GRAPHENE WIRELESS HARMONIC SENSORS

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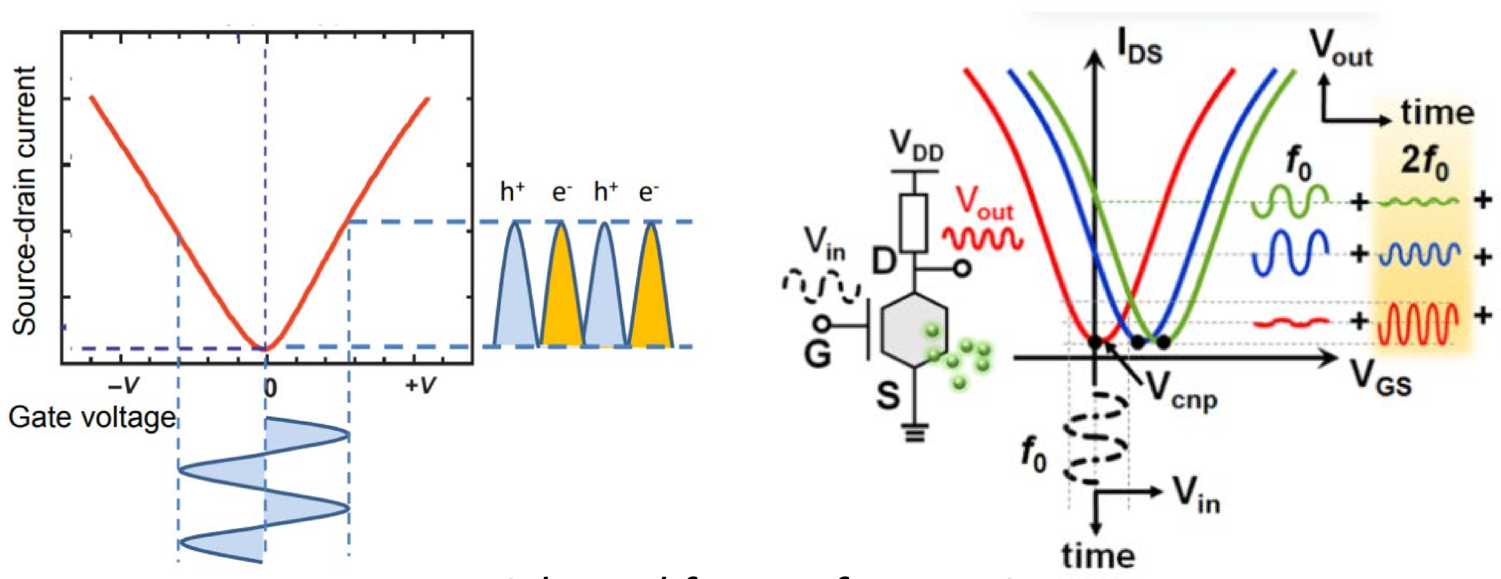
Introduction

- Graphene exhibits an ambipolar field effect where charge carriers can be continuously "tuned" between electrons and holes[1].
- Graphene field effect transistors with a coplanar waveguide structure can exhibit a frequency doubling effect, while chemical gating can modulate the output frequency by shifting the charge neutrality point[2].
- These fundamental characteristics enable the use of graphene as a highly sensitive harmonic sensor.



