Graphene for Use in Energy Storage Systems

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Overview

- Graphene
- Capacitors
- Process for Graphene Growth
- Plasma
- Experimental Plan
- Characterization
- Future Work
- Acknowledgements

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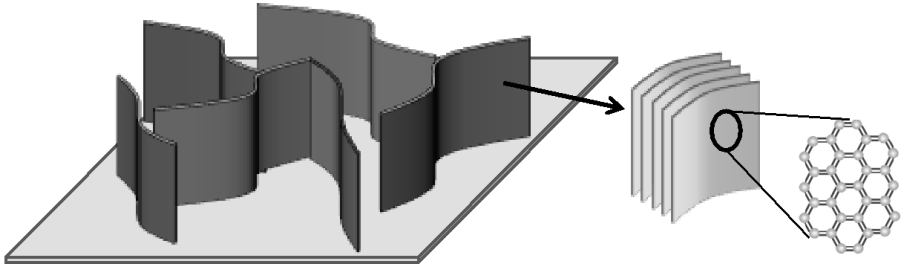
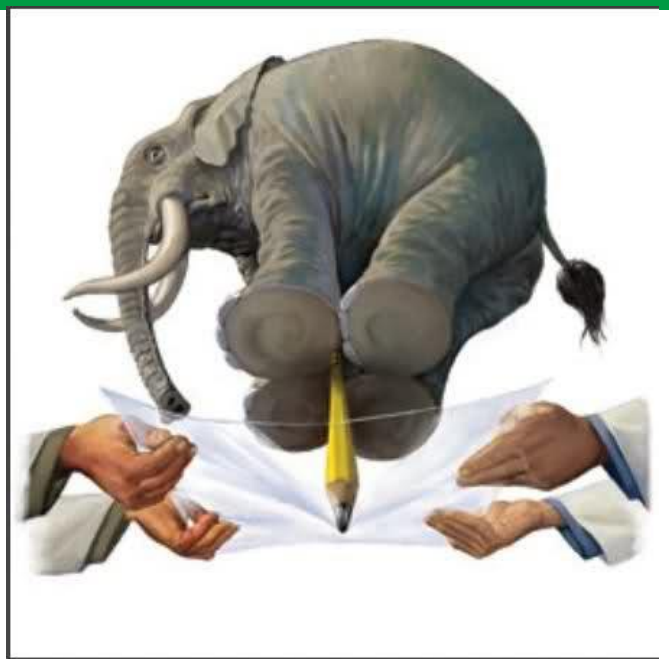
Graphene

- Graphene is a 2-Dimensional nanomaterial with excellent electrical, thermal, and mechanical properties





- This project undertakes the task of growing vertically aligned graphene nanowalls to be used in supercapacitors

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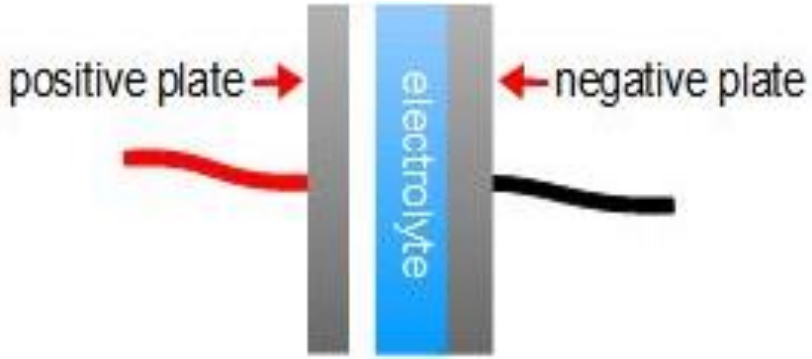
Capacitors

- A capacitor is an electrical component that stores a charge in an electric field



- Graphene walls can be used coat the electrodes

$$C = \varepsilon \frac{A}{d}$$

- Supercapacitors can store 10-100 times as much energy

Process for Graphene Growth

- A sample substrate is placed in a plasma enhanced chemical vapor deposition chamber
- A methane (CH_4) feedstock is introduced, followed by an RF power source to create a plasma, inducing graphene growth

