Graphene oxide coating of hollow fibers for simultaneous adsorption&microfiltration in water purification

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A Water Issue

2.2 billion people

lacked safely managed drinking water in 2017

80% of wastewaters

released without adequate treatment

«Ensure availability and sustainable management of water and sanitation for all»

https://unesdoc.unesco.org/ark:/48223/pf0000247553

https://sdgs.un.org/goals

Emerging Contaminants

What are they?

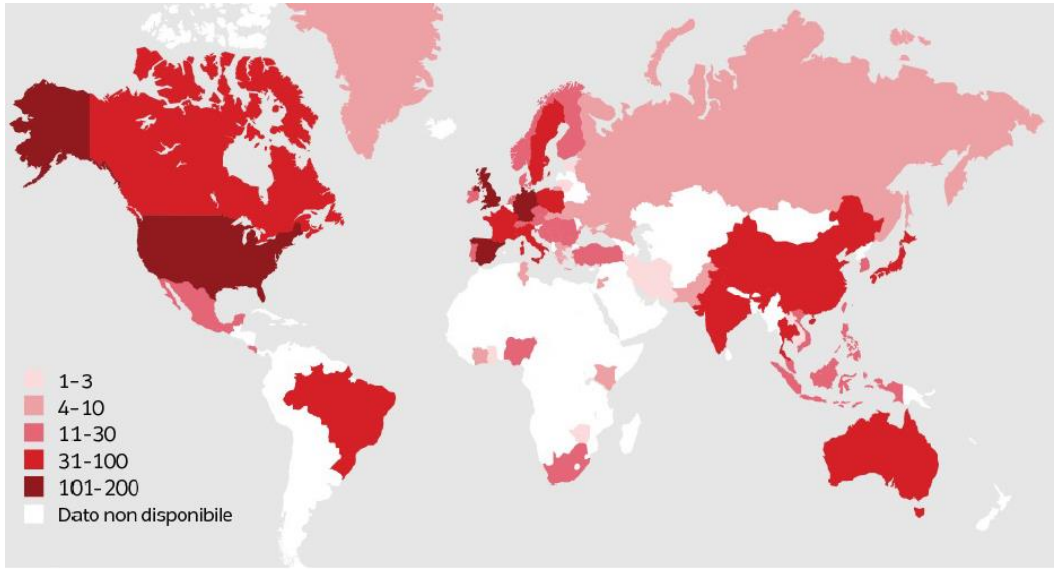
Anything not commonly monitored with the potential to enter the environment and cause adverse ecological effects

Where are they?

Superficial and ground water, wastewater, tap water

- Drugs
- Pesticides
- Personal care
- Heavy metals
- Bacteria

Number of pharmaceutical products found in water



P. Rosenfield, L. Feng, Risks of Hazardous Wastes, 2011
Water Research, 153, 2019, 80

Per Fluoro Alkyl Substances

Where do they come from?

- Oil/water/fire repulsion
- Cookware
- Food storage

Why are they a problem?

- Persistent
- Bioaccumulative
- Toxic

R. Tröger et al., Water Research, 198, 2021, 117099

G. Bertanza et al., Sci. Tot. En., 734, 2020, 139154

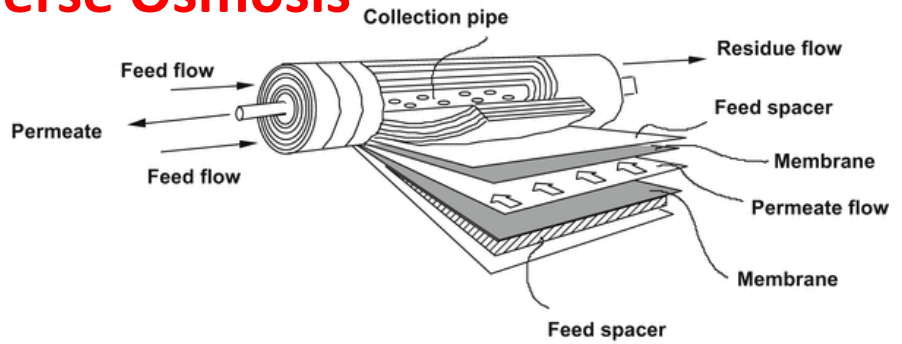
State of the Art

MULTISTEP APPROACH

- STEP 1: Filtration
- STEP 2: Adsorption
- STEP 3: Disinfection

MEMBRANE PROCESSES

Reverse Osmosis



- High water rejection
- Dangerous retentate
- Energy consumption

ADSORPTION

Granular Activated Carbon (GAC)

