Characterizing Liquid Exfoliated Graphene Films for Anti-Corrosive Coatings

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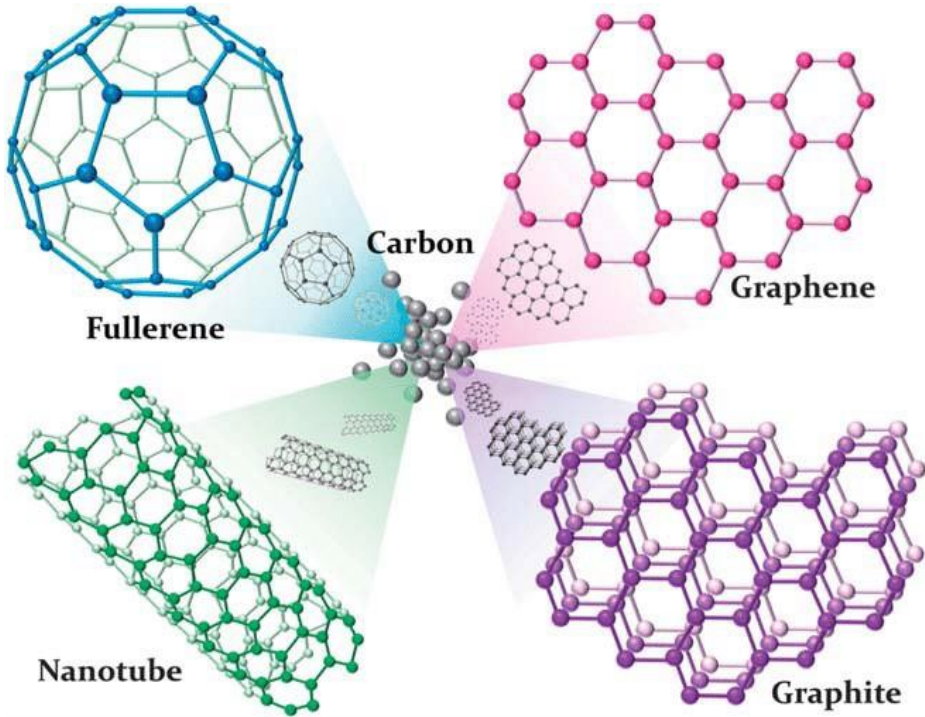
2022 REU Portland State University Symposium

Overview

- Background on graphene and graphene coatings

- Our solution for developing graphene film for coatings

- Techniques of Raman spectroscopy, SEM, and optical microscopy were used for characterization

- Analysis of the graphene films, gathered from characterizing

What is graphene?

Honeycomb like sheet of sp2 bonded carbon atoms, each one atom thick

Graphene coatings

- High thermal and electrical conductivity
- Strong chemical inertness
- Anti-corrosive properties

Cheng, Liang-Chien & Jiang, Xiu-mei & Wang, Jing & Chen, Chunying & Liu, Ru-Shi. (2013). Nano-bio effects: Interaction of nanomaterials with cells. Nanoscale. 5. 10.1039/c3nr34276j.

# Our method for developing a graphene film: Thermal Expansion & Liquid Exfoliation

- Sonicate expanded graphite in N-Methyl-2-Pyrollidone (NMP) solution to create exfoliated graphene flakes (EGFs)

