Fabrication of Flexible Reduced Graphene Oxide Films for Capacitive Displacement Pressure Transducer

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Abstract

The long-term goal of this project is to synthesize a flexible graphene film to act as an electrode for a capacitive pressure transducer. This project was commissioned by Dwyer Instruments, Inc. to replace the silicon electrode in their miniature capacitive displacement pressure transducer. Replacing silicon with graphene should yield a pressure transducer that more accurately measures low pressures and has a larger dynamic range. The first step of this project is to convert graphite to graphite oxide (GO) using permanganate and hydrogen peroxide oxidation. The resulting GO powder has been characterized using x-ray diffraction and infrared spectroscopy. Several methods are being explored to reduce the GO to form a flexible graphene-containing film. One potential method is to soak sheets of paper in an aqueous GO solution, allow the water to evaporate, and then reduce the GO by heating the film in a 250 °C oven.

Background: Capacitive Pressure Transducer

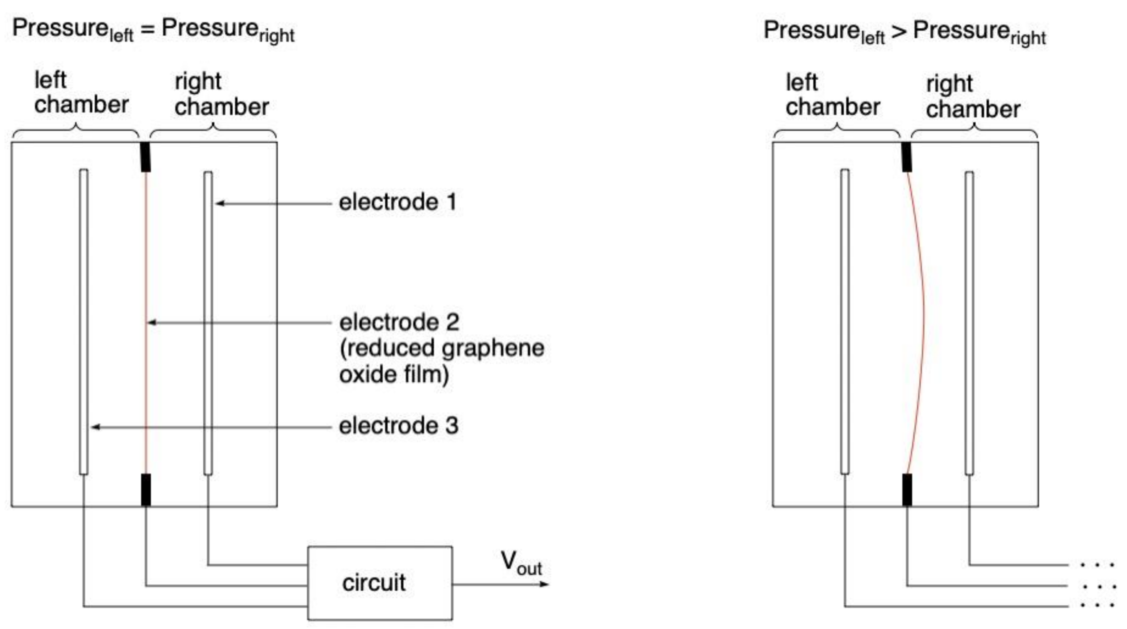
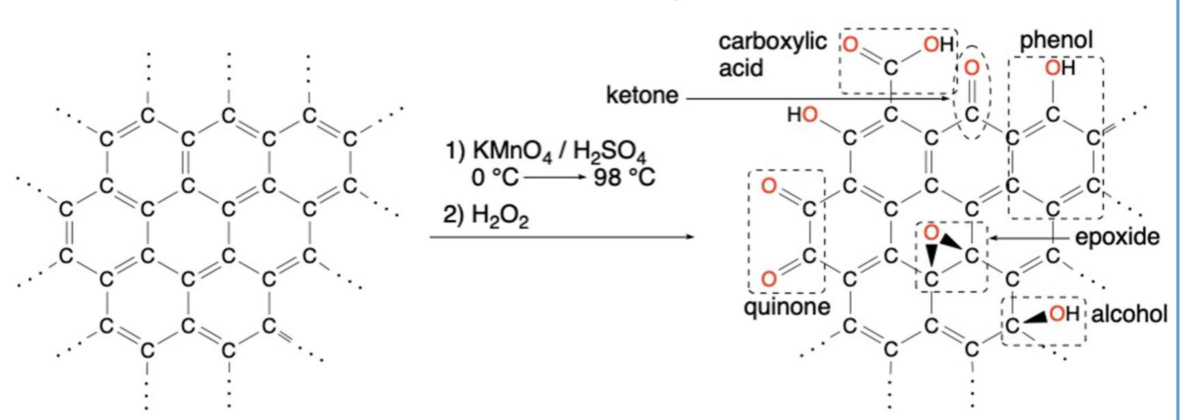