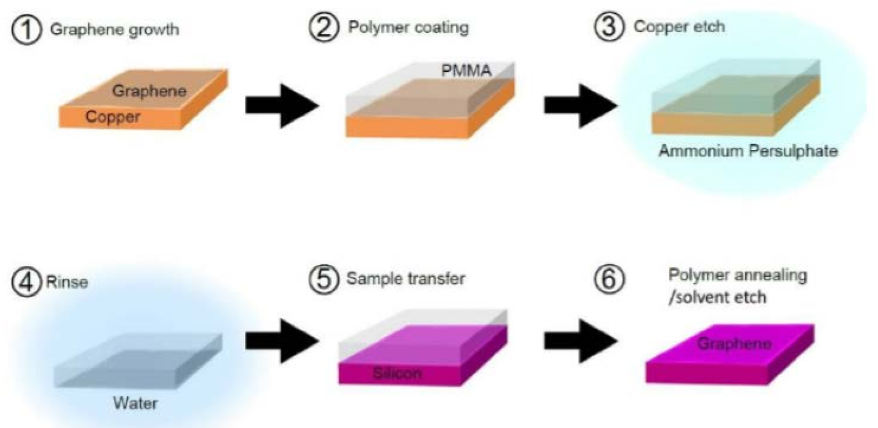
Adapted from reference 1

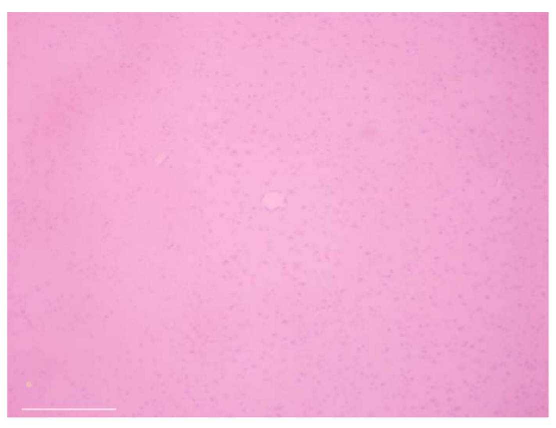
Aim

- To fabricate a graphene radiofrequency transistor with a coplanar waveguide configuration.
- To extract the electrical properties of the CVD graphene.
- To measure the frequency doubling effect of the transistor as a function of gate voltage.

