Core-shell Graphene Oxide and Carboxymethyl Cellulose Vortex Ring Aerogel Particles for the Adsorptive Removal of Contrasting Azo Dyes from Water

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Abstract
Wastewater streams from industrial sources contain various dissolved organic pollutants that pose environmental contamination challenges even at extremely low concentrations if discharged. Porous materials, such as graphene-based functional frameworks, have been demonstrated for the efficient adsorptive remediation of such contaminants, but significant scope for improving their adsorption efficiency, versatility and reusability remains. We have recently developed the graphene oxide vortex-ring (GO-VR) particles, whose unique 'donut' shape has been shown to deliver exceptional adsorptive removal efficiency. In this study, we further develop a carboxymethylcellulose (CMC) functionalised GO-VR particle system, which achieves ambi-functional adsorptive removal of cationic and anionic model dyes, methylene blue (MB) and methyl orange (MO). Various key factors that affect the adsorption process, including pH, adsorbent dose, particle shape, contact time, and initial concentration of dyes are optimised and investigated. The optimum values of pH for MB and MO adsorption are 10 and 6, respectively, at which the adsorption capacity of GO/CMC-VR particles for MB and MO are 988 ± 5.84 mg/g and 783 ± 13 mg/g, respectively, resulting in 100% contaminant removal even at very low contaminant concenration of 5 ppm and using a very low adsorbant dose of 0.005 mg/ml. The pseudo-second-order kinetic adsorption model is shown to fit well with fast remediation rates, confirming that the driving force is predominantly electrostatic interaction. Furthermore, we demonstrate that the particles can be regenerated in an elution cycle and reused in adsorption-desorption cycles, retaining their high adsorption efficiency and improving the sustainability of this approach. We conclude that GO/CMC-VR particles are rapidly emerging as a promising universal adsorbent for the remediation of dissolved pollutants from wastewater.

References

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Figures

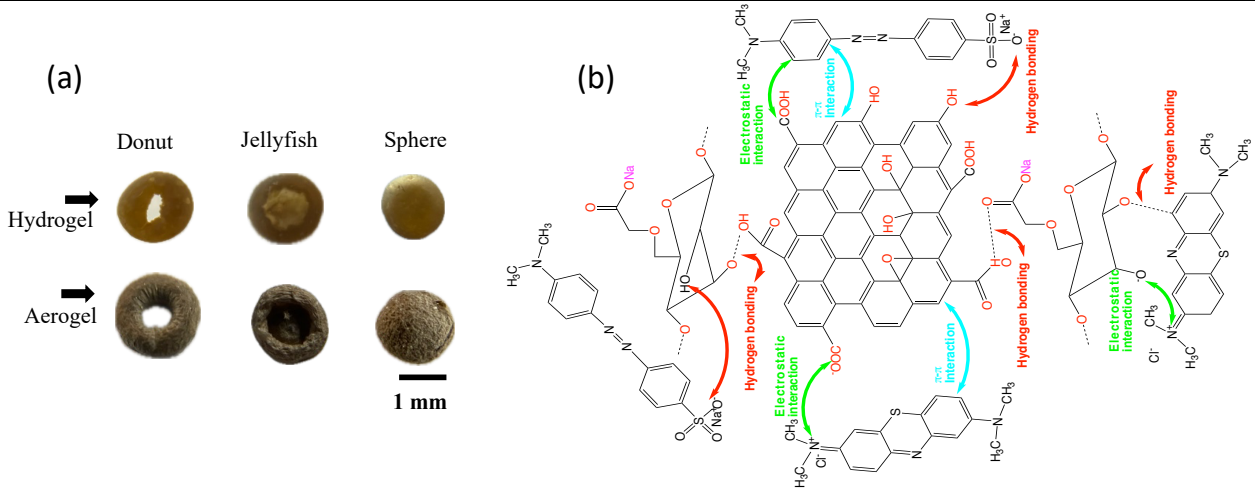

Figure 1: (a) Optical image of GO/CMC-VR particles both in hydrogel and aerogel forms, (b)Possible interaction and adsorption mechanism of MB and MO on the GO/CMC-VR particles