Small Chem International Online Conference

February 17-18, 2021

GRAPHENE-POLYSULFONE SORBENTS FOR THE REMOVAL OF CONTAMINANTS OF EMERGING CONCERN FROM DRINKING WATER

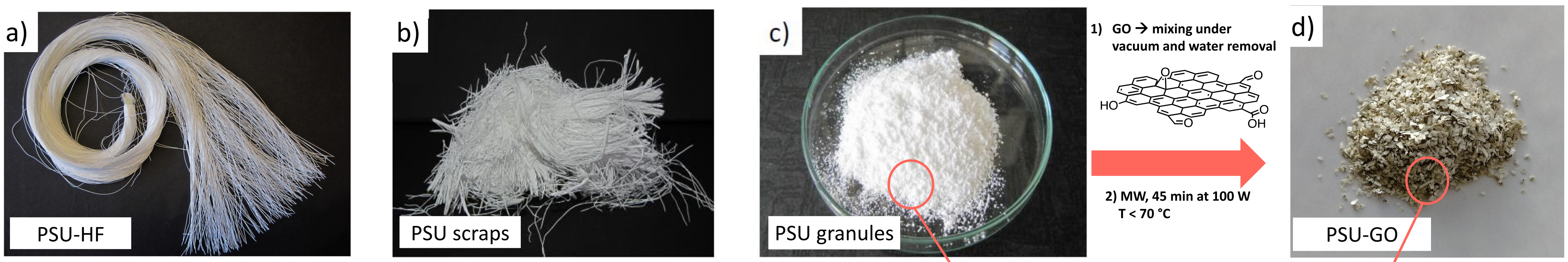
S. Khaliha[1], A. Bianchi[1], A. Kovtun[1], M. Zambianchi[1], S. Valsecchi[2], S. Polesello[2], B. Casentini[3], V. Palermo[1], M. Melucci[1].

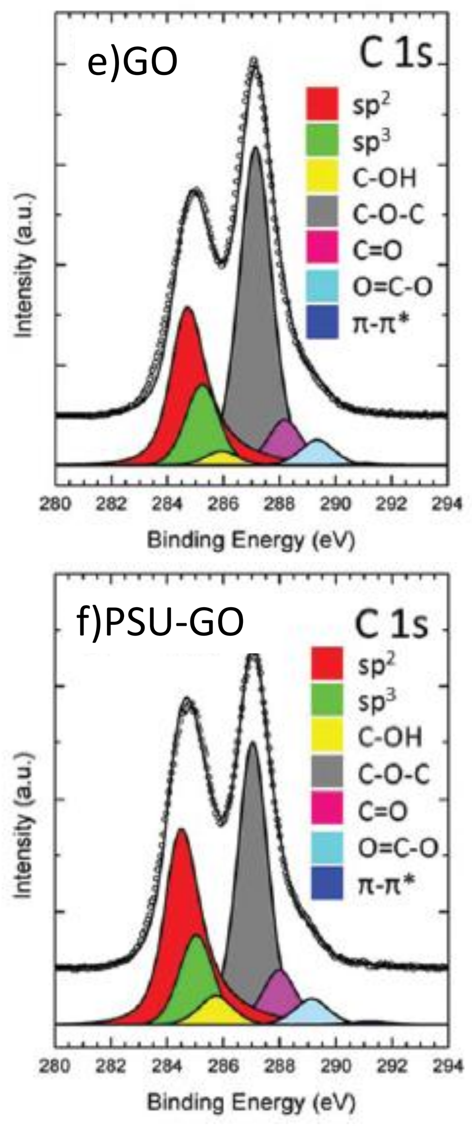
[1]CNR-ISOF (Bologna, Italy), [2]CNR-IRSA (Brugherio Milan, Italy), [3]CNR-IRSA (Rome, Italy)

ABSTRACT

The recently adopted European Drinking Water Directive EU 2020/2184 imposes the monitoring and removal of new emerging contaminants (ECs), such as per- and polyfluoroalkyl substances (PFAS) from our drinking water and tighten the limits for already regulated substances (e.g lead). Such stringent requirements are pushing academic and industrial research to the development of new materials and strategies for efficient water treatment. Graphene based materials, due to their high surface area and multiple interactions pathways with organic molecules and metal ions allowed by the abundant surface chemical moieties, have shown great potential for water purification purposes [1]. Here, we present the preparation of a polysulfone-graphene oxide-composite (PSU-GO) and its use as sorbent of ECs in drinking water, including PFAS and lead.