- Thermal expansion occurs in a tube furnace, heated to 1000 °C

- Centrifuged to separate EGFs from NMP

Expansion

heat

Exfoliation

Centrifugation

Dispersion

Coating
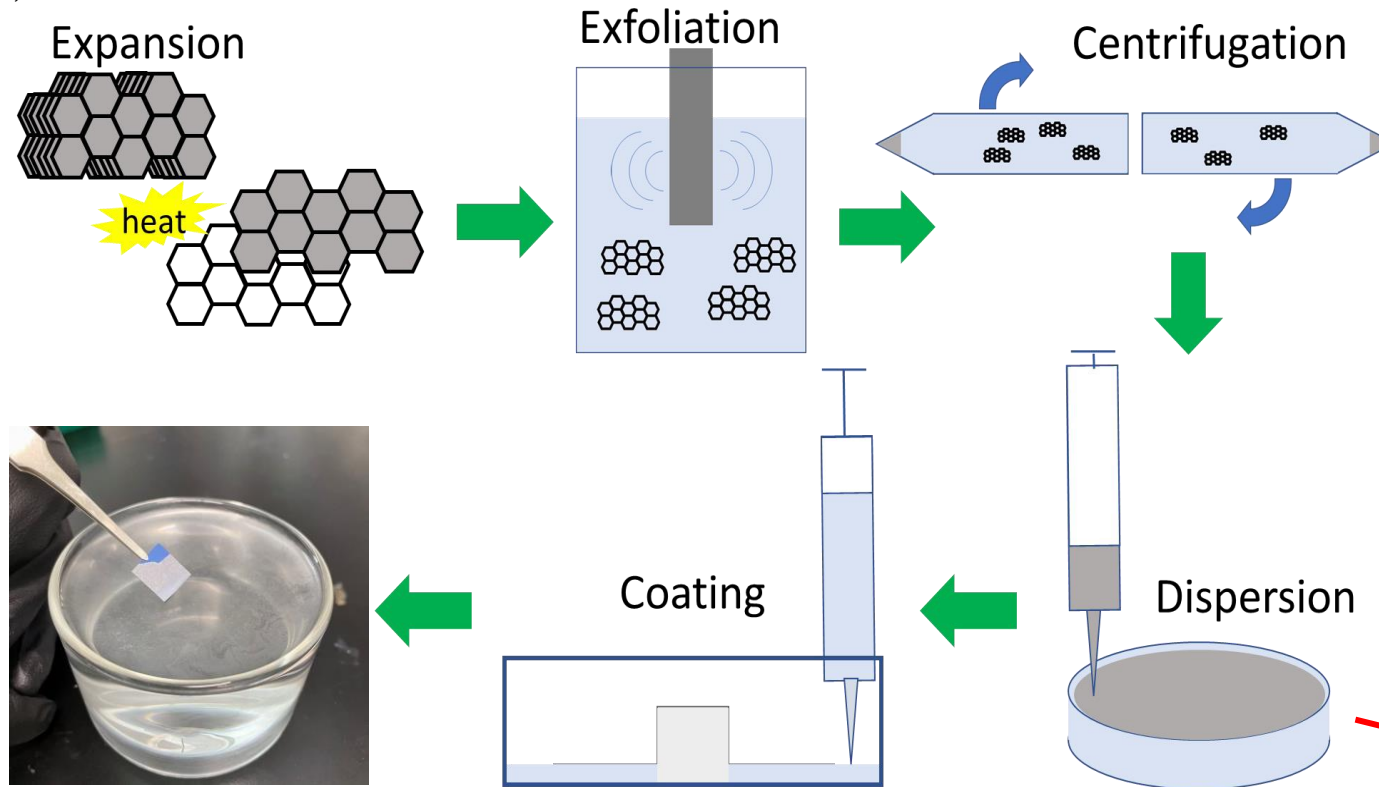
- Coated by dipping a silicon wafer under the film on the water surface

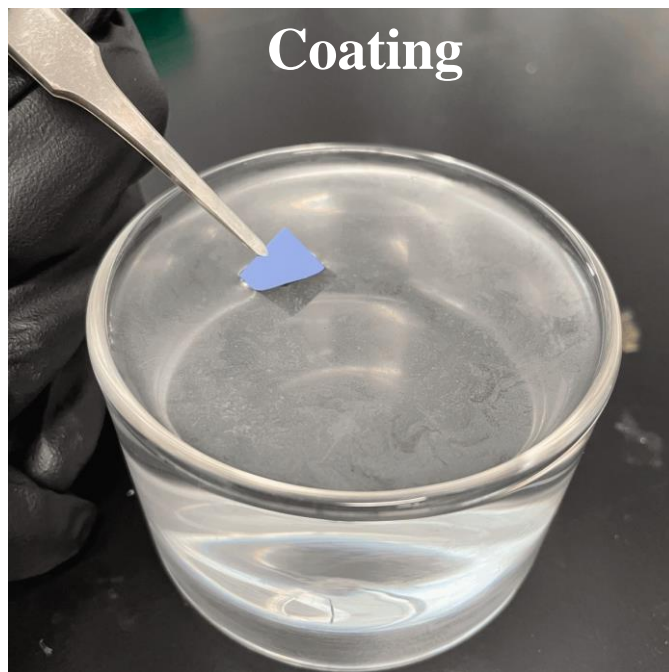- Dispersed EGF/EtOH solution on a petri dish filled with DI water to create a film