- Bacterial growth
- High environ. costs
- Ethical issues

Verlicchi, P. et al.; Science of the total environment, (2012), 429, 123

Innovation

Drinking Water Directive 98/83/EC

SAFETY

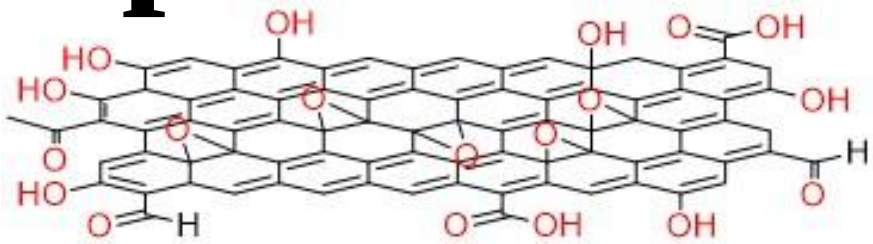
1998

New Drinking Water Directive EU 2020/2184

SAFETY | MONITORING | ACCESSIBILITY

12/01/2021

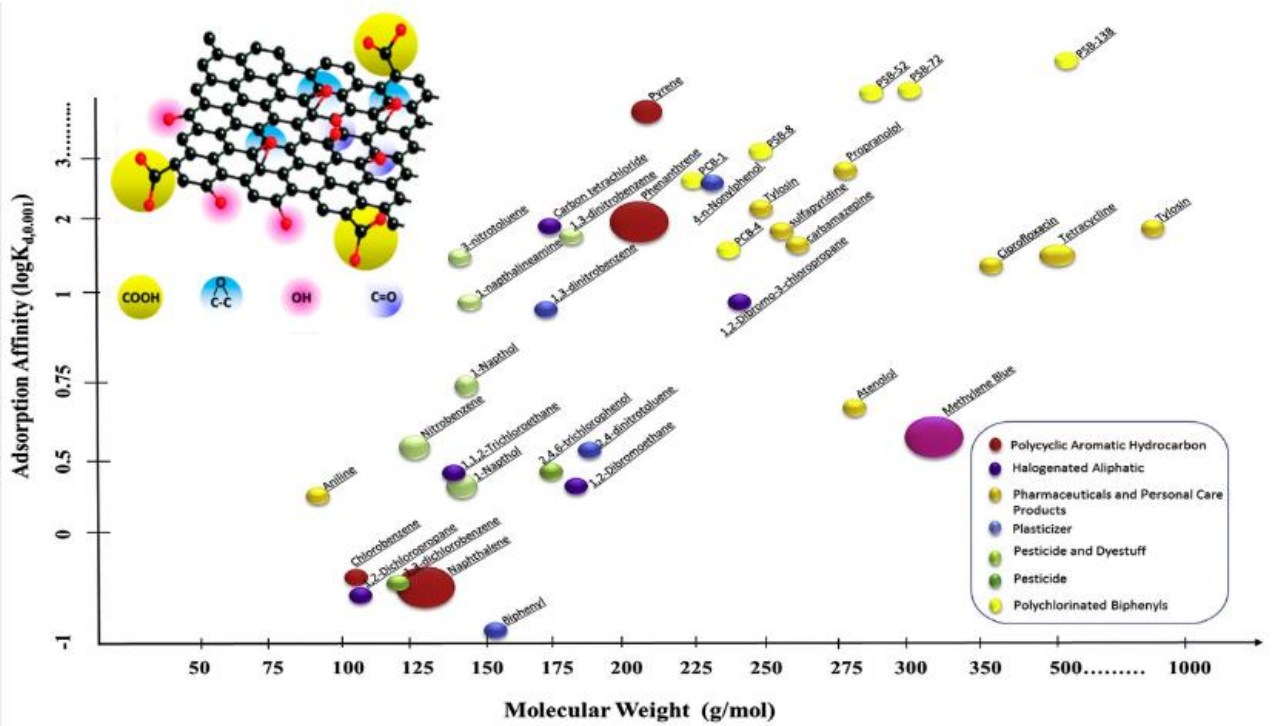
Graphene Oxide



I **High versatility**

II **High adsorption efficiency**

III **Processability in water**



https://ec.europa.eu/environment/water/water-drink/legislation_en.html

G. Ersan et al., *Water Research* **2017**, *126*, 385

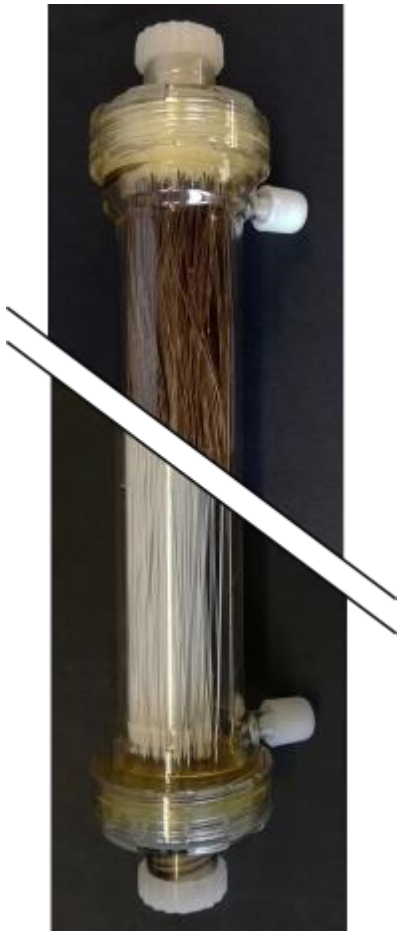