Figure 1: Capacitive Displacement Pressure Transducer

- Pressure change causes deflection of the flexible film which, in turn, causes a change in the relative capacitances of the left- and right-hand capacitors.
- Silicon film is suitable at pressures >10kPa but isn't sensitive enough for lower pressures.
- A flexible reduced graphene oxide film is potentially sensitive at low pressures while still retaining the strength to be used at higher pressures.

Methodology

Step 1: Conversion of graphite to GO



graphite graphene oxide (GO)

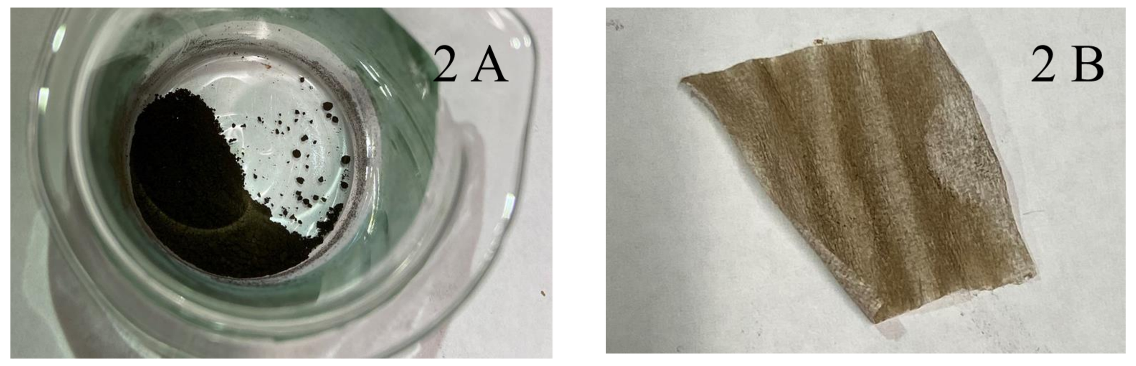
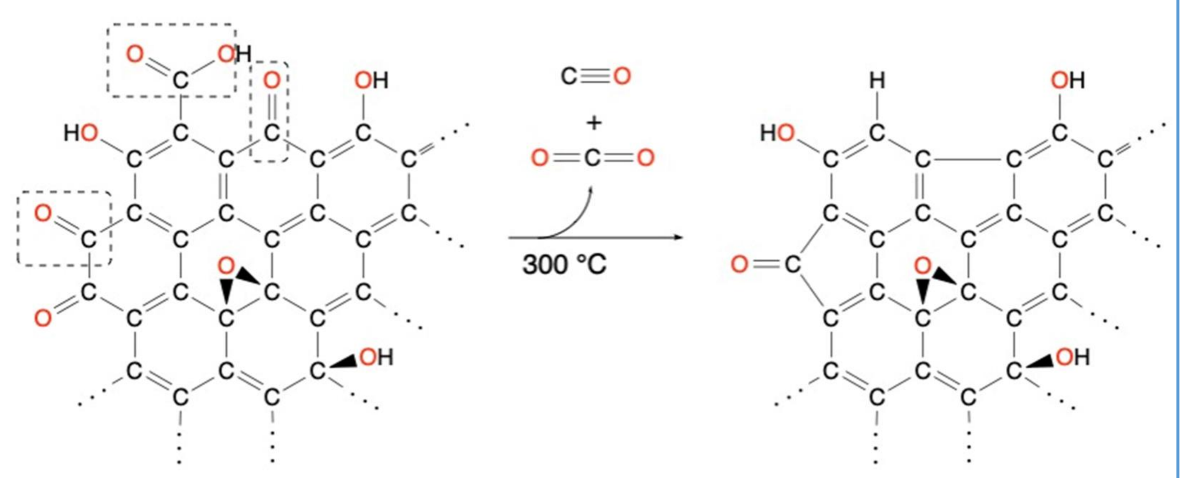


Figure 2: A) Graphene oxide (GO) B) Tissue paper soaked in GO solution, dried & cut into squares.