Visuals of each stage
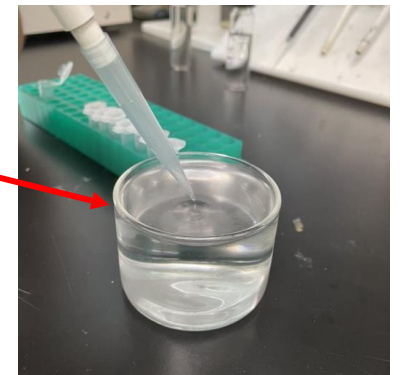
Expandable Graphite (Precursor)
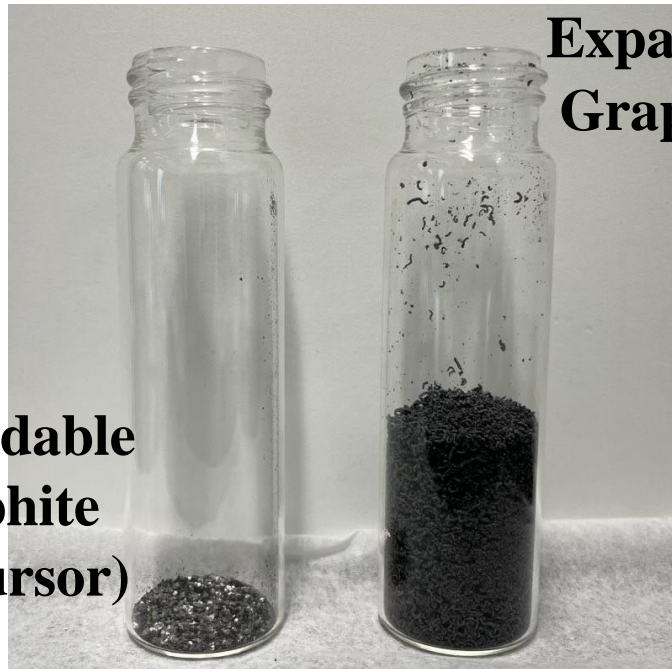
Expanded Graphite