Our Goal: Multivalent filters

GRAPHENE FLAGSHIP

GO ➡ Adsorption

\+

HF ➡ Filtration



Drinking water purification

The Cartridges

Plasmart 100

Gruppo MEDICA Group

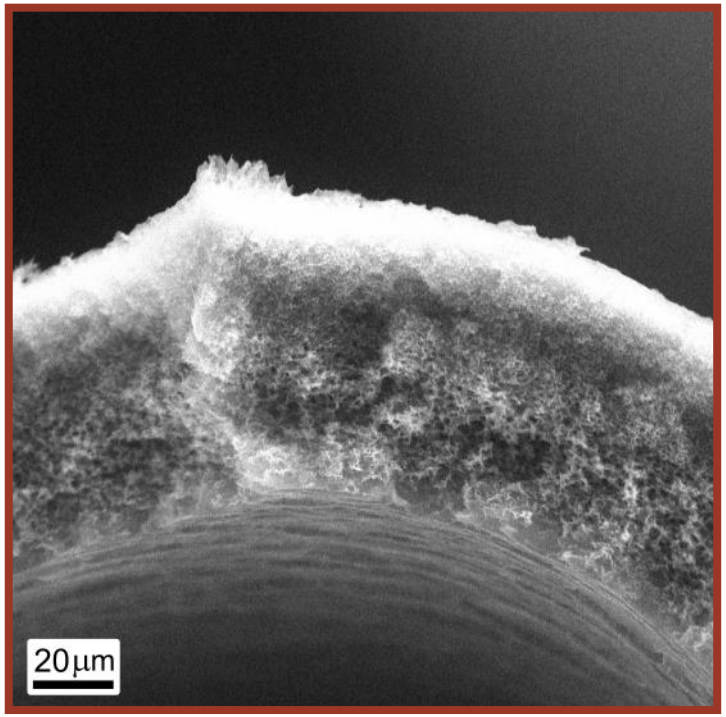
Hemodialysis filters

Graphil

Cut-off

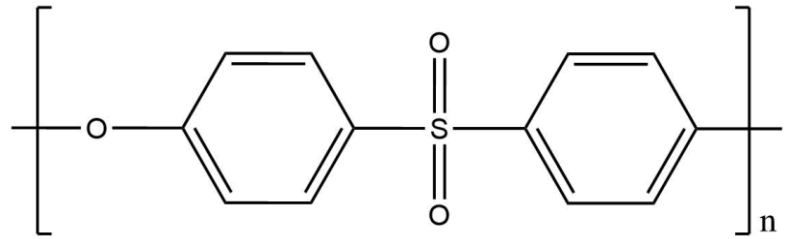
100-200 nm

MICROfiltration



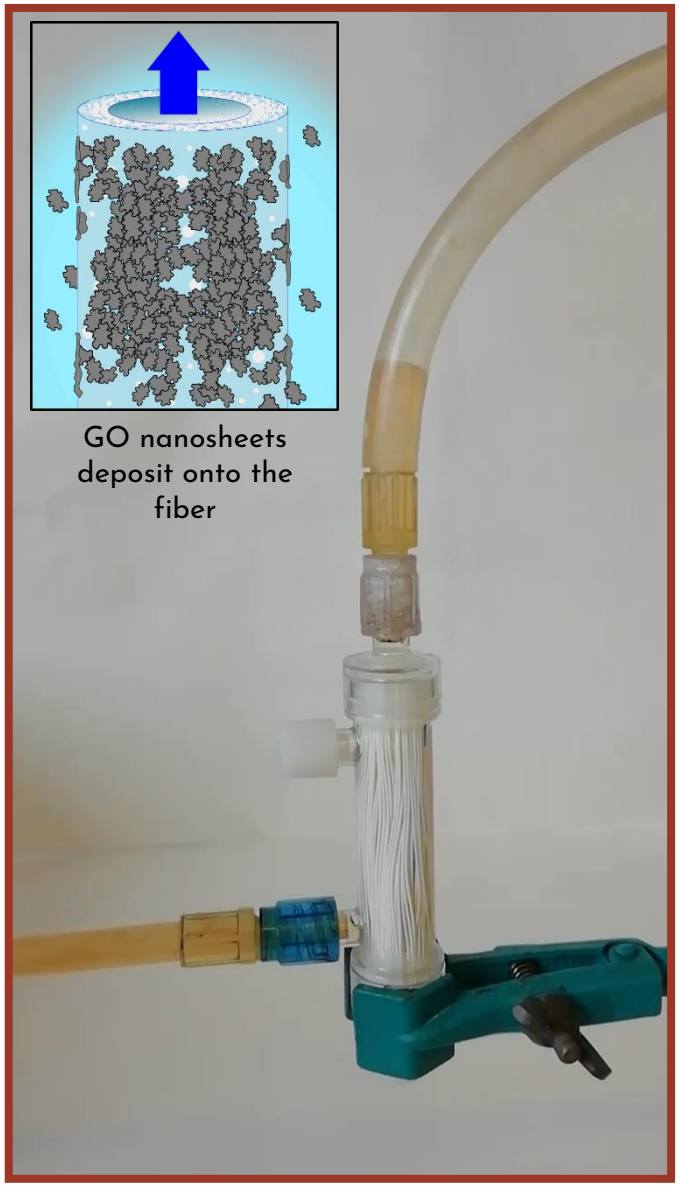
Versatile™ PES

Polyethersulfone (PES)



Plasmart 25

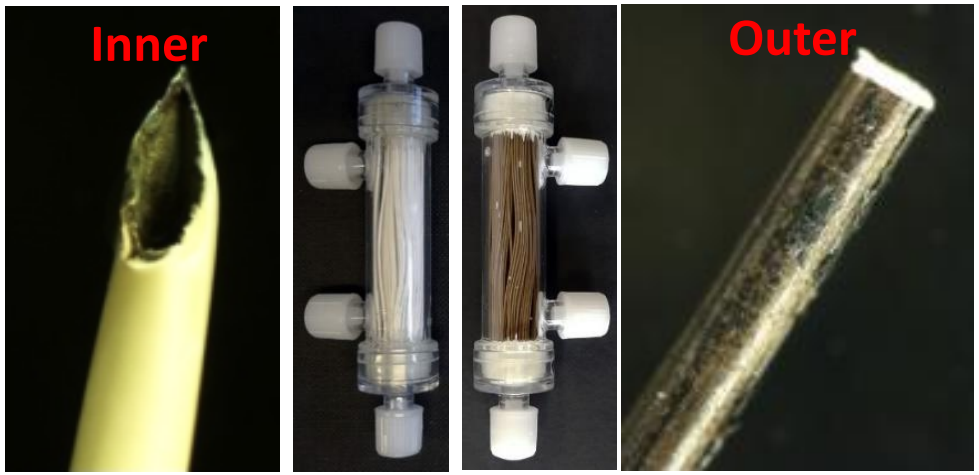
Core-Shell PES-GO



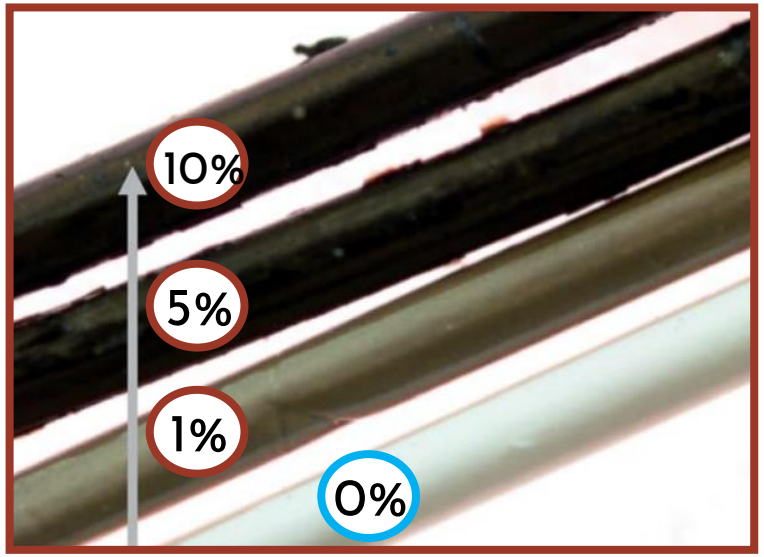
Step 1
Filtration
(1 bar or 100 mL/min; 2 mg/mL)

Step 2
Thermal annealing
(Overnight 80 °C)