Step 2: Conversion of graphene oxide to reduced graphene oxide (rGO).



graphene oxide reduced graphene oxide (rGO)

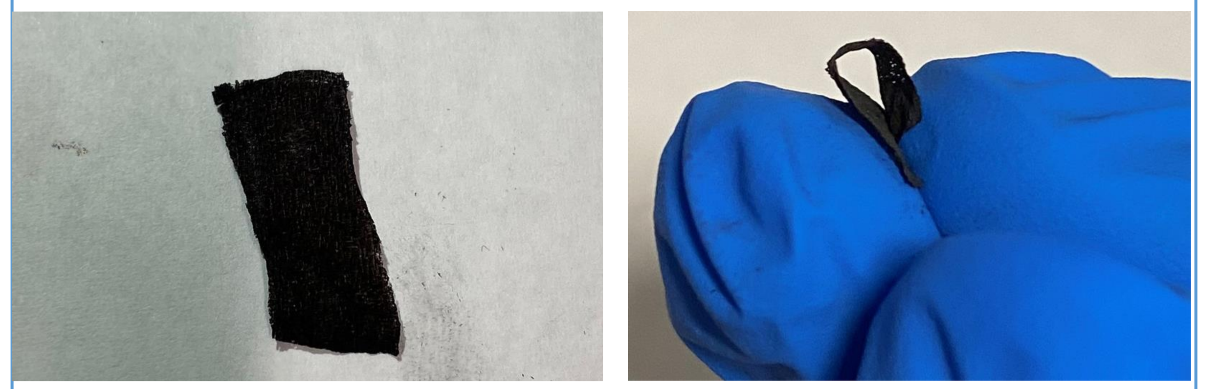


Figure 3 Flexible rGO film after reduction in tube furnace.