EGF/NMP solution after sonication
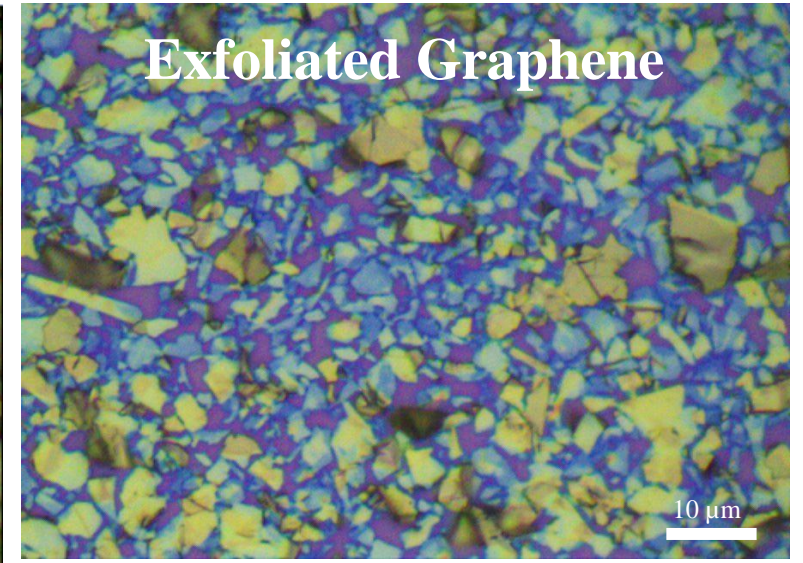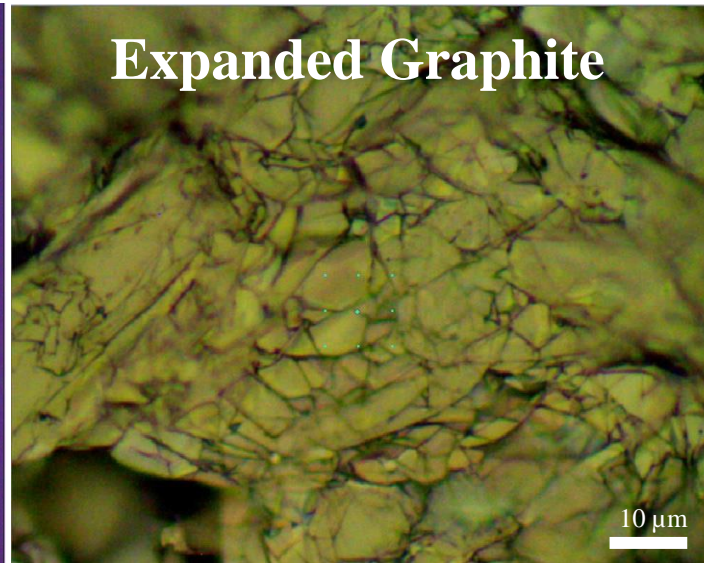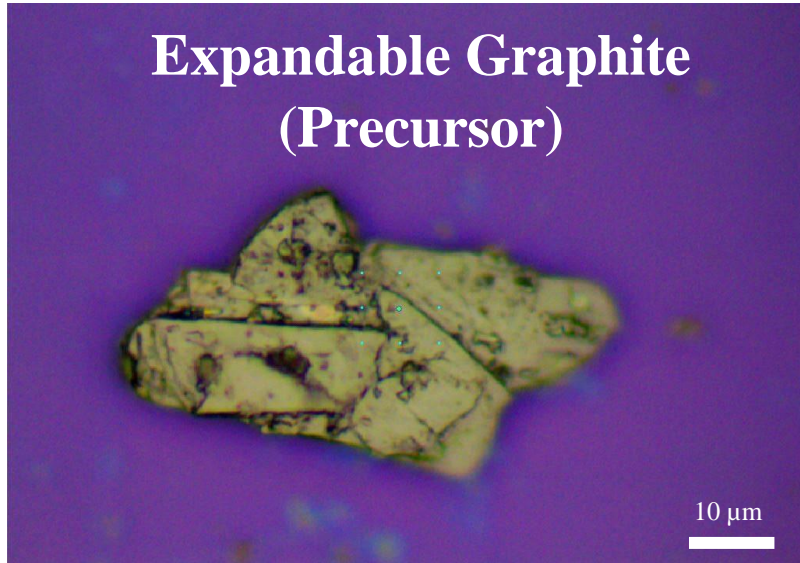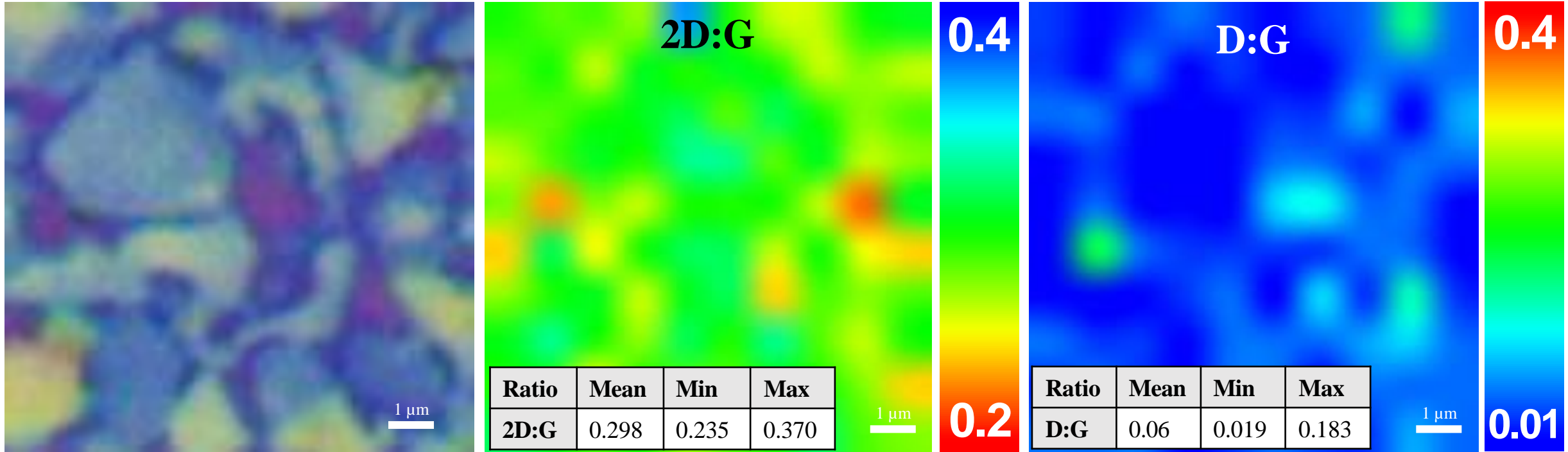
Coating
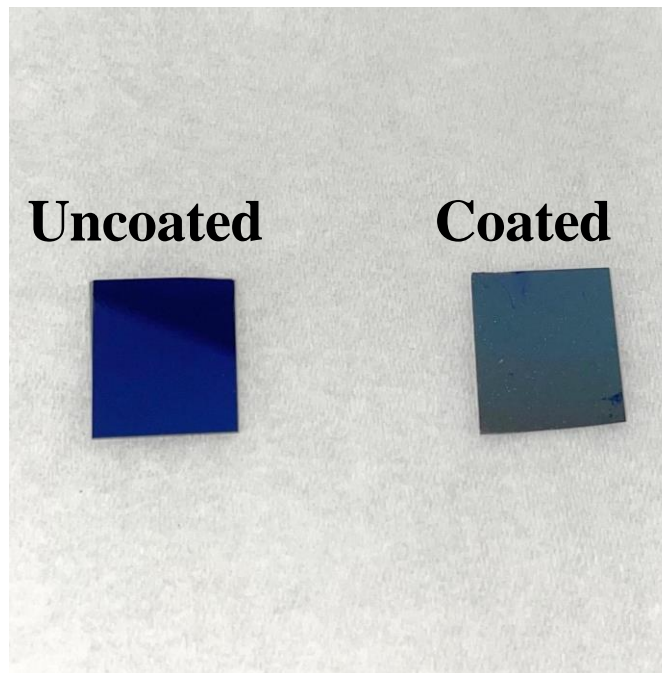
Uncoated

