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Enhancement of a Hollow Fiber Filter via Graphene Oxide Coating

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Emerging Contaminants: A Water Issue

In the recent years, new classes of contaminants of emerging concern (ECs) are consistently being found in water supplies, leading to severe environmental pollution and health problems [1]. Nanomaterials are expected to contribute to the development of new and efficient technologies for the removal of ECs from water [2]. In particular, graphene oxide (GO) based adsorbents and membranes show a great potential due to the high surface area, chemical versatility and processability of GO [3]. Polyethersulfone-polyvinylpirrolidinone (PES) hollow fibers (HF) are used for microfiltration in biomedical and water disinfection areas but are ineffective against water pollution from ECs. In this communication, we describe the fabrication of core-shell PES-GO hollow fiber membranes (HF-GO) and their use in filters for simultaneous adsorption of ECs (promoted by GO) and microfiltration (allowed by PES) [4].

Core-Shell Hollow Fiber Membranes and Filters Fabrication

- Graphene oxide suspension (lateral size of the sheets is below 150 nm) was filtered through the fiber sections. GO is stopped by the pores and a multilayer of GO is formed on the fiber wall (either inner (fig. a) or outer wall (fig. b)).
- A thermal annealing step at 80 °C was then performed to fix the GO layer. Stability was checked by dedicated release experiments.
- Reiteration of the filtration-annealing process permits to tune the degree of the coating (fig. c).

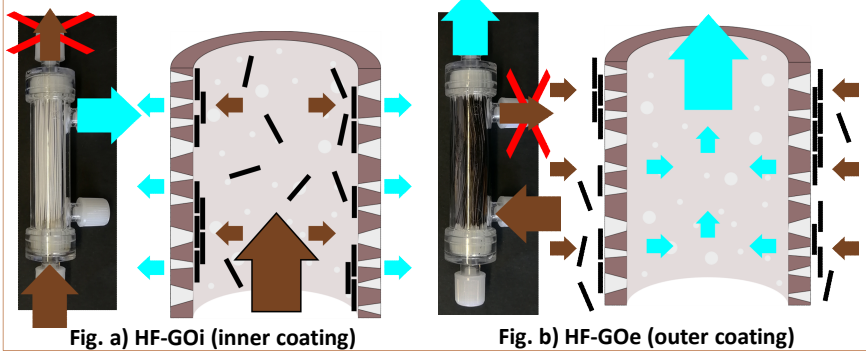
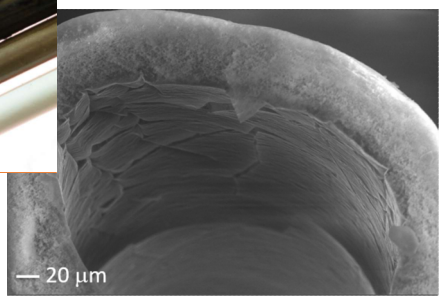


Fig. a) HF-GOi (inner coating)

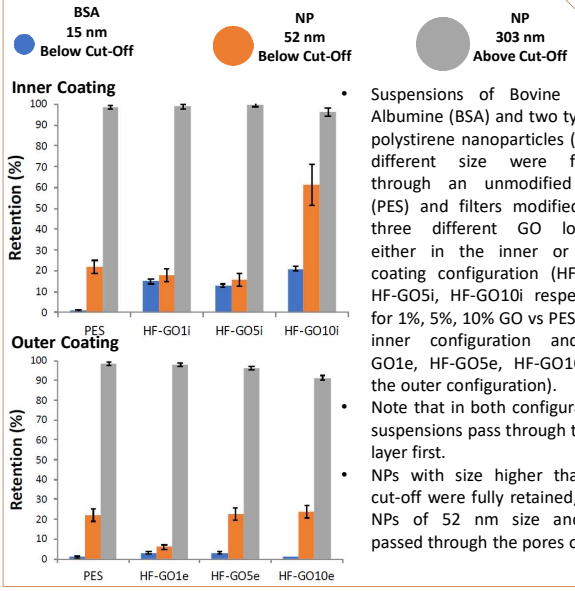
Fig. b) HF-GOe (outer coating)

Fig. c

Cut-Off 0.1-0.2 μm



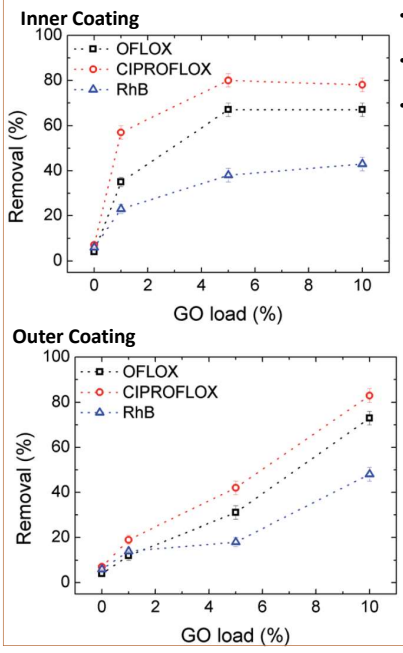
Microfiltration



- Suspensions of Bovine Serum Albumine (BSA) and two types of polystirene nanoparticles (NP) of different size were filtered through an unmodified filter (PES) and filters modified with three different GO loadings either in the inner or outer coating configuration (HF-GO1i, HF-GO5i, HF-GO10i respectively for 1%, 5%, 10% GO vs PES in the inner configuration and HF-GO1e, HF-GO5e, HF-GO10e for the outer configuration).
- Note that in both configurations, suspensions pass through the GO layer first.
- NPs with size higher than the cut-off were fully retained, while NPs of 52 nm size and BSA passed through the pores of PES.

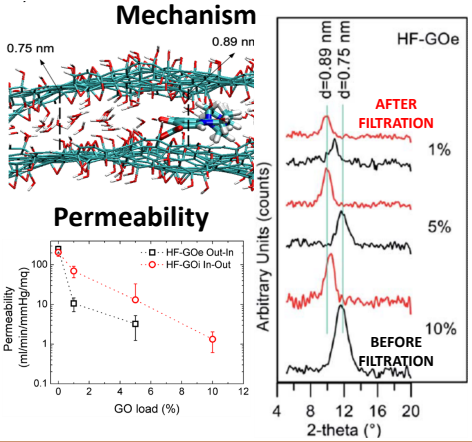
Adsorption

Efficiency



- Tap water spiked with two antibiotics (ofloxacin and ciprofloxacin) and an industrial dye (rhodamine B) was treated with PES and HF-GO filters (typical of adsorption mechanism).
- Removal efficiency increases on increasing of the GO loading.
- Decreased water permeability was found at higher GO loadings.
- The mechanism of adsorption was investigated by XRD on the fibers before and after filtration and by theoretical calculations. Experimental and theoretical data suggest intercalation of ofloxacin in between overlapped GO sheets.

Mechanism



Permeability

Conclusions

- HF-GO were successfully prepared directly in commercially available PES filters.
- HF-GO selectively capture ECs while letting small NPs pass through.
- Intercalation as adsorption mechanism was demonstrated.

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Project N. 2017W8KNZW NANO-CARBO-CAT
Project n. 881603 SH1-GRAPHIL
Project n. 825207 GO-FOR-WATER

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