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Synthesis and Characterization of Graphene oxide Polydopamine Aerogels for Contaminant Removal in Water

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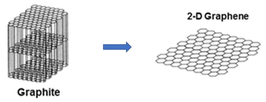
Background

- Graphene, a two dimensional nanomaterial, emerged as a highly efficient adsorbent for removing contaminants from water and wastewater



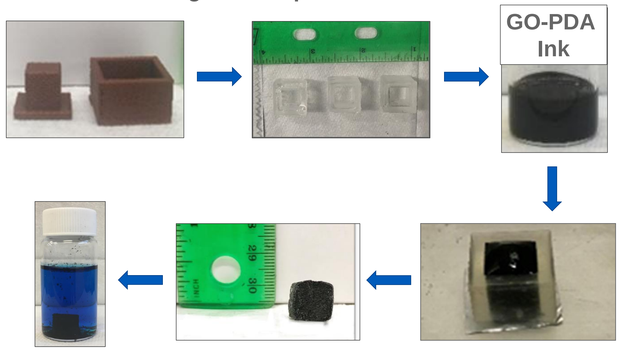
- Graphene needs to be assembled into architecturally controllable monolithic structures to:
  - Incorporate into functional water treatment devices
  - Resist release of graphene into treated water

Objective

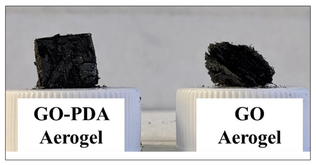
- Utilize bio-inspired polymer (polydopamine) modified graphene to synthesize monolithic aerogels with controllable architecture using 3D printed mold
- Characterize physiochemical properties of the synthesized graphene oxide-polydopamine (GO-PDA) aerogel
- Evaluate the removal capacity for a range of contaminants

Method

- **Freeze casting with 3D printed molds**

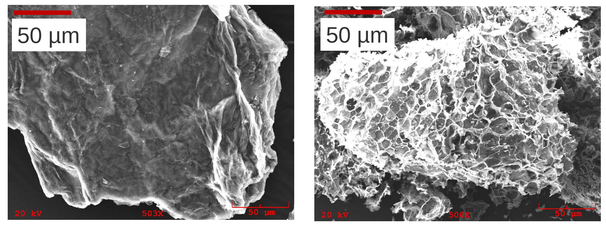


- **PDA helps to provide structural integrity to the aerogel**



Characterization

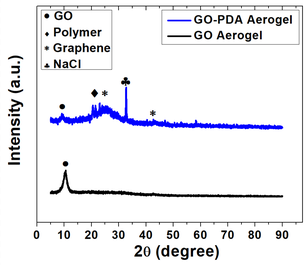
Scanning Electron Microscope Image



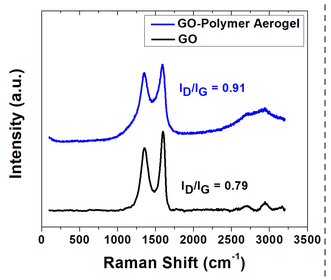
Graphene Oxide **Graphene Polymer Aerogel**

More porous network in graphene polymer aerogel

X-Ray Diffraction Spectroscopy



Raman Spectroscopy

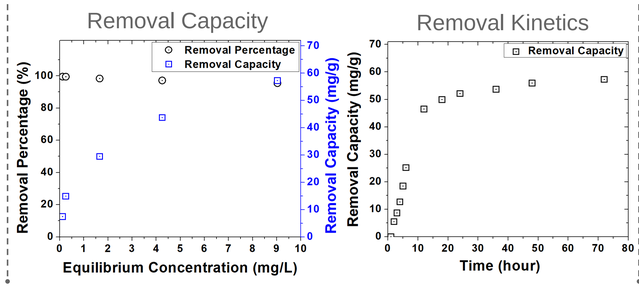


Confirms chemical bond between graphene and PDA

Contaminant Removal

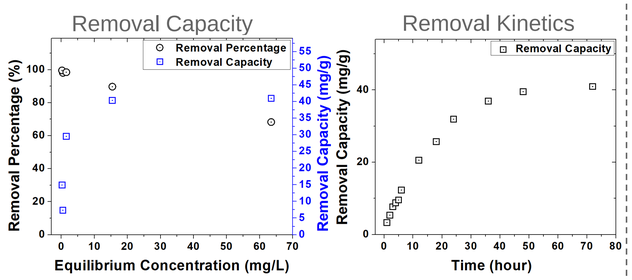
Dye Removal:

Methylene Blue (MB) - Cationic Dye



Highest Removal Capacity 57.29 mg/g

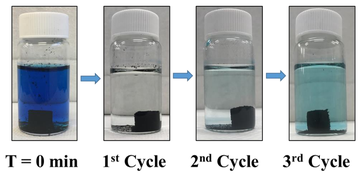
Evans Blue (EB) - Anionic Dye



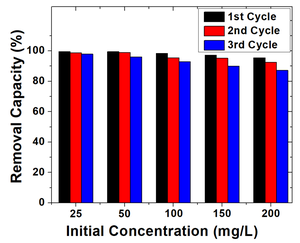
Highest Removal Capacity 40.96 mg/g

Recycling of Aerogel for MB Removal

- **Desorption:** Ethanol (pH 2) solution for 24 hr



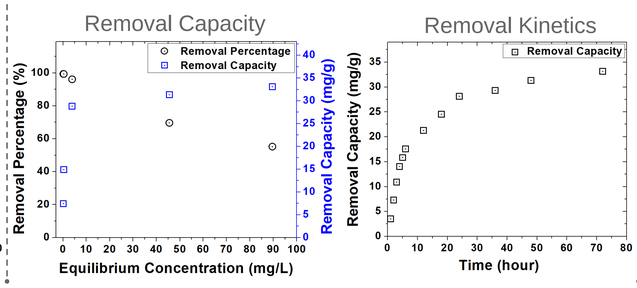
Recycling and reuse experiment for GO-PDA Aerogel with initial MB concentration of 25 mg/L



High recycling performance up to 3 cycles

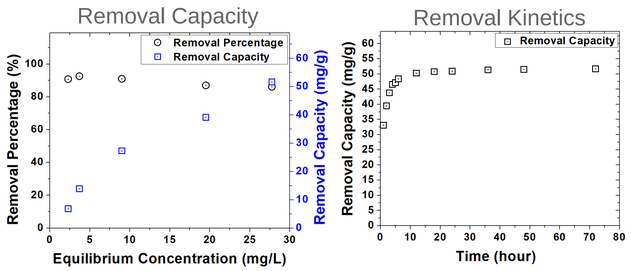
Heavy Metal Removal:

Hexavalent Chromium (Cr (VI))



Highest Removal Capacity 33.13 mg/g

Lead (Pb (II))



Highest Removal Capacity 51.67 mg/g

Conclusion

- 3D printed molds can be utilized to synthesize graphene based aerogel with architectural flexibility
- Polydopamine can provide structural integrity to the freeze casted graphene based aerogels
- Synthesized GO-PDA aerogel exhibited high and fast contaminant (dyes and heavy metals) removal

Future Work

- 3D print molds with optimum geometry to enable better performance of the aerogels
- Hybridize the aerogel with metallic nanoparticles with the same synthesis route to enable contaminant removal with other reactive mechanism
- 3D print the graphene based ink directly to come up with mold-free synthesis route

References

- L. Qiu, J. Z. Liu, S. L. Chang, Y. Wu, and D. Li, Nature Communications, 2012
- Y. Lin, F. Liu, G. Casano, R. Bhavsar, I. A. Kinloch, and B. Derby, Advanced Materials, 2016

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