Coated

Raman Spectroscopy
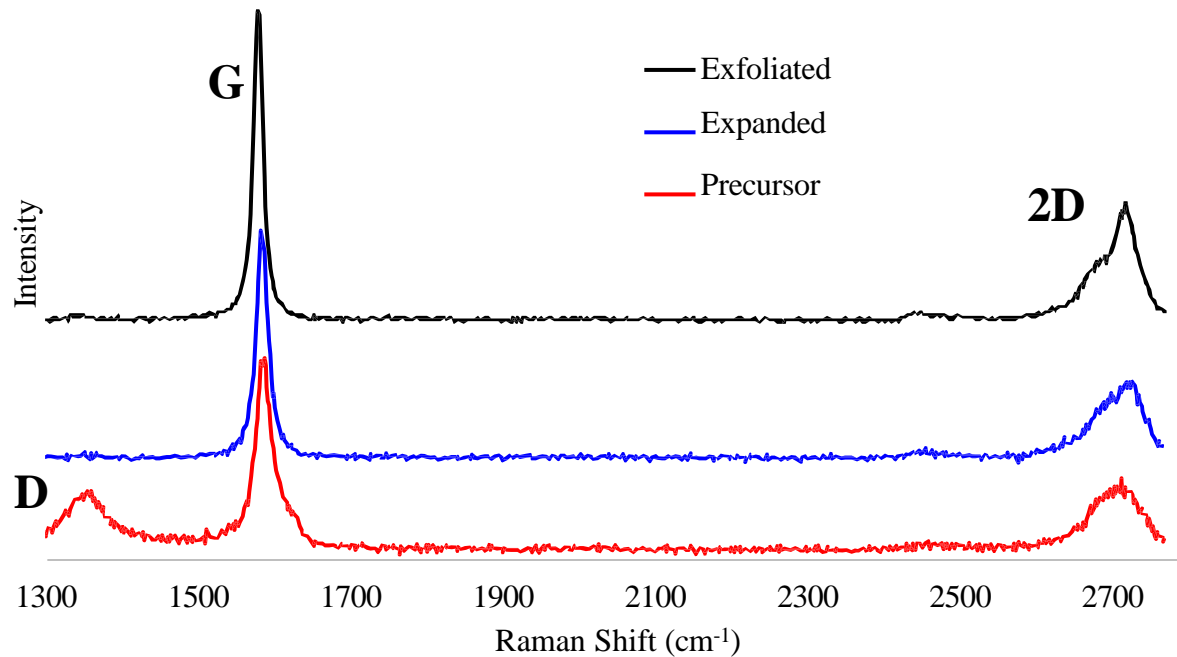
- Raman spectroscopy was used to characterize the properties of individual exfoliated graphene flakes
- The ratios of 2D:G and D:G peaks can determine the thickness and defectiveness of EGFs