Results

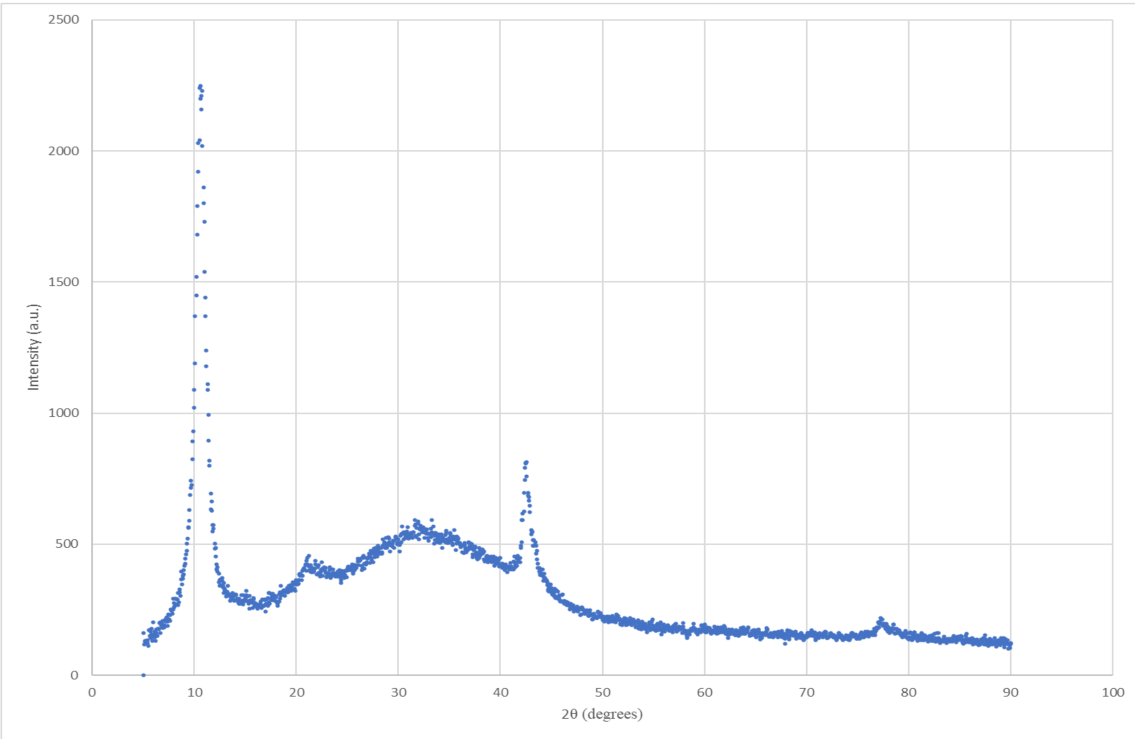


Figure 4: X-ray diffraction (XRD) spectrum for graphene oxide (GO)

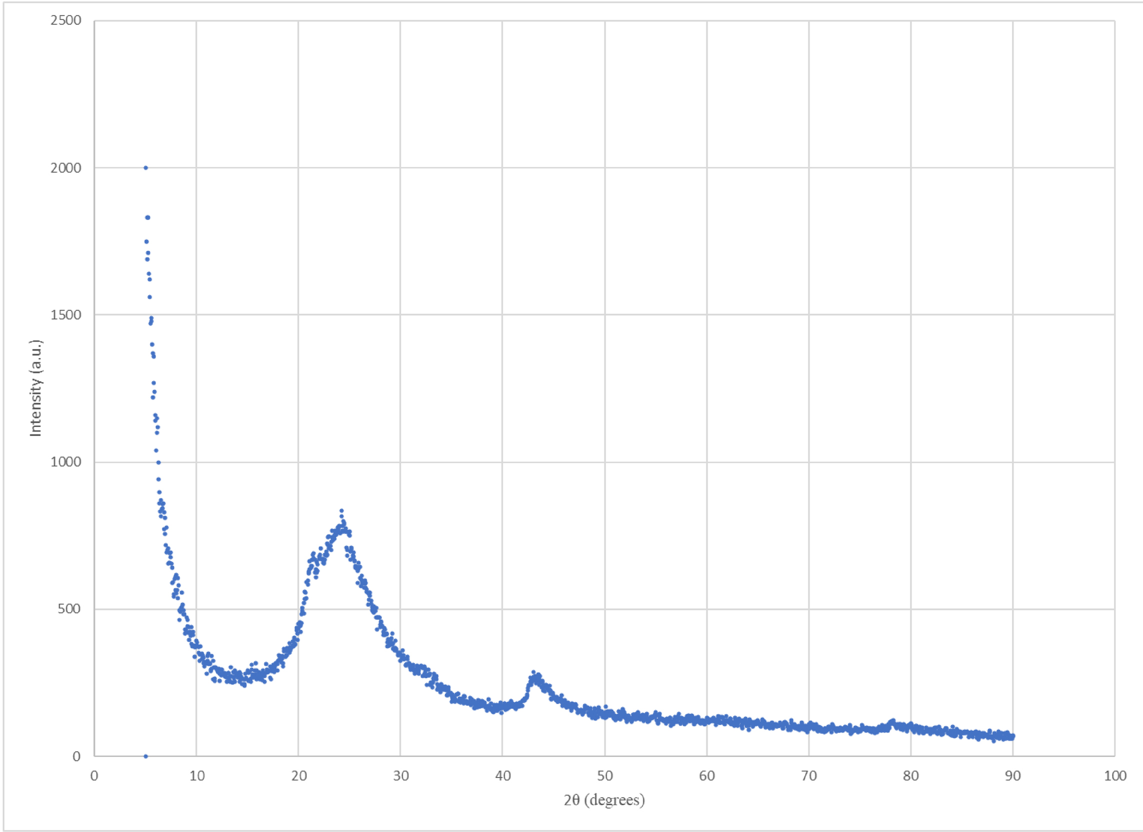


Figure 5: XRD spectrum for reduced graphene oxide (rGO)