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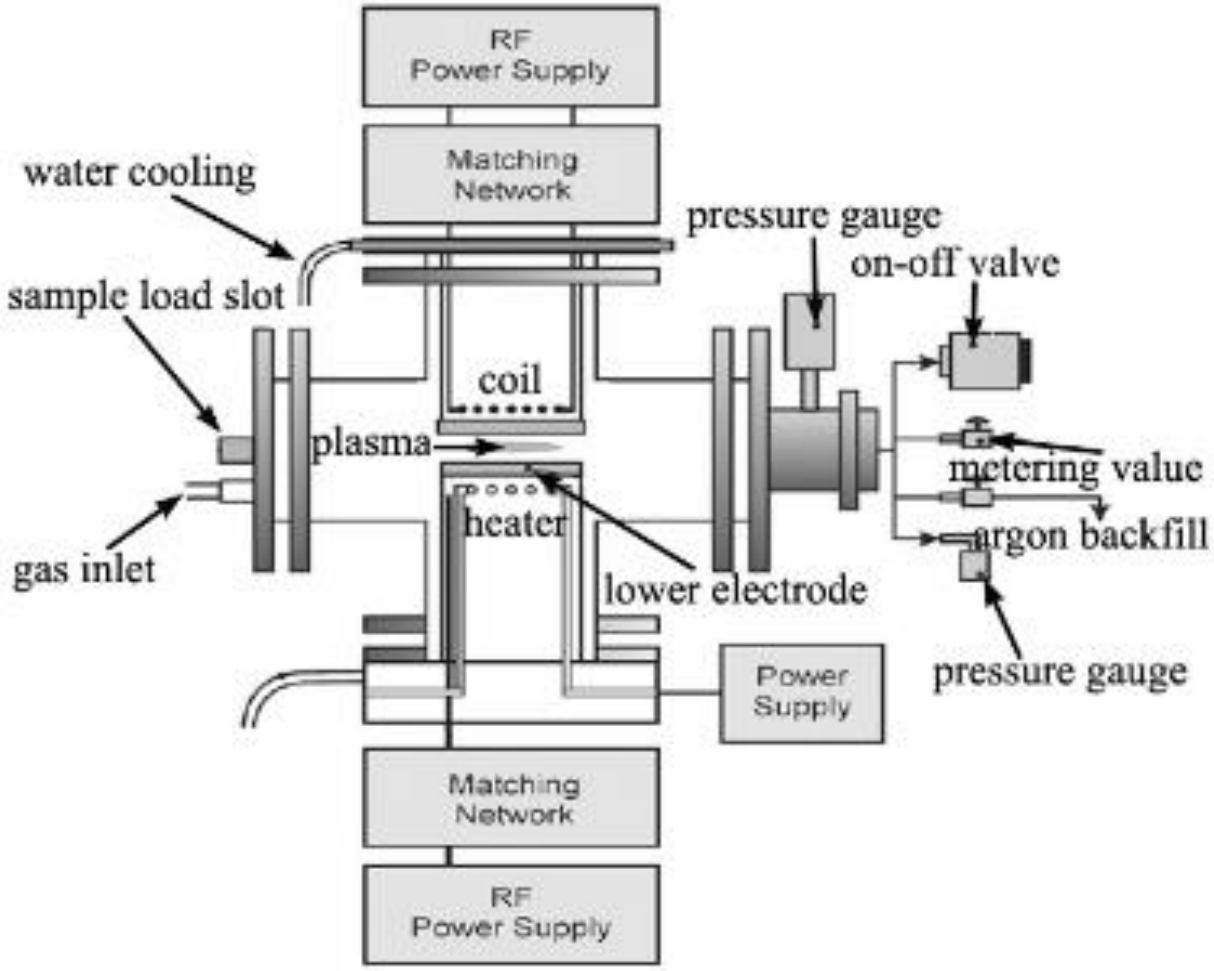
Plasma Enhanced Chemical Vapor Deposition



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Plasma

- Plasma is an abundant state of matter in the universe
- Caused by the ionization of a gas, forcing electrons to occupy higher orbitals
- This is achieved in PECVD by heating the system and applying an RF source, creating an alternating electric field

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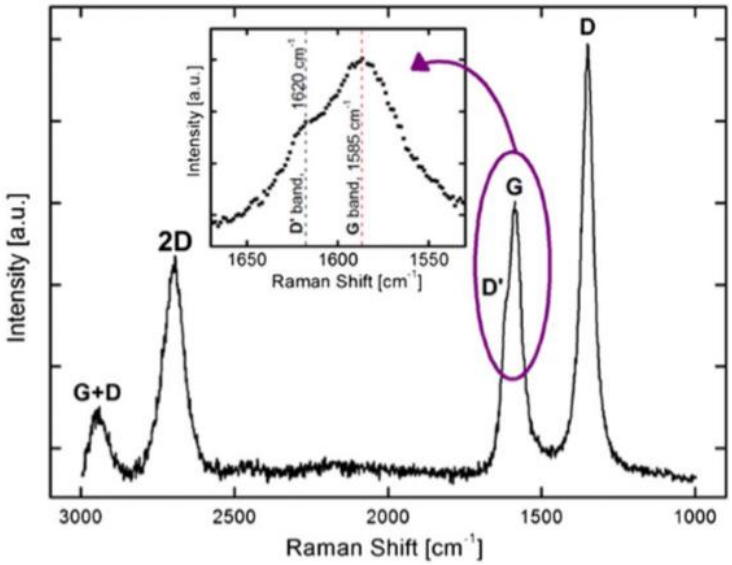
Experimental Plan