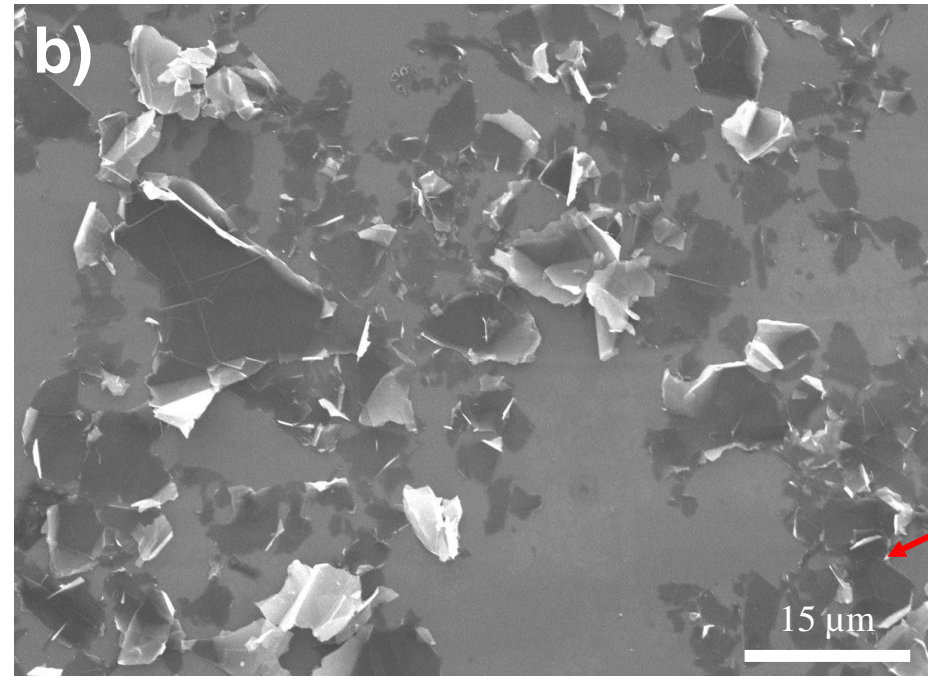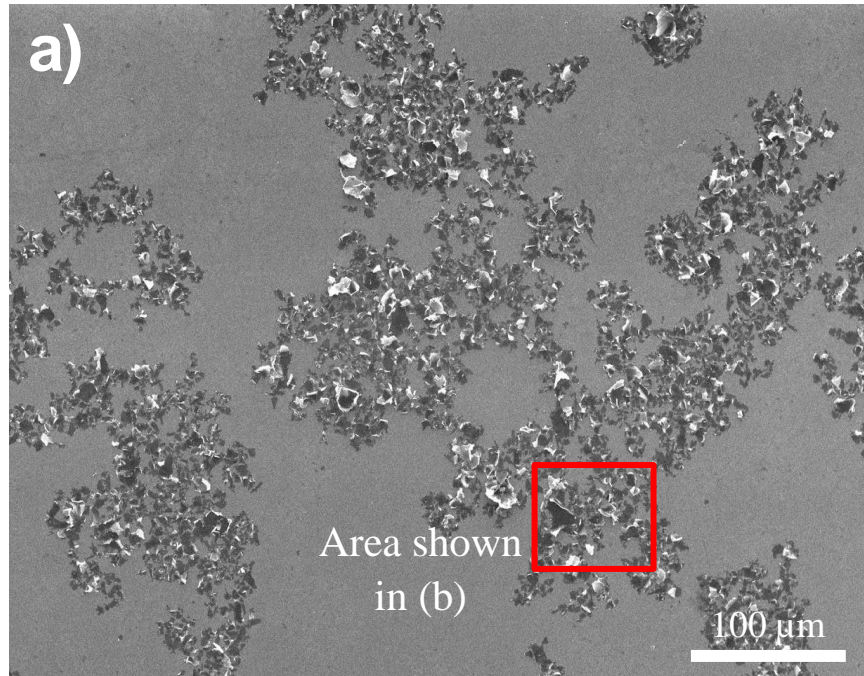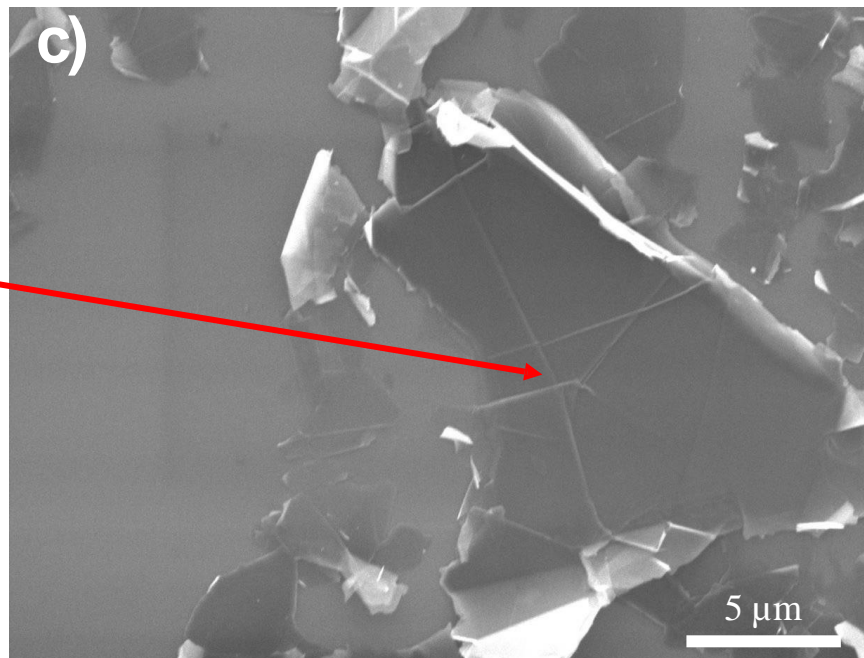
Mapped Graphene Film Using Raman Spectroscopy

100 spectra mapped in a
10x10 µm² array

2D:G

Ratio	Mean	Min	Max
2D:G	0.298	0.235	0.370

D:G

Ratio	Mean	Min	Max
D:G	0.06	0.019	0.183

SEM Images

a) Area shown in (b)