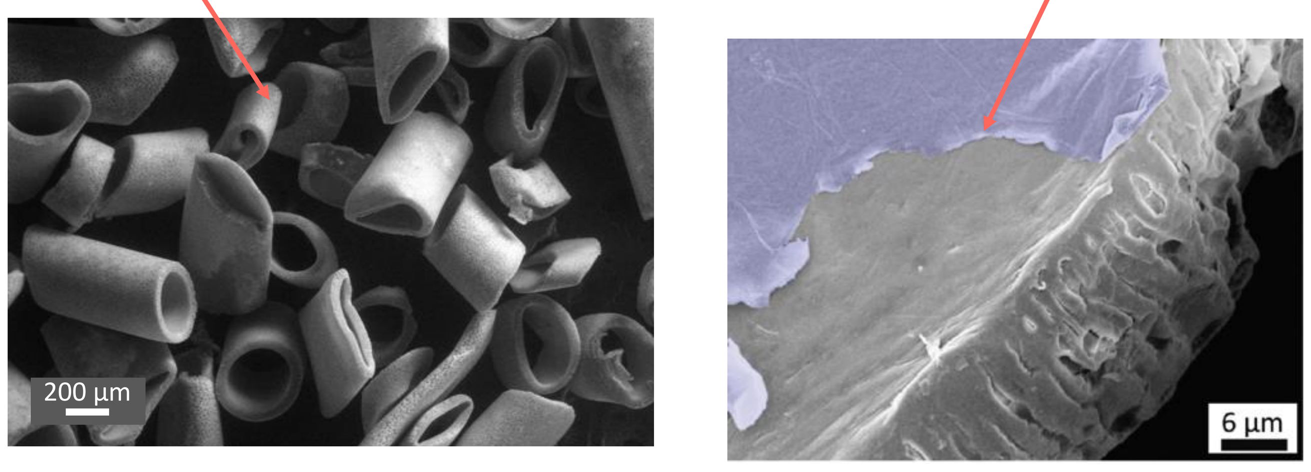
SYNTHESIS AND CHARACTERIZATION





MW treatment does not induce GO reduction.

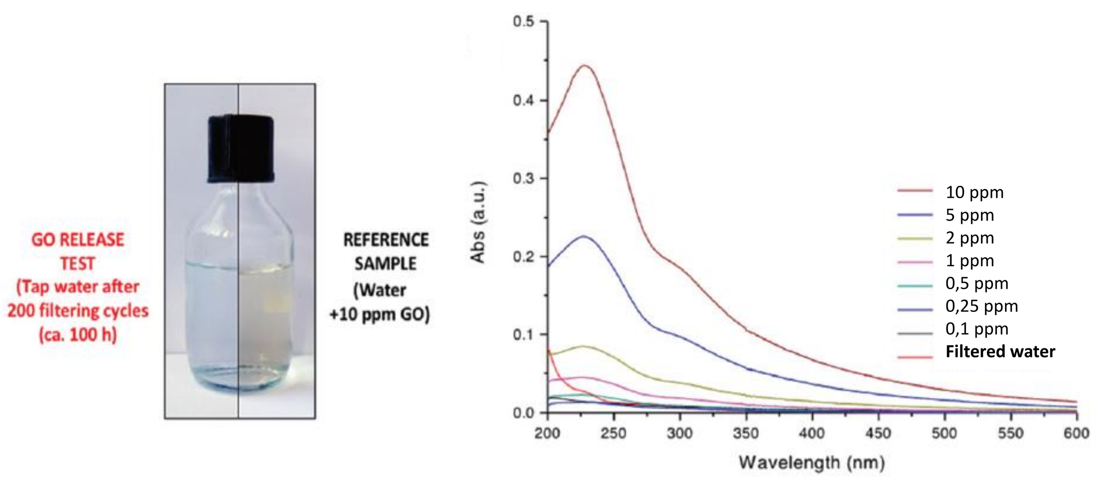
- Polysulfone Hollow fibers (**PSU-HF**) are used for the fabrication of ultrafiltration filters for biomedical applications (fig. a) [2]
- Scraps of the industrial production of polysulfone membranes (**PSU**) are industrial wastes representing 10% of the yearly production, about 6 tons. (fig. b)
- Mechanically grounded PSU scraps(fig c.) are coated by graphene oxide (**GO**) by a two steps method based on 1) mixing in water and partially drying under vacuum and 2) stabilization, performed under microwaves heating (MW). Content of GO in PSU-GO composite is 2,5% w/w (fig. d). [3]



Coating of PSU by about 10 layers of GO.