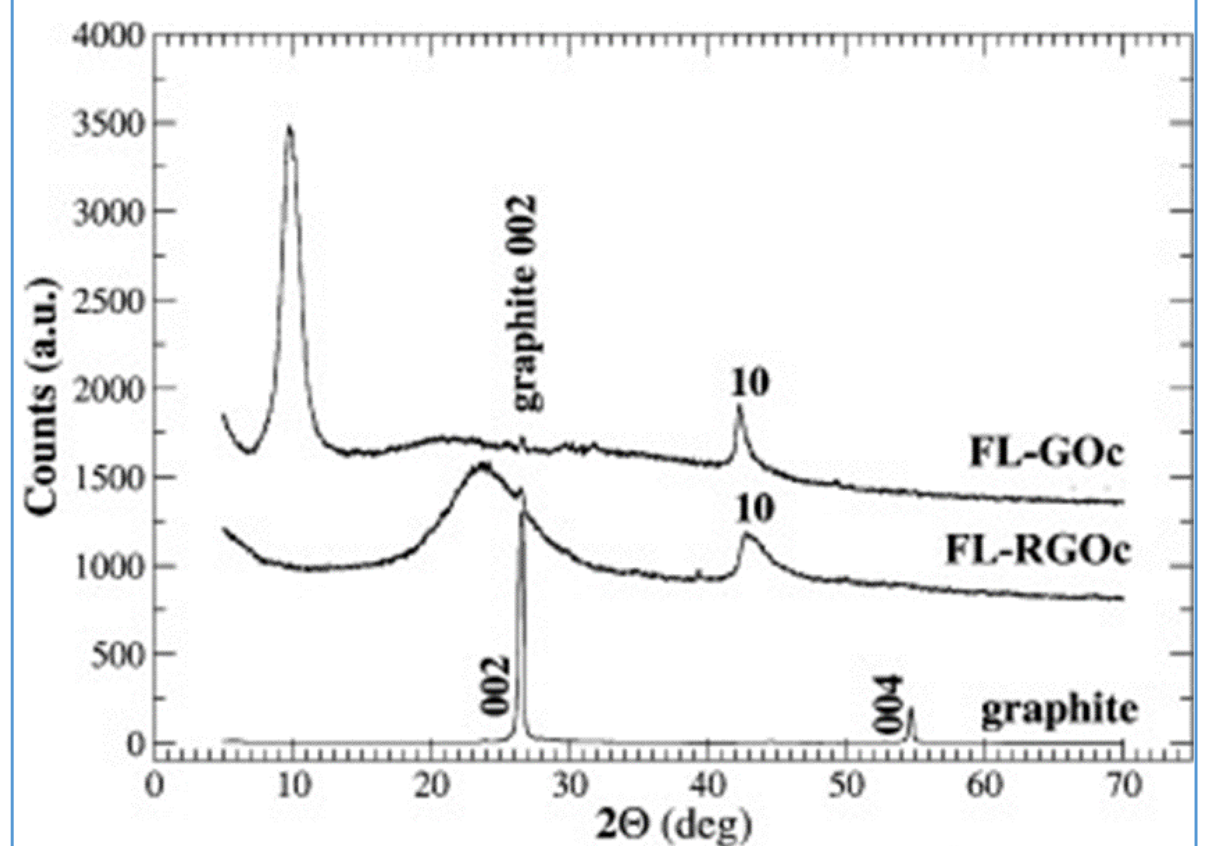


Figure 6: Literature XRD results[3]

Conclusions

- The angular location of the peaks for the GO sample match the GO peaks from the literature indicating that the synthesis was successful.
- The angular location of the peaks from the sample that was heat treated in the tube furnace match the literature values for rGO. This indicates that the reduction was successful.
- More testing needs to be done in order to determine if the rGO film has the desired elastic properties for the application.

References

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2. Tao Lu-Qi, Zhang Kun-Ning, Tian He, et al. 2017. "Graphene-Paper Pressure Sensor for Detecting Human Motions*." ACS Nano* **11**, 8790-8795.
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