100 µm

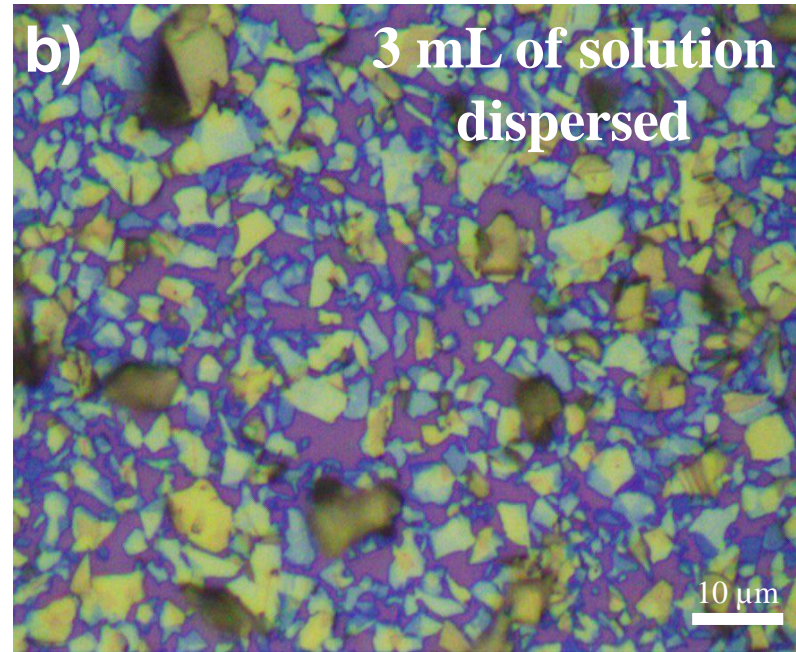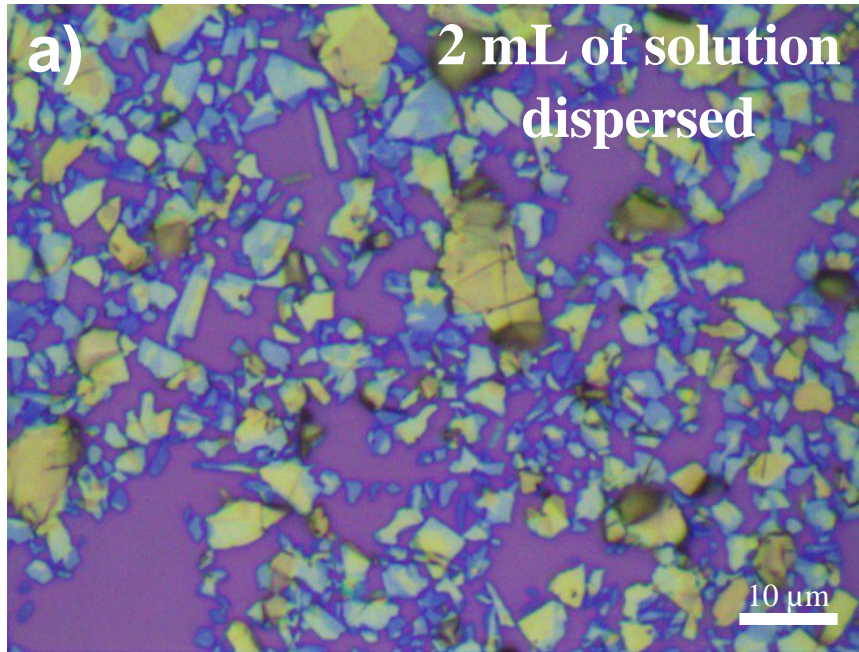b) Overlapping & stacking of flakes
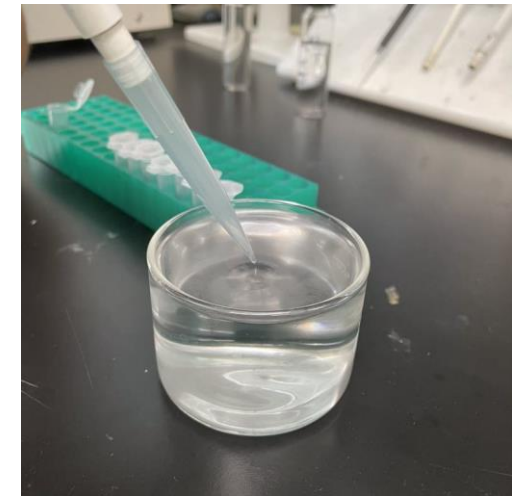
15 µm