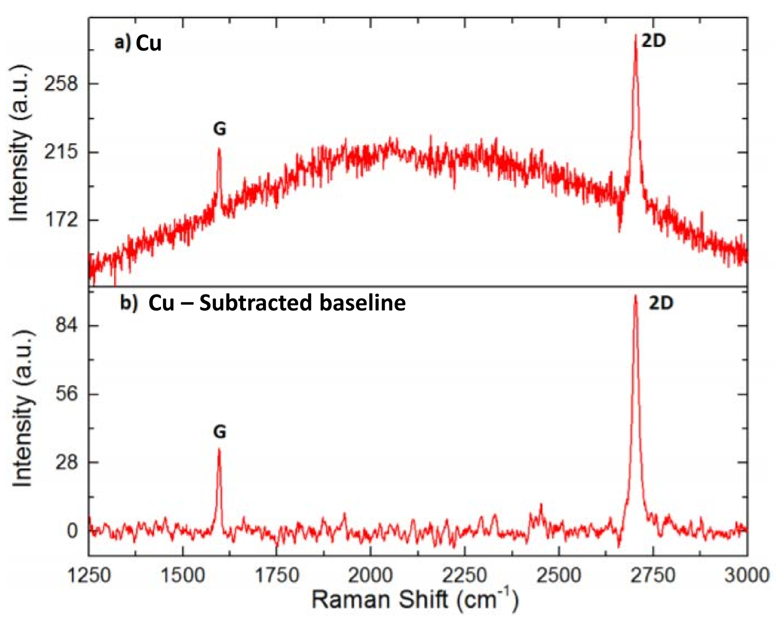
Methods

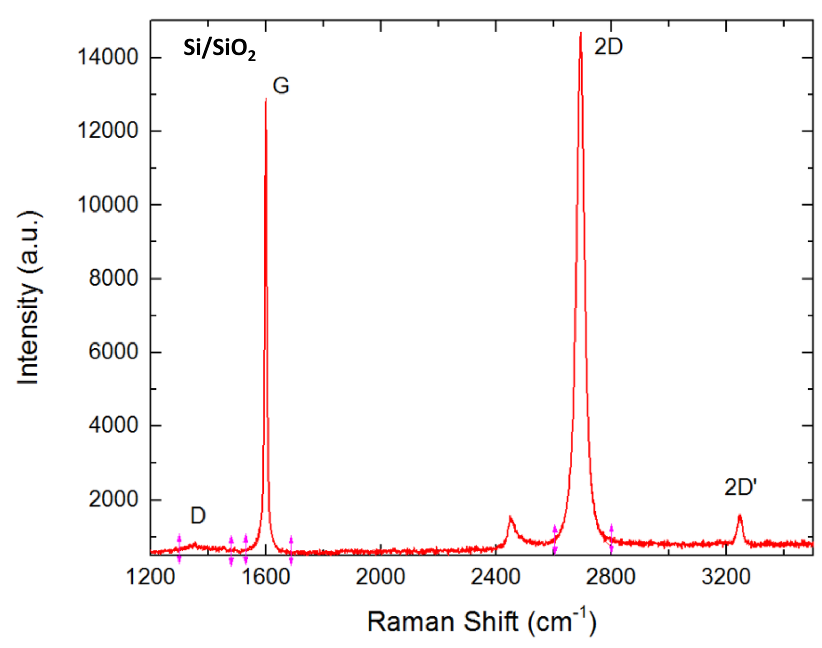
- Graphene was grown by chemical vapour deposition (CVD) onto a copper substrate and transferred by wet transfer methods onto a silicon substrate (Si/SiO_2).[3]





- Raman spectroscopy was used to confirm the presence of single layer and few layer graphene, as well as any potential defects on both Cu and Si/SiO_2.[4]