Two Modalities
Inside or outside the fibers



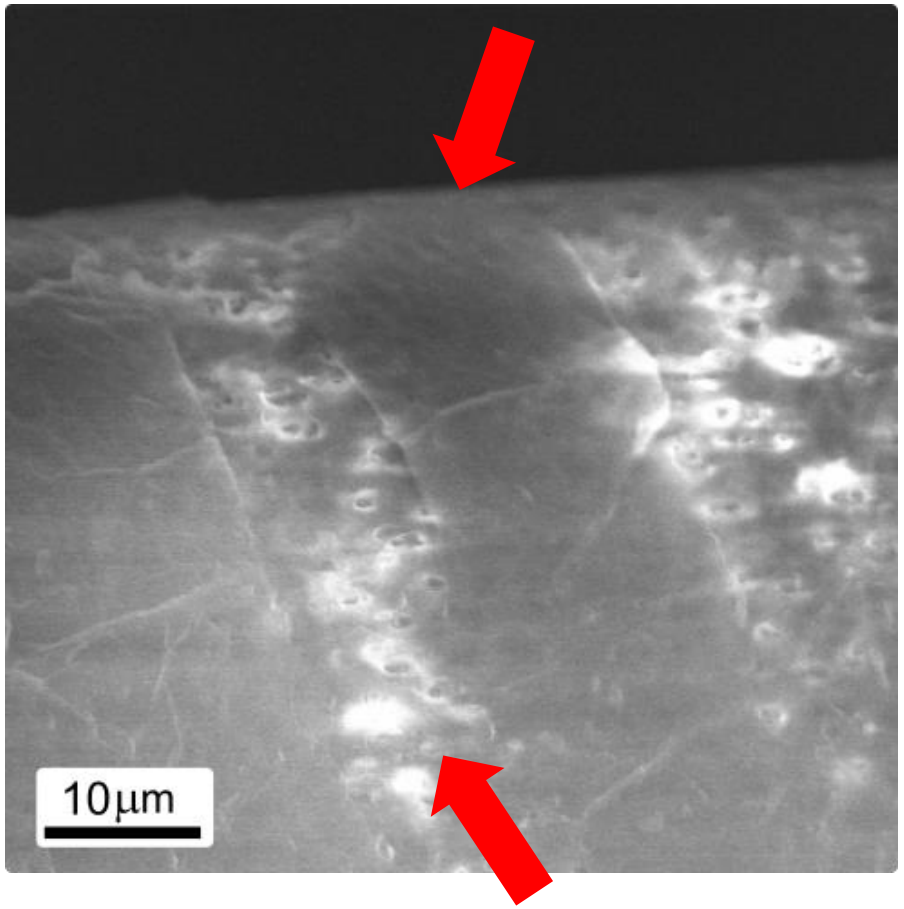
Repeat
to tune percentage of GO



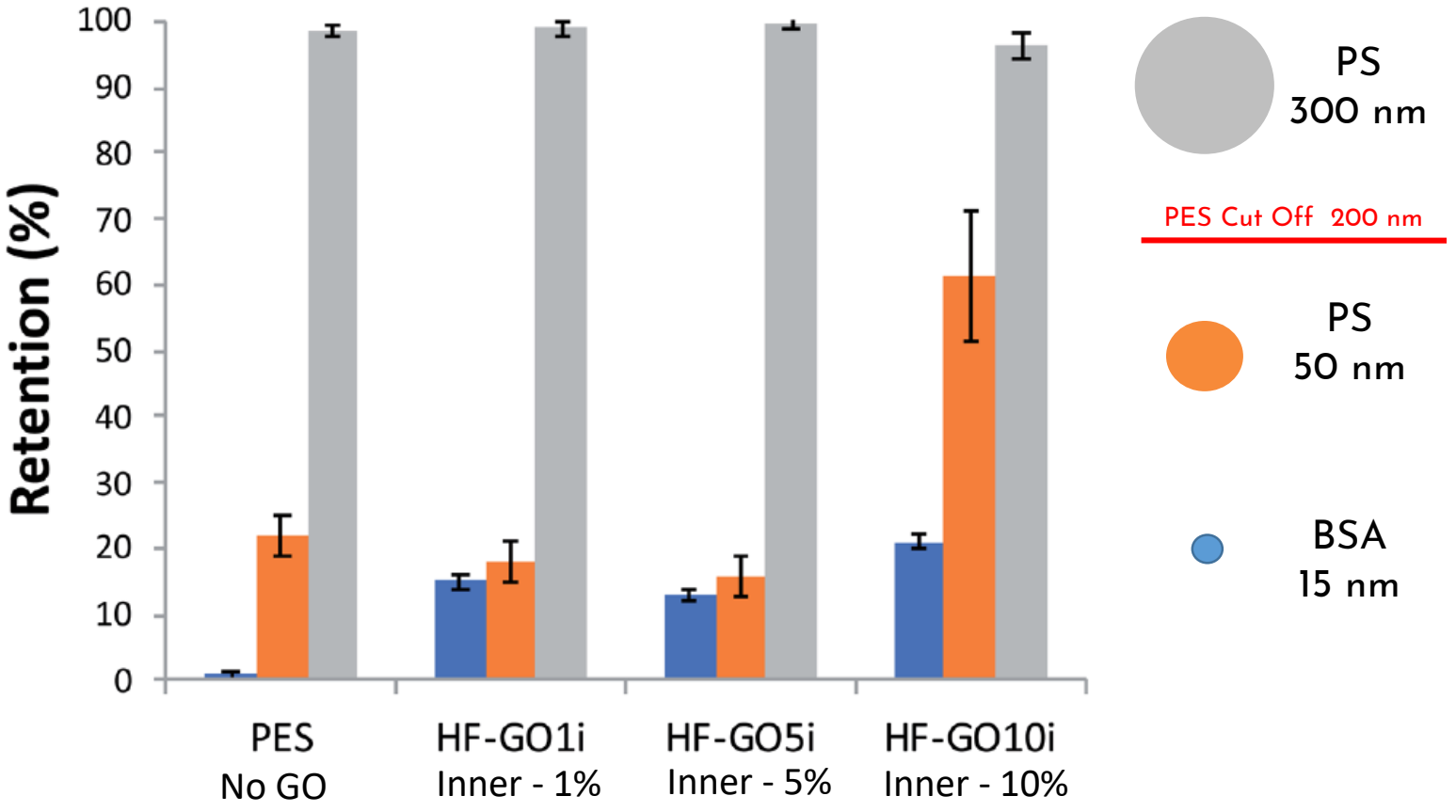
A. Bianchi, A. Kovtun, M. Zambianchi, C. Bettini, F. Corticelli, G. Ruani, L. Bocchi, F. Stante, M. Gazzano, T. D. Marforio, M. Calvaresi, M. Minelli, M. L. Navacchia, V. Palermo, M. Melucci, Faraday Discuss., 2021, 227, 274-290

