Tuneable electrohydrodynamics of graphene oxide vortex rings

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The vortex ring (VR) effect occurs when fluid droplets impact on another fluid, where the toroidal flow emerges within the impacting droplet due to viscous friction, resulting in a wide variety of flow-induced morphologies [1]. Here, this effect was used to generate 3-dimensional assemblies of graphene oxide (GO) flakes [2]. In order to stabilise various axially symmetric shapes, the cationic aqueous surfactant system (cetyltrimethylammonium bromide, CTAB) was utilised, which could interact with GO flakes who showed negative-charged in water. Then, GO hydrogel and aerogel particles with sphere, donut and jellyfish shapes could be obtained which all with a core-shell structure were featuring a shell of aligned GO flakes. The mechanism of this can be controlled by the competing influence of impact forces, viscous friction and graphene-fluid electrostatic interactions. Also, these GO particles have rich porous structure on their shell. In this fashion, these particles can be used in the water purification [3].

References

[1] Ji San Lee et al., Nature Communications, 6 (2015) 8187.
[2] Duo An et al., Nature Communications, 7 (2016) 12401.
[3] Yizhen Shao et al., Paper Submitted (2022).

Figures

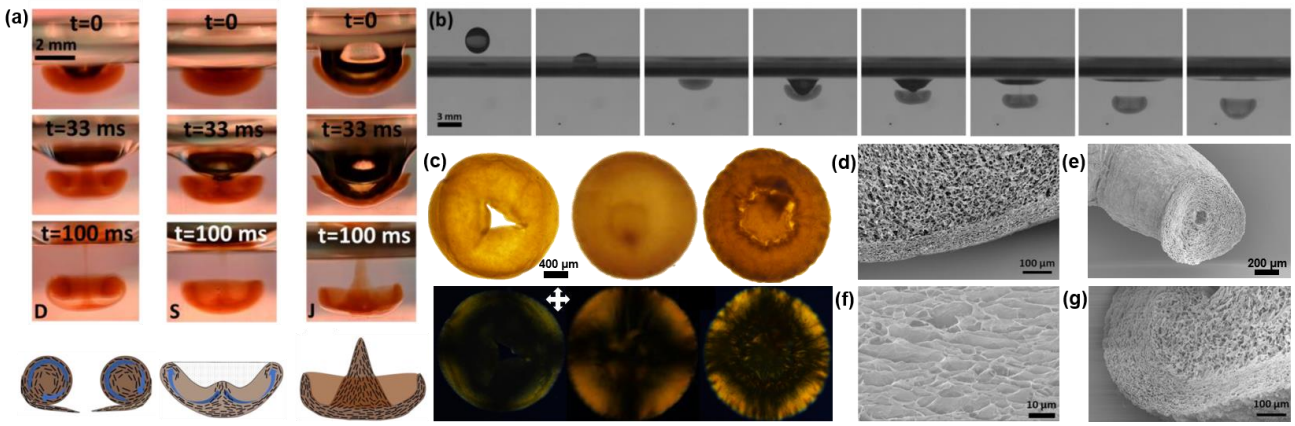

Figure 1: (a) Resting stages of GO-VRs formed by GO with donut, sphere and jellyfish shapes. (b) High-speed photographic images of a GO droplet penetrating CTAB solution and the formation of a vortex ring. (c) Microscopic and polarised optical microscopic images. (d)-(g) Core-shell structure.

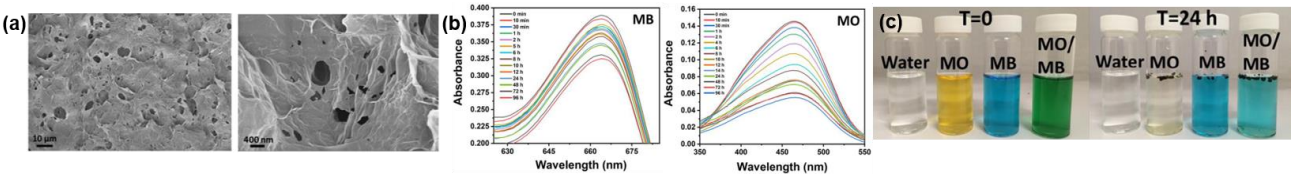

Figure 2: (a) Porous structure of GO aerogel particles. (b)-(c) UV-vis spectra and color change for the adsorption test at different time for methyl orange and methyl blue respectively.