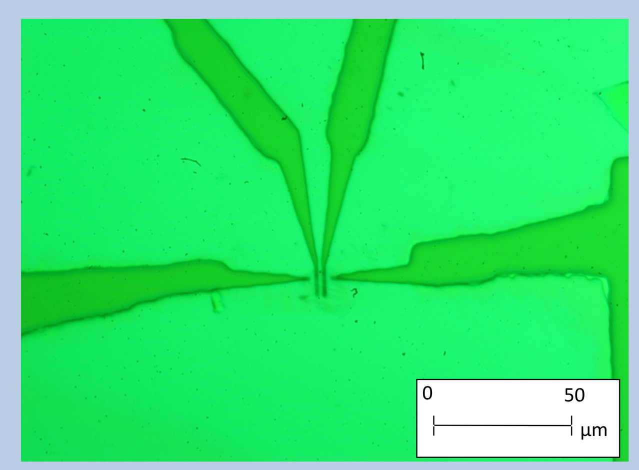

Figure 8. Photolithography prepares patterns that will become circuit leads.

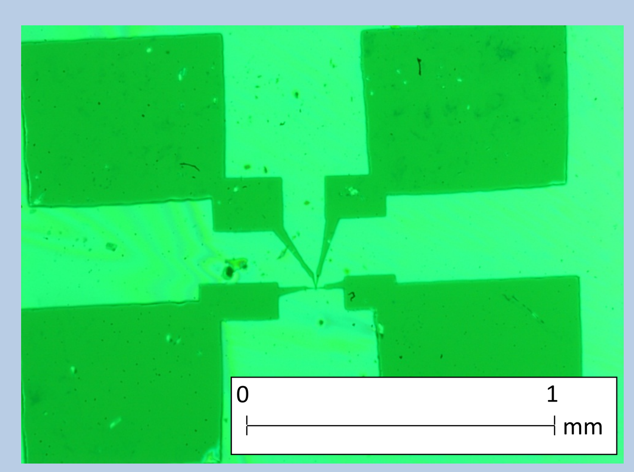

Figure 9. The pattern expands from a few hundred micrometers to a few millimeters so wires can attach to the pads.

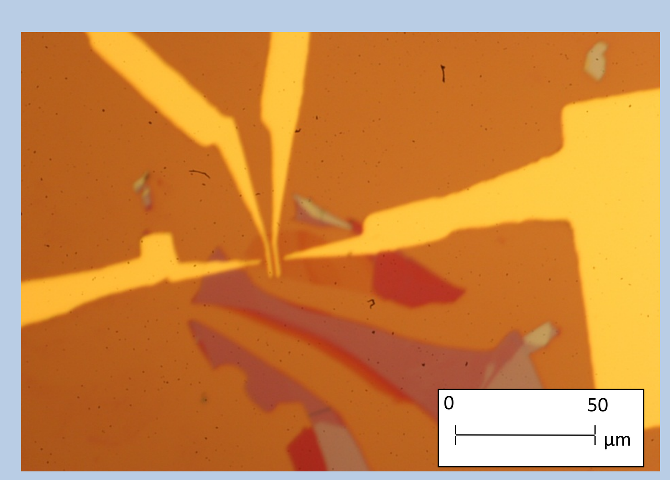

Figure 10. Gold is thermally evaporated.

Figure 11. Final device, after lift off.

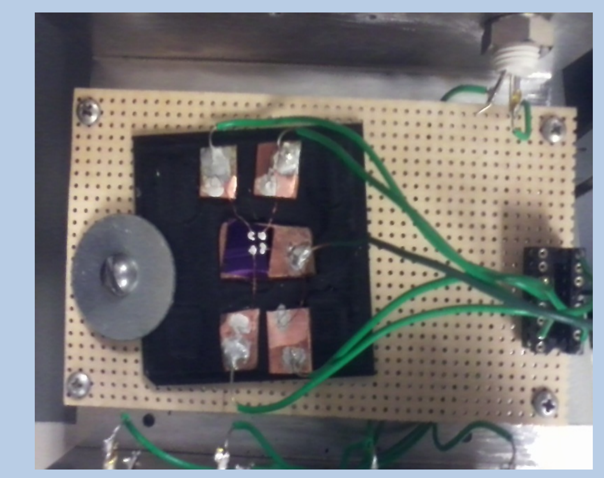

Figure 12. Device wired into circuit box.

Future Work

When Novosolov, *et al*. applied a voltage across the gate, they showed that they could change the resistance of the graphene as a function of V_{BG} (V). Gao, *et al*. have shown that gas molecules adsorbed on the graphene also affect the resistance [2], by shifting the peak of the resistance graph left or right. Due to, we assume, poor contacts, we have yet to see these effects. We hope to measure similar results to previous work soon. To display a shift due to gas molecules, we will select a gate voltage and measure how the resistance changes while it is exposed to different gases.

References

[1] Novosolov KS, Geim AK, *et al*. Electric field effect in atomically thin carbon films. *Science* 2004;306:666-9.
[2] Gao, Libo *et al*. Repeated Growth and Bubbling Transfer of Graphene with Millimetre-size Single-crystal Grains Using Platinum. *Nat Commun* 3 (2012): 699.

Acknowledgements

This project is supported by the Linfield College Faculty/Student Collaborative Research Grant.

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