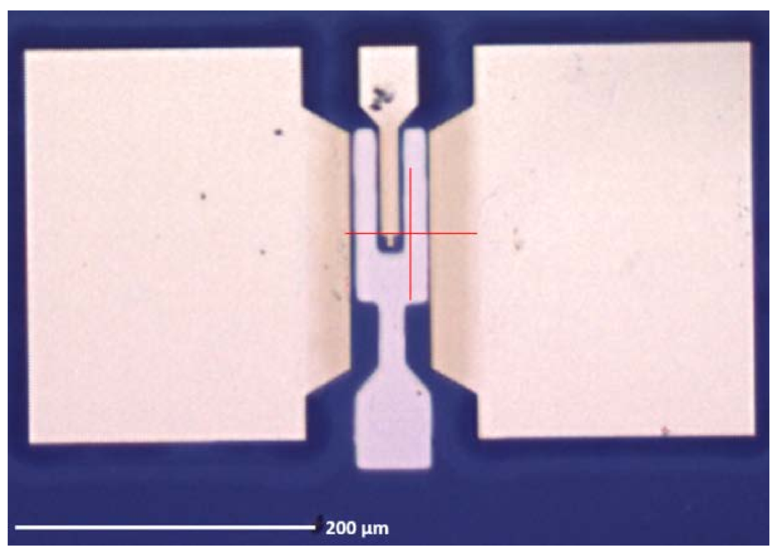


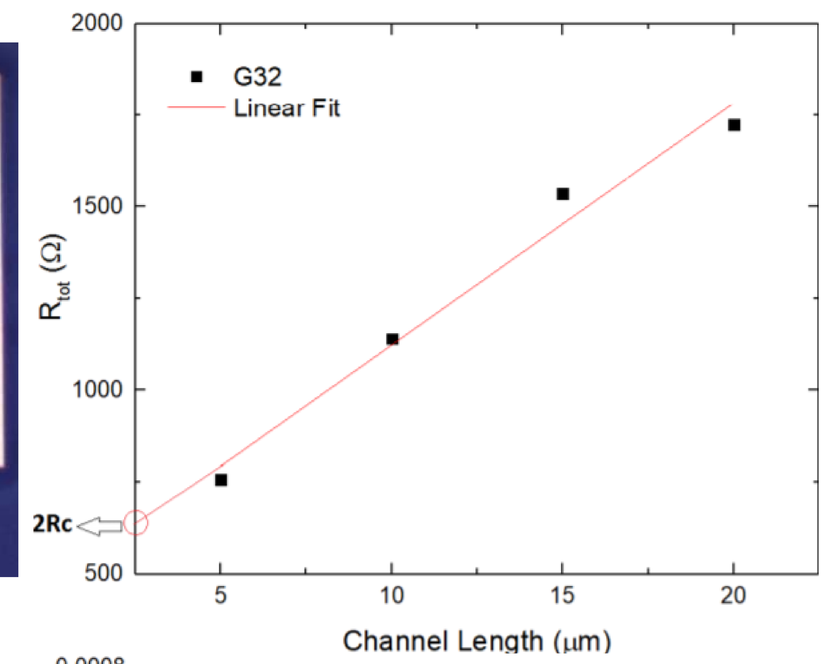


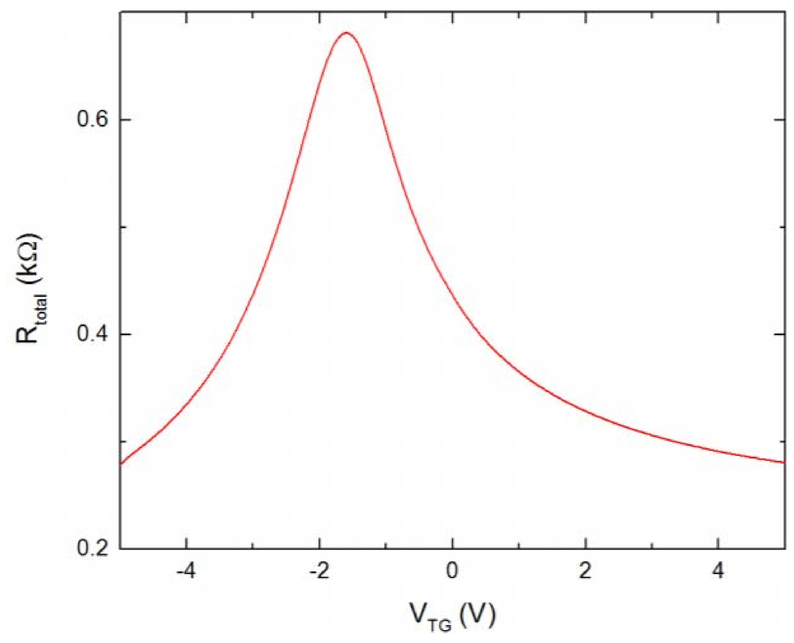
- A varying channel length, Hall bar, and coplanar waveguide graphene field effect transistor was fabricated *via* standard photolithography and dry (plasma) etching techniques.

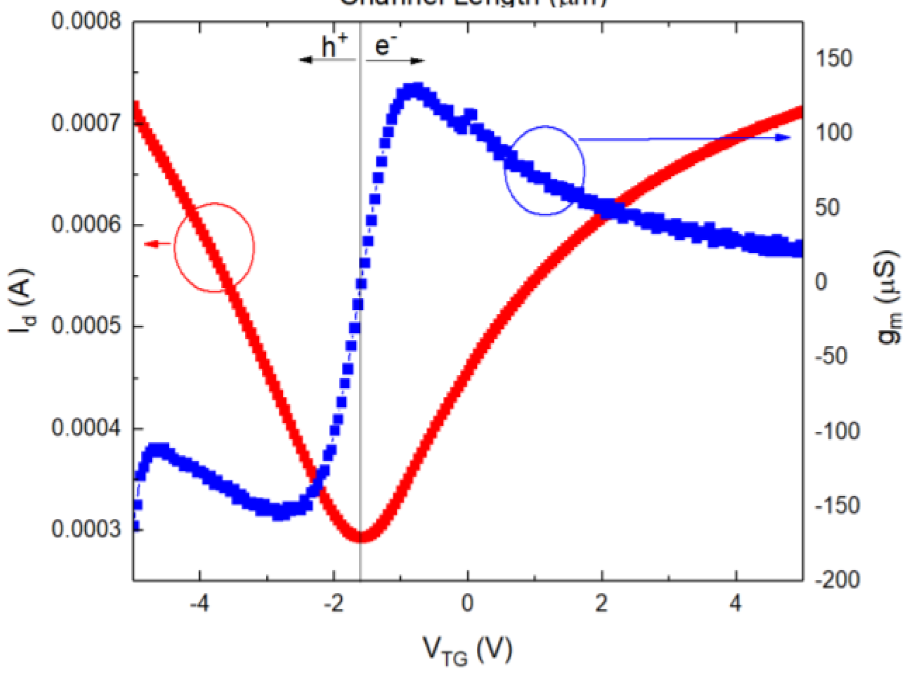
Results and Discussion

- Hall bar and transfer length devices were fabricated on the same chip to yield a contact resistance of 2.2 kΩ.μm and a hole mobility of ~ 2,000 $cm^2/V\,s$.