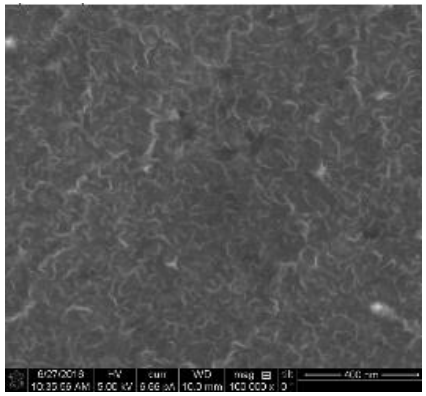
A temperature of 750 ˚C is maintained within the PECVD reactor while the methane feedstock flows at 10, 15, or 20 sccm. Furthermore, a 13.56 MHz RF source provides a constant power of 200, 250, and 300 W. This results in 18 unique combinations of growth conditions between the Ni and FeCrAl substrates. The results of each growth are then analyzed to determine the optimum growth conditions for vertically aligned graphene

Characterization

- Raman Spectroscopy is used to examine the substrate for peaks in the Raman Shift, indicating vertically aligned graphene

- Further imaging is accomplished with SEM analysis





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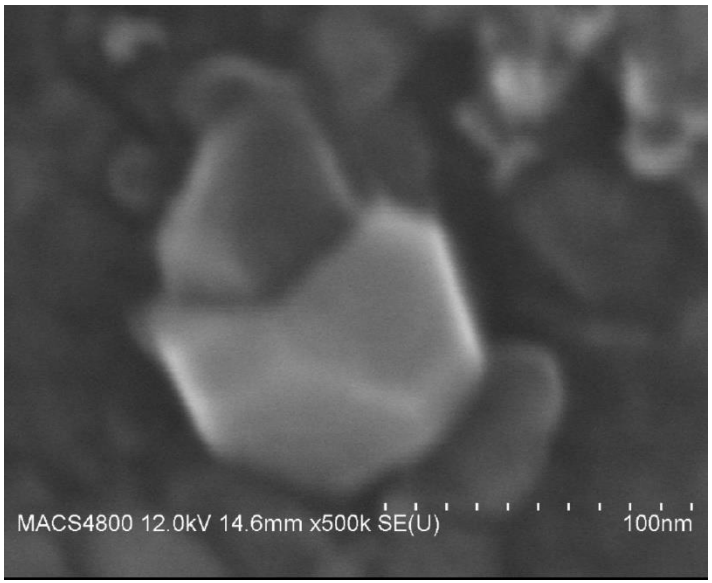
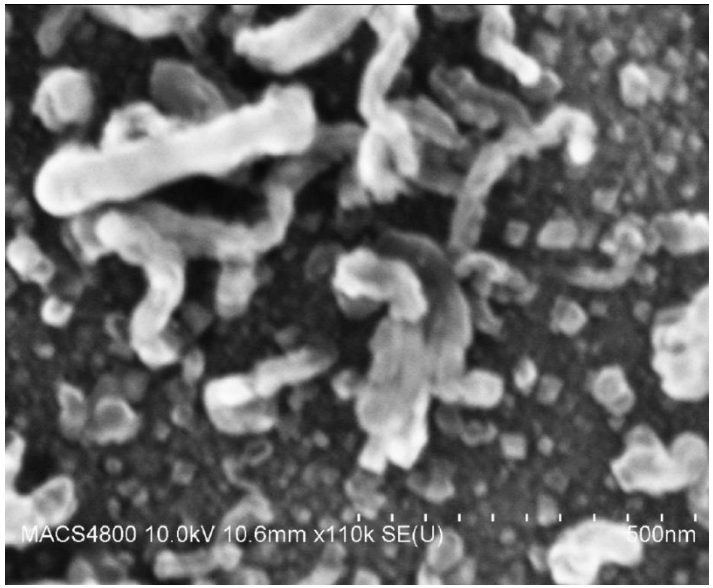
Future Work

Going forward, the next step will be to consider growth on other substrates and at different conditions. It is also worth considering the possibility of photons within the plasma having an effect on graphene growth.





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