Characterization

GO coating

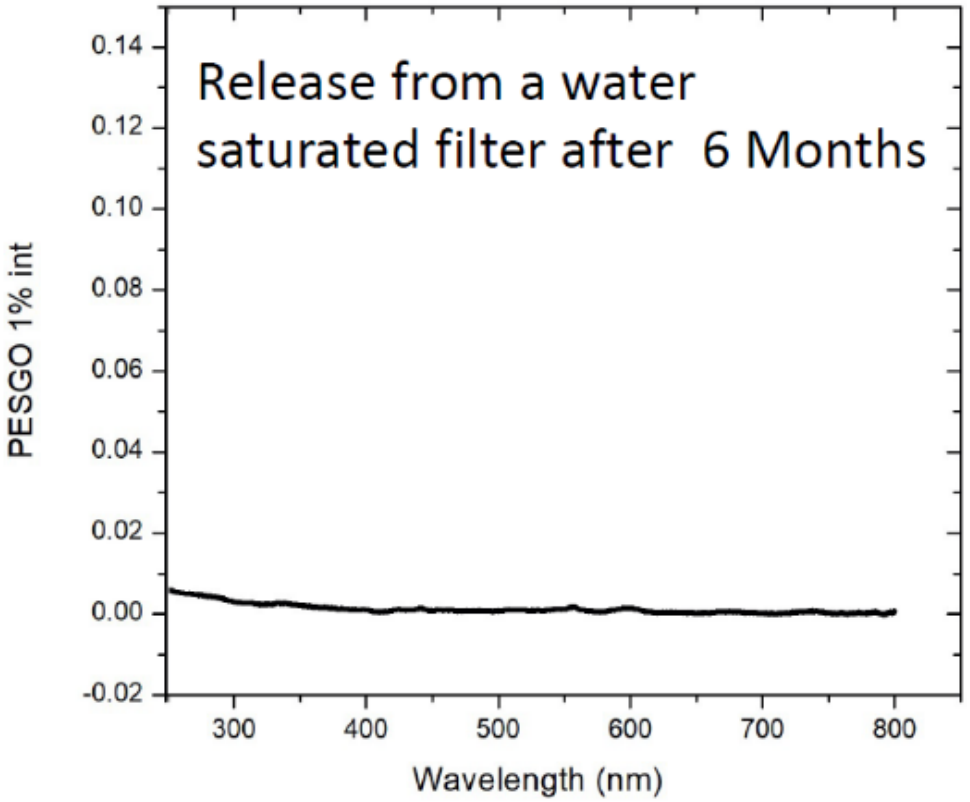


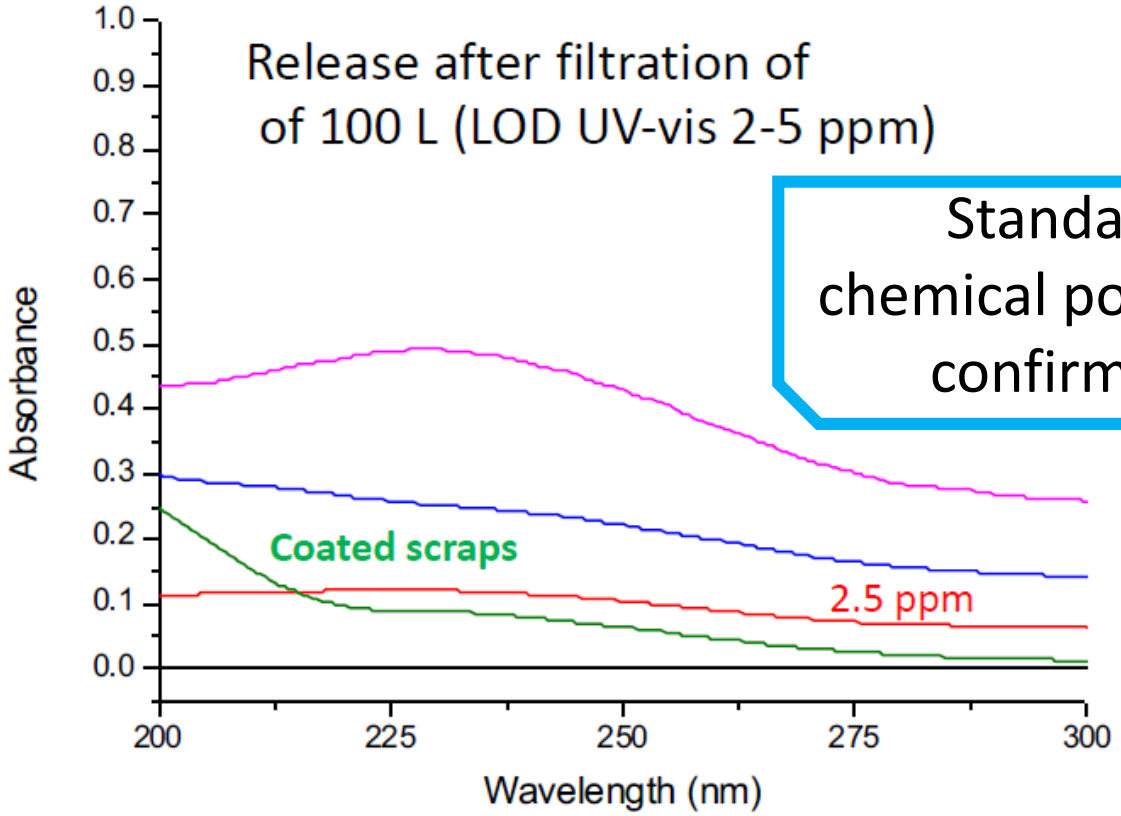
Uncoated PES



Microfiltration cabability preserved

Stability & Potability





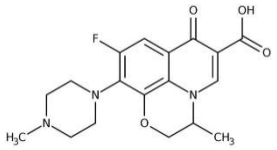
Standard chemical potability confirmed