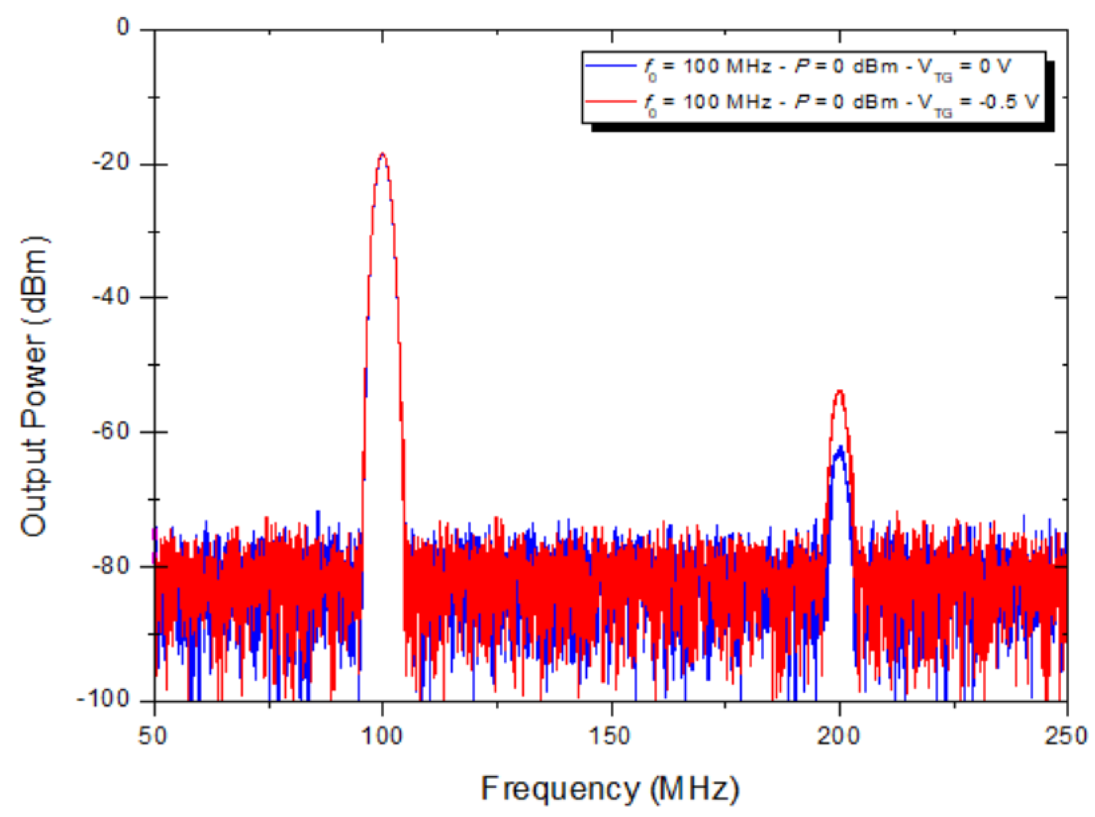








- A sinusoidal fundamental frequency of 100 MHz was input into the top gate of the CPW device.
- A doubled frequency was observed with a conversion efficiency of 30 % at zero gate voltage.
- At a gate voltage of -0.5 V the conversion efficiency increased to 34 %.



Conclusion

- GFET devices were fabricated and their electrical properties were extracted.
- A CPW GFET was used to measure the frequency doubling effect, which was found to be a function of the gate voltage.
- This work has demonstrated the potential use of graphene as a harmonic sensor for the potential detection of chemicals, such as glucose.

References

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Acknowledgments

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