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Designing & Building a Microwave Plasma Reactor for Graphene Synthesis

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Designing & Building a Microwave Plasma Chemical Vapor Deposition Reactor for Graphene Synthesis

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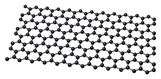
Background

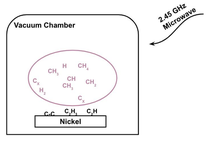
Graphene is a single layer of sp^2 hybridized carbon atoms arranged in a hexagonal lattice. Its extreme thinness and molecular structure give rise to a unique combination of outstanding electrical, optical, and mechanical properties that will revolutionize technology.



However, manufacturing graphene is an elusive task.

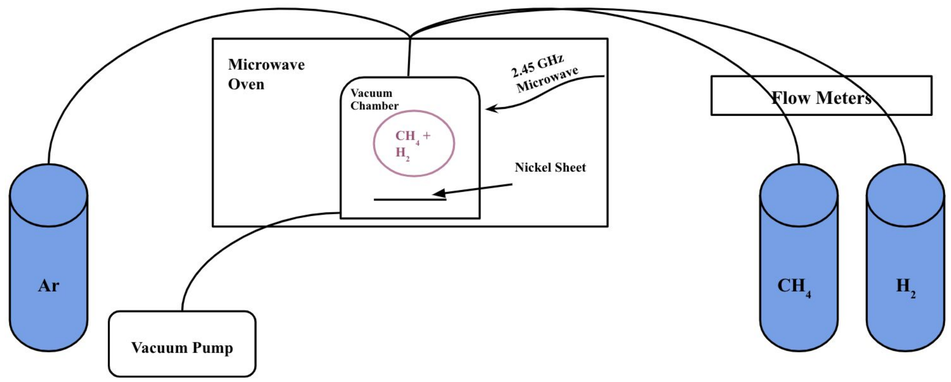
Introduction

Microwave plasma chemical vapor deposition (MPCVD) is a promising graphene production method. MPCVD utilizes microwaves to generate a plasma which deposits its contents onto a substrate. Here, methane and hydrogen plasma is harnessed to form graphene sheets on a nickel substrate.



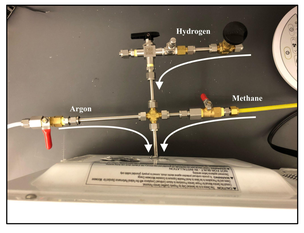
Methane has a low dissociation bond energy, which increases formation of reactive carbon species that bond with the substrate. Hydrogen catalyzes carbon activation by dehydrogenation of methane. Nickel is carbon-soluble, which enhances graphene growth and promotes crystallinity of the graphene film.

Microwave Plasma Reactor Design

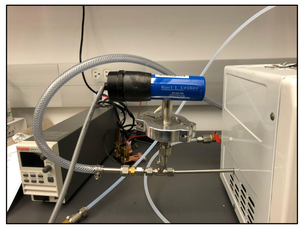


Deposition Chamber

Gas Inlets



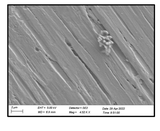
Vacuum Gauge & Inlet



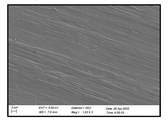
Results

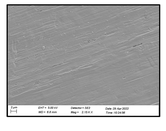
Microwave Plasma

Scanning Electron Microscopy



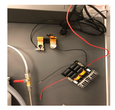
Bare Nickel Substrate





Deposition Samples

Forthcoming Work



Enhance the formation of reactive carbon species by inducing a voltage in the plasma, thereby increasing particle-collisions.

Measure the system temperature with a thermocouple as a precursor to depositing graphene on insulating substrates like plastic or glass that would melt at high temperatures.

Utilize machine learning algorithms to predict the optimal parameters for graphene production.

Acknowledgements

I would like to thank Dr. Jerry LaRue for allowing me to establish this project in his lab – despite its unrelatedness to his research agenda – and for the freedom to pursue it limitlessly.