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

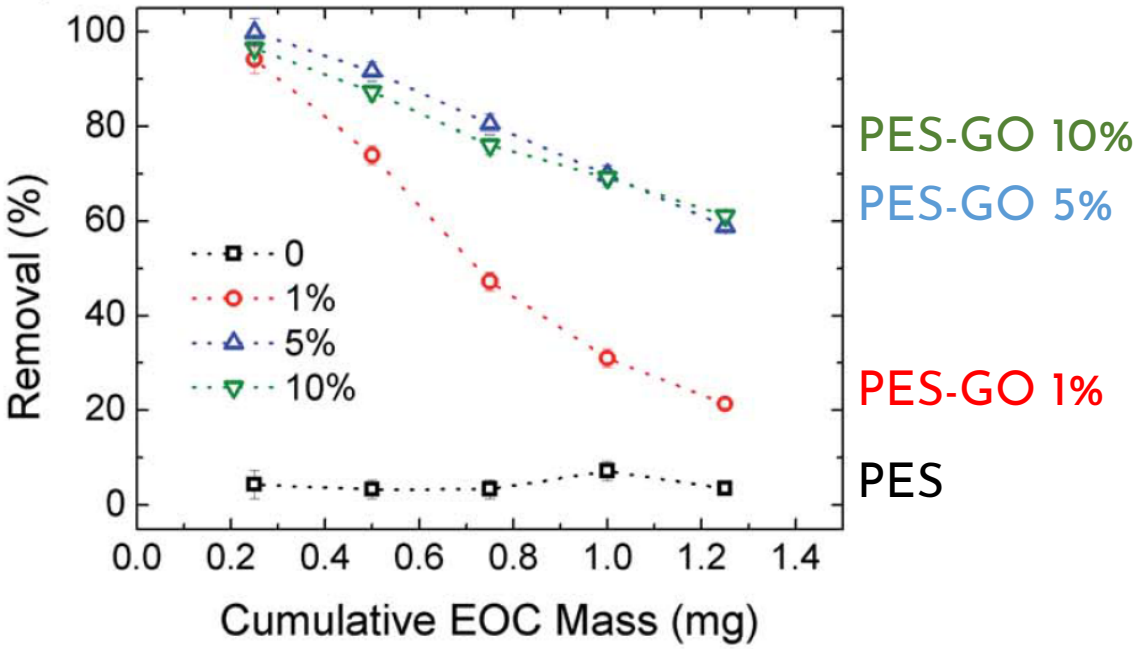
GRUPPO STANTE
Your Environmental Solution

(Salts, TOC, metal ions, organolepctic characteristics)
D . Lgs. 31/01 Agg. D.M. 14/06/2017

Synergistic Effect

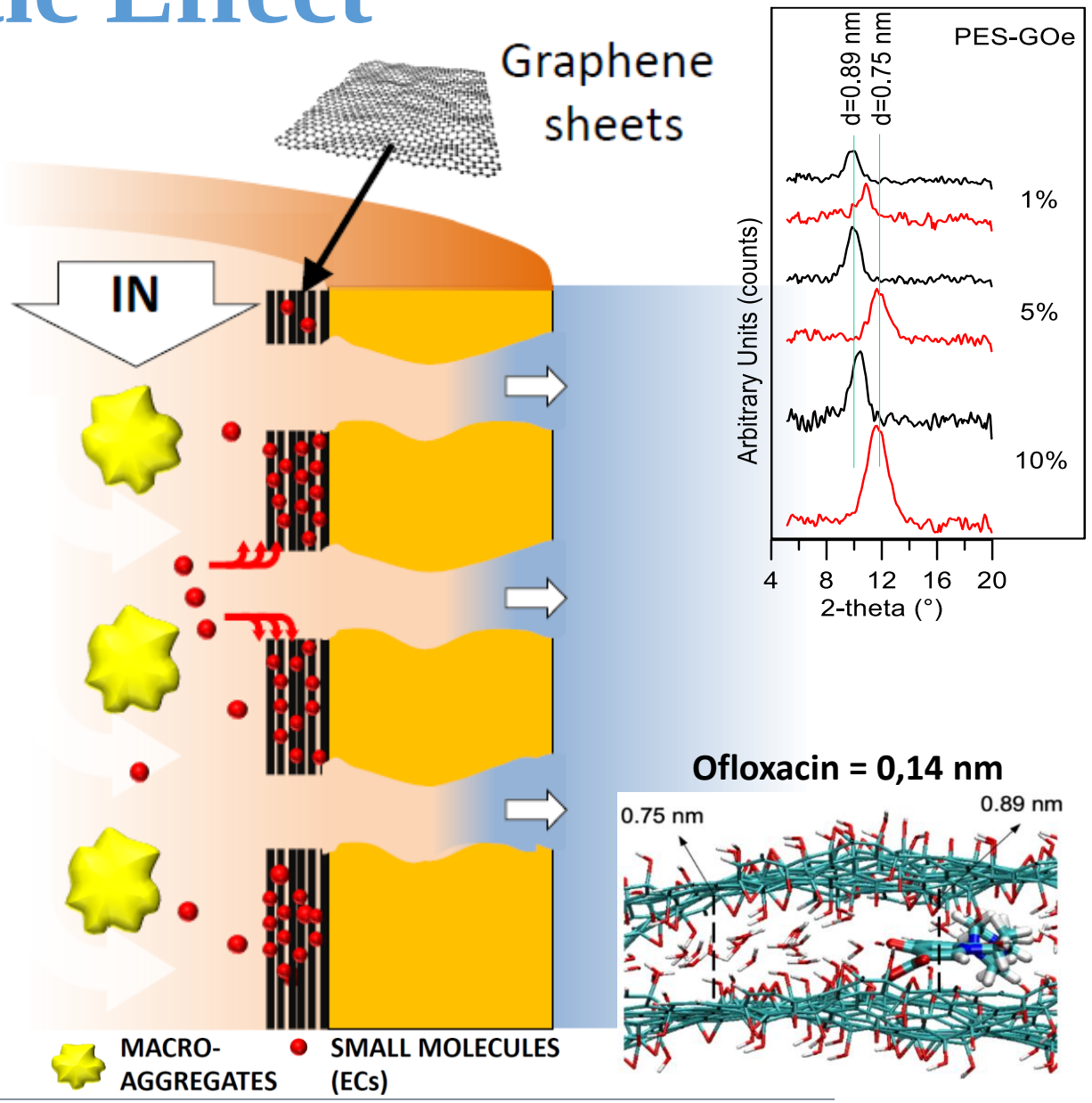


Ofloxacin
Antibiotic (EC)