c) Edges from stacked flakes or wrinkles

5 µm

d) Thin flakes

2.5 µm
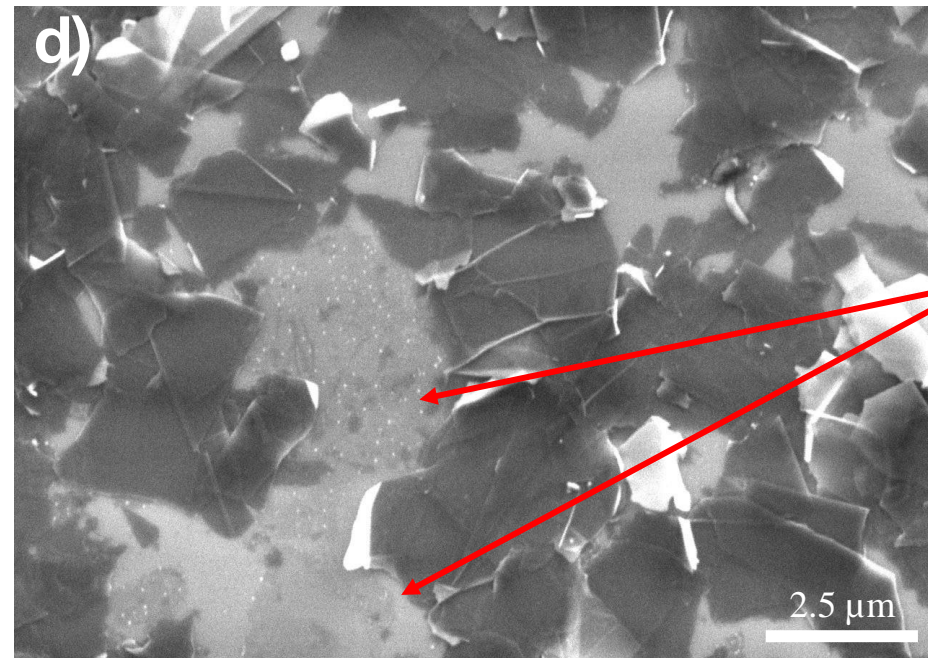
Increasing density of graphene film as more solution is dispersed

a) 2 mL of solution dispersed

10 μm

b) 3 mL of solution dispersed

10 μm

c) 7 mL of solution dispersed

10 μm
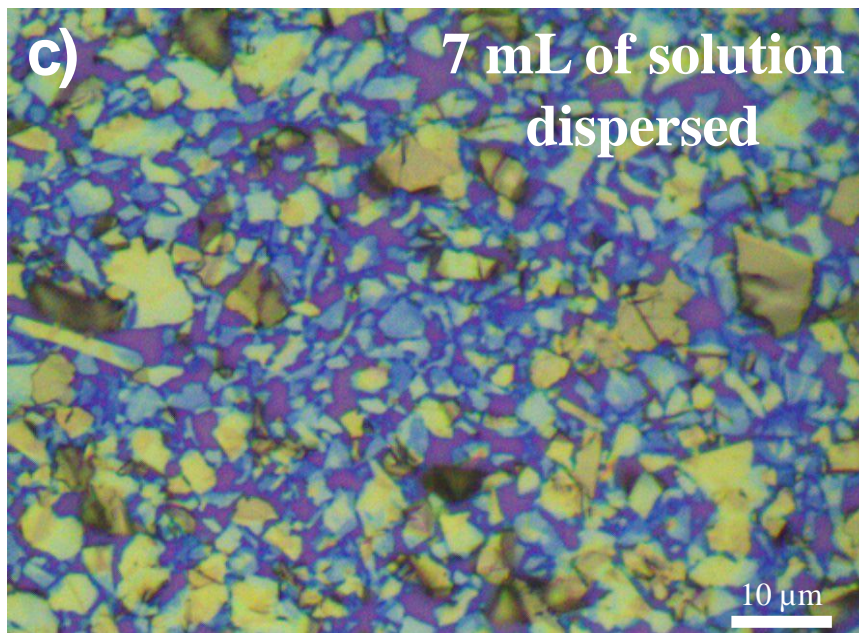
Concentration of EGF/EtOH solution is 1 mg/1 mL

After every 1 mL of solution added, a sample was coated from the same film

Summary & Future Work

- Graphene films developed through thermal expansion and liquid exfoliation.

- Samples were coated with graphene films characterizing the graphene.

- Characterization techniques such as Raman spectroscopy, SEM, and optical microscopy were used.

- It was shown that the higher the density of graphene film, the better the coverage. More coverage would provide better protection and thinner films will be more flexible for coatings.

- Current research involves working with anti-corrosive coatings for additive manufactured steel.

Acknowledgments

Thank you & Questions?