GO COATING STABILITY

- Stable fixation was confirmed by circulating water through the cartridge for 100 h.
- Filtered water was analyzed with UV-vis and compared to samples of water with different amounts of GO.



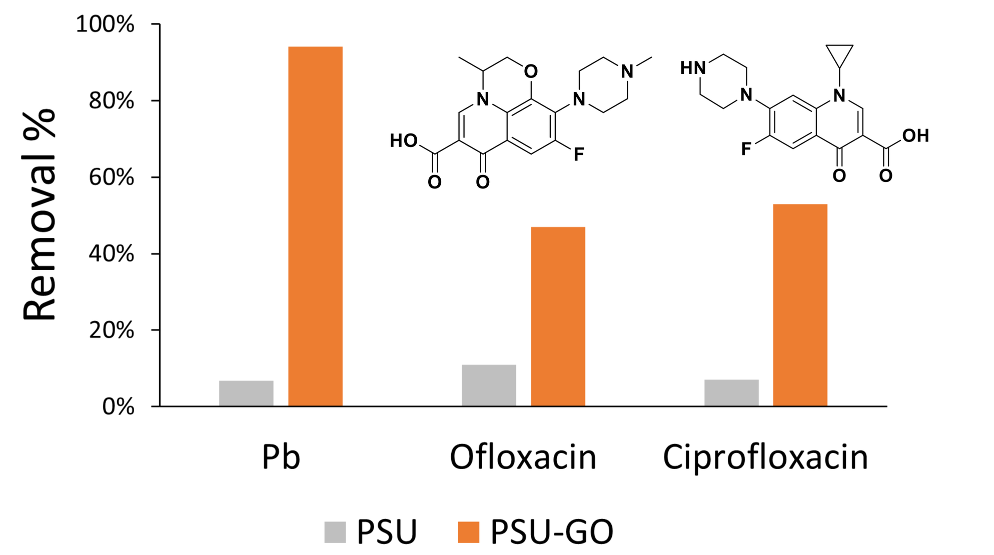
GO content was below 2 ppm (detection limit of GO with UV-vis analysis was in the range of 2-5 ppm).

SELECTIVITY

- PSU-GO adsorption performance was tested by inserting the composite in a commercial water filter cartridge and flowing spiked tap water with **lead**, **antibiotics** and a mixture of **PFAS** of different chain length.