Expanded selectivity

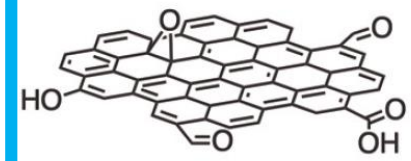
Low contact time



PFAS Removal

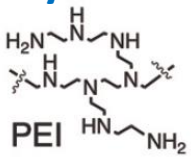
Chemical Manipulation

ζ-potential
-23,2 mV

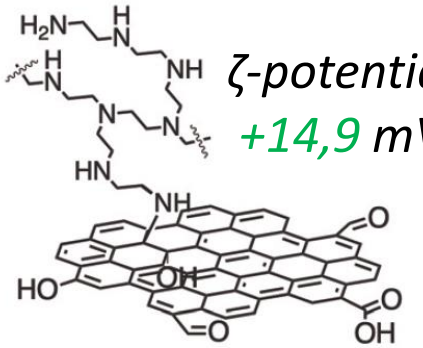


GO

PolyEthylen Imine

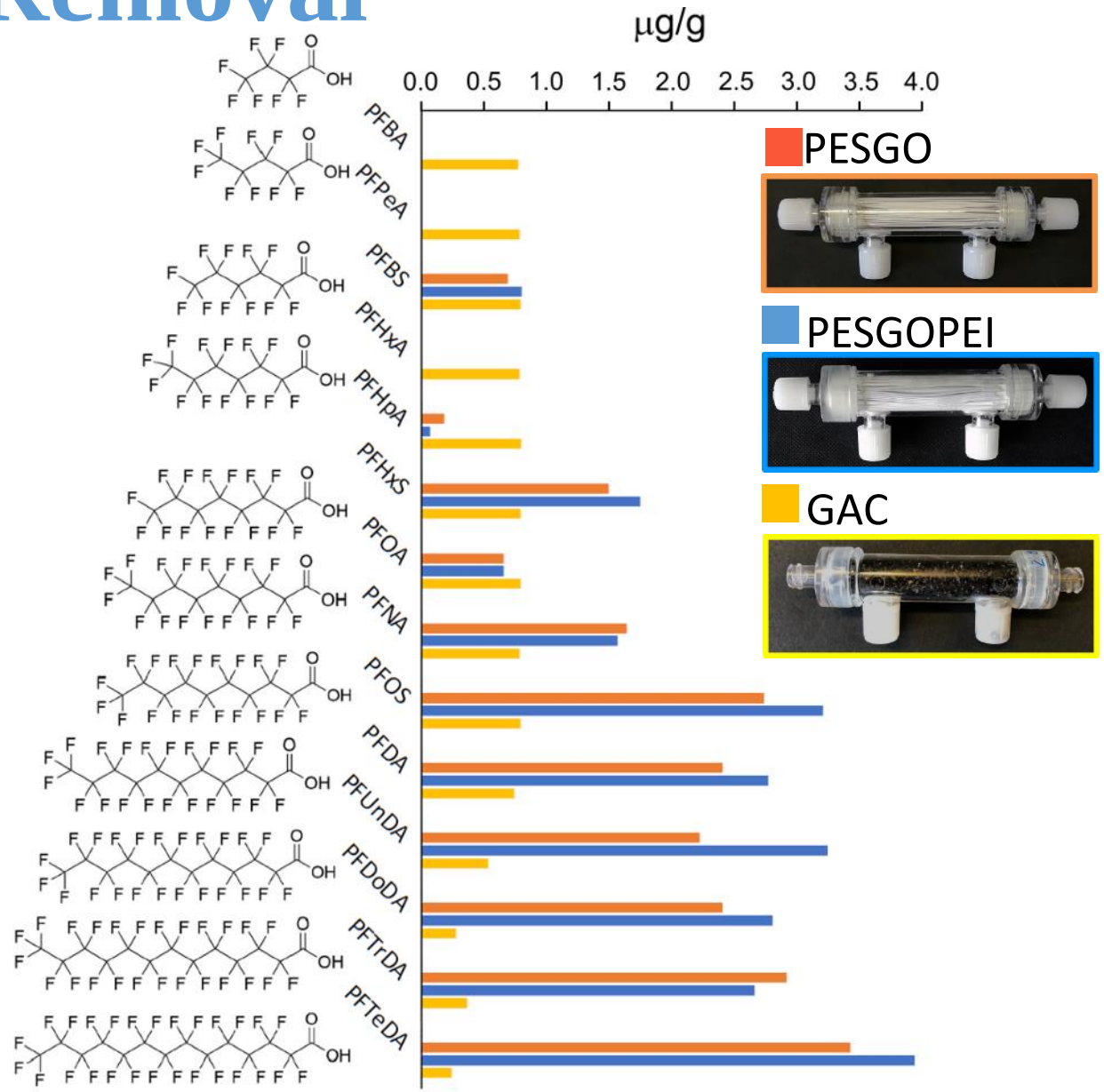


MW 80°C, 30'
EtOH:H_2O(1:1)



GOPEI

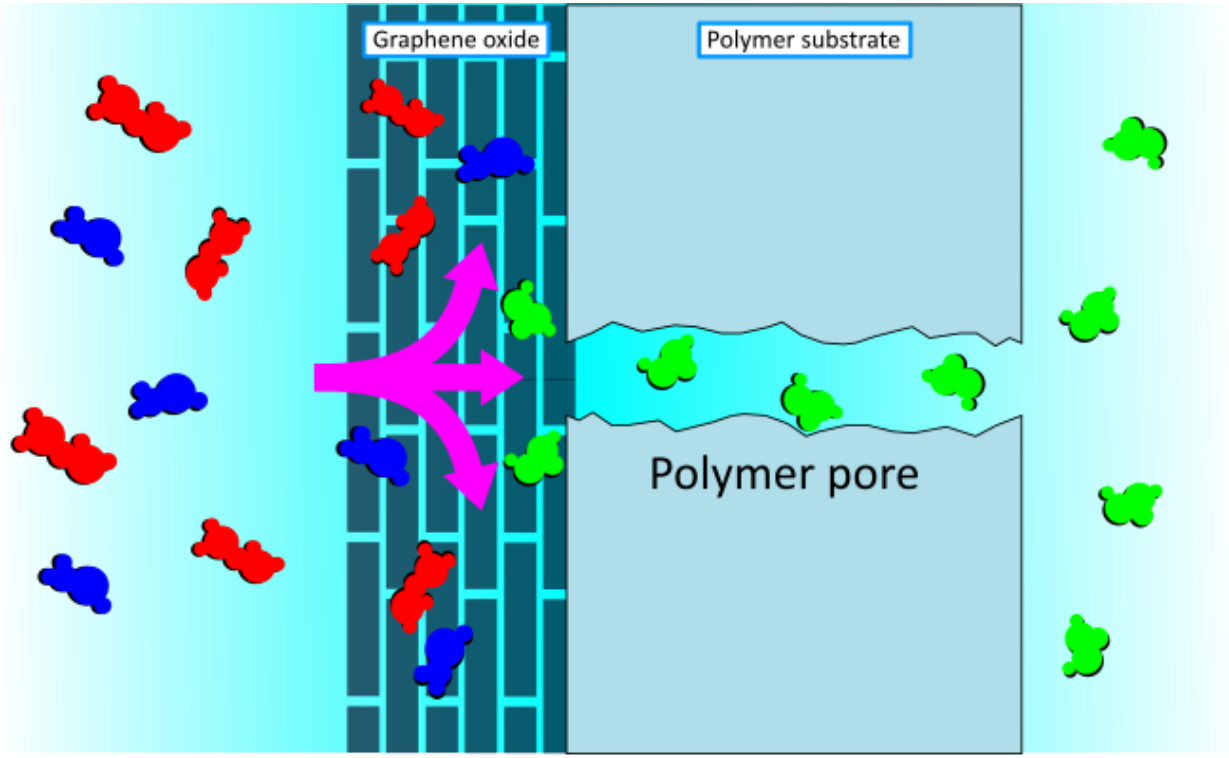
ζ-potential
+14,9 mV



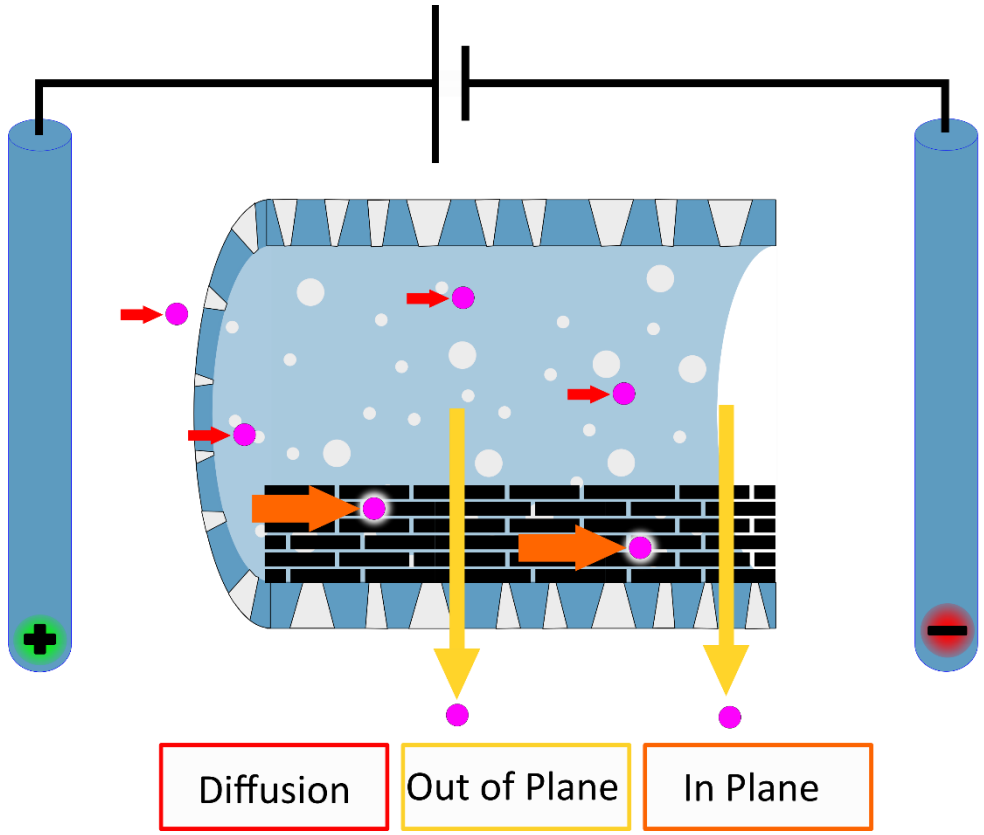
Institute for Water Research

Application of HF-GO Filters

Flow-Catalysis



Ion sieving



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MODENA E REGGIO EMILIA

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GRAPHENE FLAGSHIP

C3-SH1
Graphil

FLAG-ERA

GO-for-WATER

MIUR PRIN

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POR FESR
EMILIA-ROMAGNA
2014/2020

Core–shell graphene oxide–polymer hollow fibers as water filters with enhanced performance and selectivity

A. Bianchi', A. Kovtun', M. Zambianchi, C. Bettini, F. Corticelli, G. Ruani, L. Bocchi, F. Stante, M. Gazzano, T. D. Marforio, M. Calvaresi, M. Minelli,M. L. Navacchia, V. Palermo* and M. Melucci*, *Faraday Discuss.*, 2021, 227, 274-290

Chem. Commun., 2021, 57, 3765-3768

Chem. Eng. J., 2017, 130-140

Nanoscale, 2019, 11, 22780

J. Mater. Chem., 2010, 20, 9052-9060

Thank you for the kind attention!