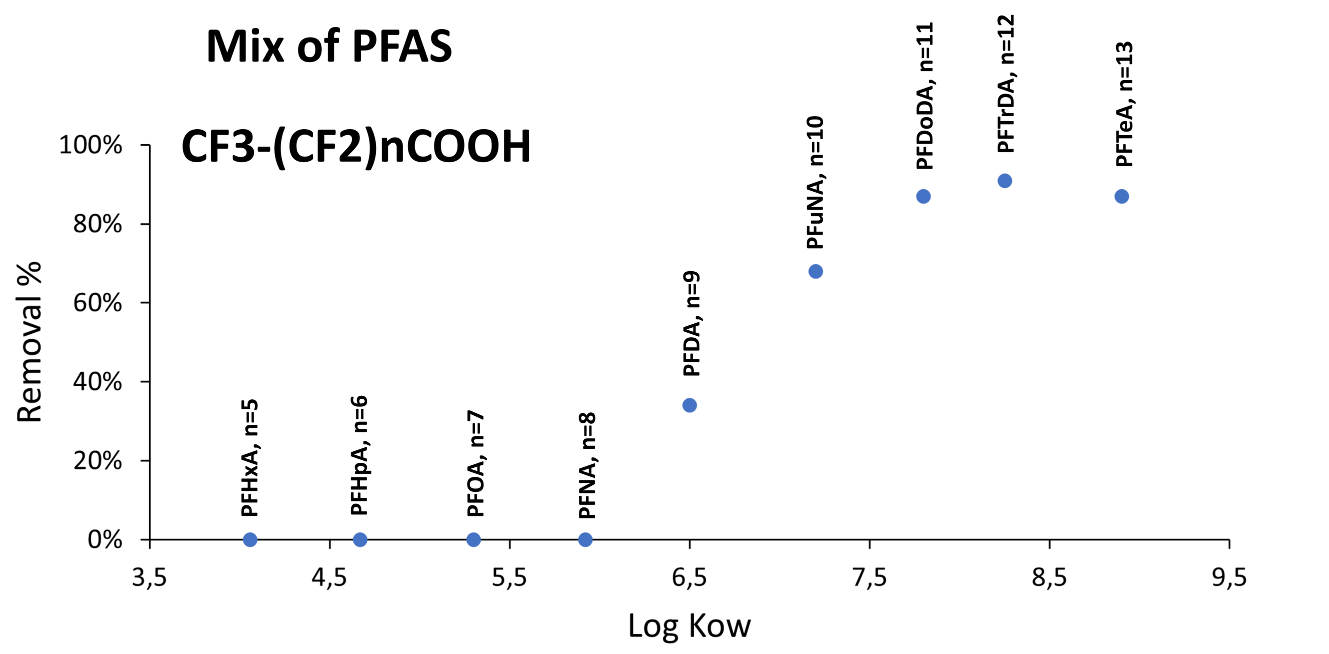
PSU-GO composite filter

Lead and Antibiotics



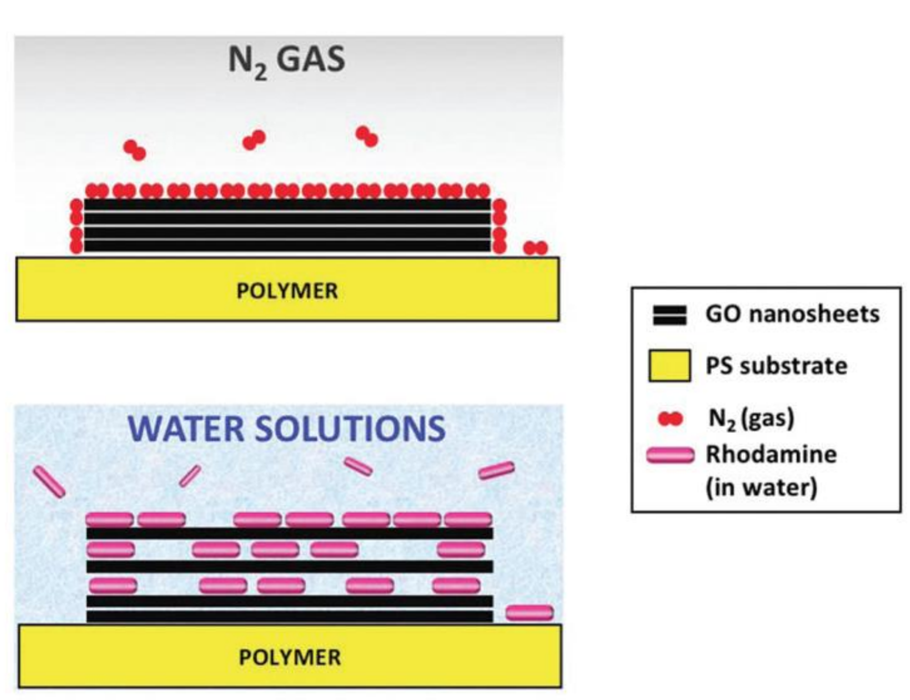
PSU-GO adsorbes fluoroquinaolonic antibiotics and Lead, while PSU is uneffective. (C_{in}= 100 -500 ppb).

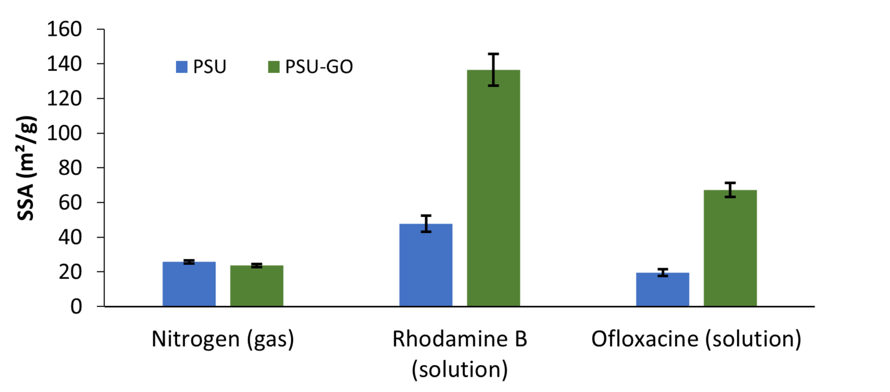
Mix of PFAS



The removal increase on increasing the molecule hydrophobicity (i.e. the CF2 chain number). C_{in} = 10 ppb, tap water.

ADSORPTION MECHANISM

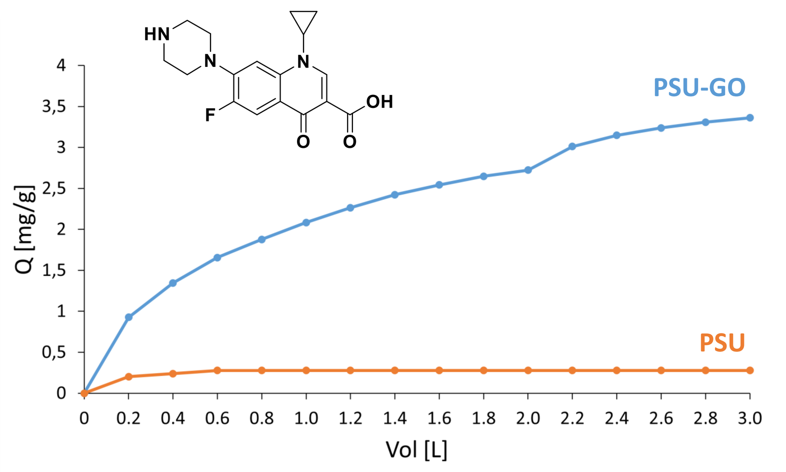




- PSU-GO surface area measured by gas adsorption was much lower than that estimated by liquid sorption. [4]
- Intercalation between overlapped **GO nanosheets** provide a further available adsorption sites for EC molecules.

PERFORMANCE

- Filtration until breaktrough of Ciprofloxacin revealed a removal efficiency about **4 mg** per cartridge (1 g of PSU-GO composite).
- The efficiency is **ten times** higher than that of PSU and about one order of magnitude higher than Granular activated carbon (20 ug/g). [5]



Loading expriments of a solution of Ciprofloxacin.

CONCLUSION AND PERSPECTIVE

- GO can be stably grafted on PSU recycled granules and the PSU-GO composite can be used to realize filters for drinking water treatment.
- **Future:** Test the removal of substitutive PFAS, life-time and regeneration of composite. The use of functionalized GO could tune the removal selectivity.

CONTACT PERSON

sara.khaliha@isof.cnr.it

GRAPHENE FLAGSHIP
Project n. 881603 SH1-GRAPHIL
FLAG-ERA
Project n. 825207 GO-FOR-WATER

REFERENCES

[1] F. Perreault, A. Fonseca de Faria, M. Elimelech, Chem. Soc. Rev., 44, (2015), 5861-5896.
[2] Medica S.p.a , https://www.medica.it/
[3] A. Kovtun, M. Zambianchi, C. Bettini, A. Liscio, M. Gazzano, F. Corticelli, E. Treossi, M.L. Navacchia, V. Palermo, M. Melucci, Nanoscale, 11, (2019), 22780-22787.
[4] J. C. Santamarina, K. A. Klein, Y. H. Wang and E. Prencke, Can. Geotech. J., 2002, 39, 233–241.
[5] A. Kovtun, A. Bianchi, M. Zambianchi, C. Bettini, F. Corticelli, G. P. Ruani, L. Bocchi, F. Stante, M. Gazzano, T. D. Marforio, M. Calvaresi, M. Minelli, M.L. Navacchia,V. Palermo, M. Melucci, Faraday Discuss., 2020, DOI: 10.1039/C9FD00117D

2021 ONLINE February 17-18 sC SmallChem