Nanotechnologies for water treatments

From nanostructured electrodes for water splitting to bio-inspired microbial electrochemical cells and graphene-based desalination membranes

Marzia Quaglio

October 14, 2015

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Graphene as a key material

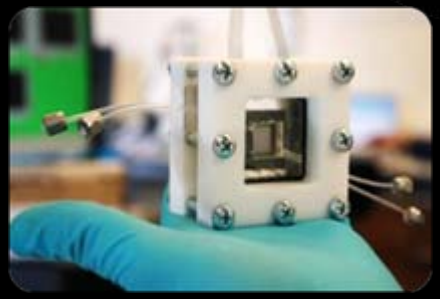
desalting

water

light

Bio Electro Chemistry

Photo Electro Chemistry



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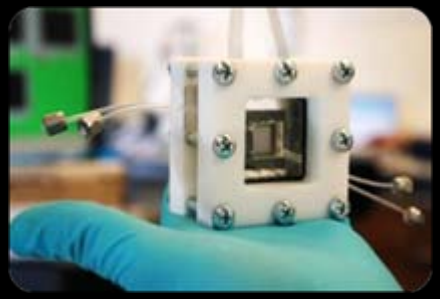
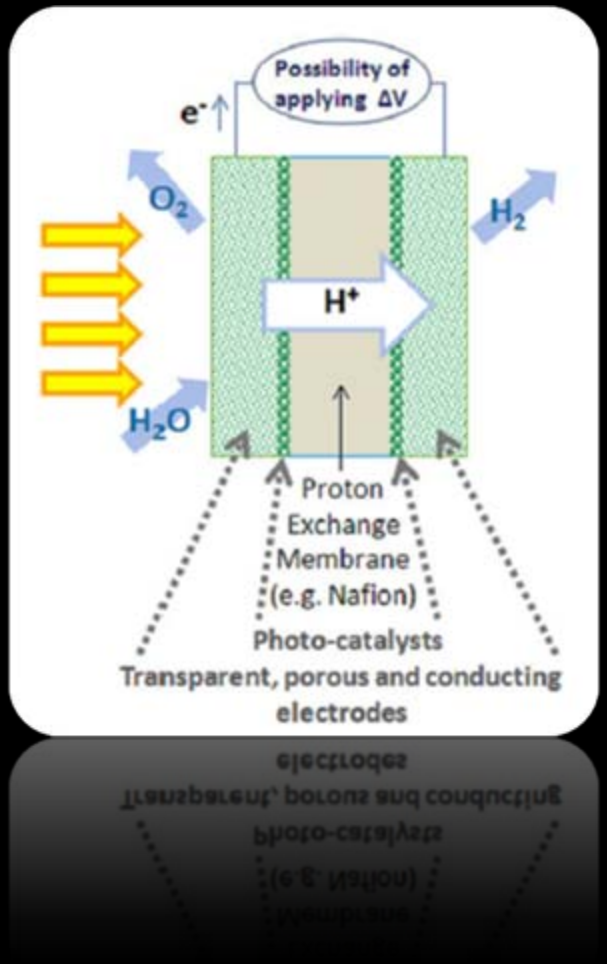


Photoelectrochemical water splitting



The photo-electrochemical water splitting, or “artificial photosynthesis”, is the light-driven splitting of water into H_2 and O_2

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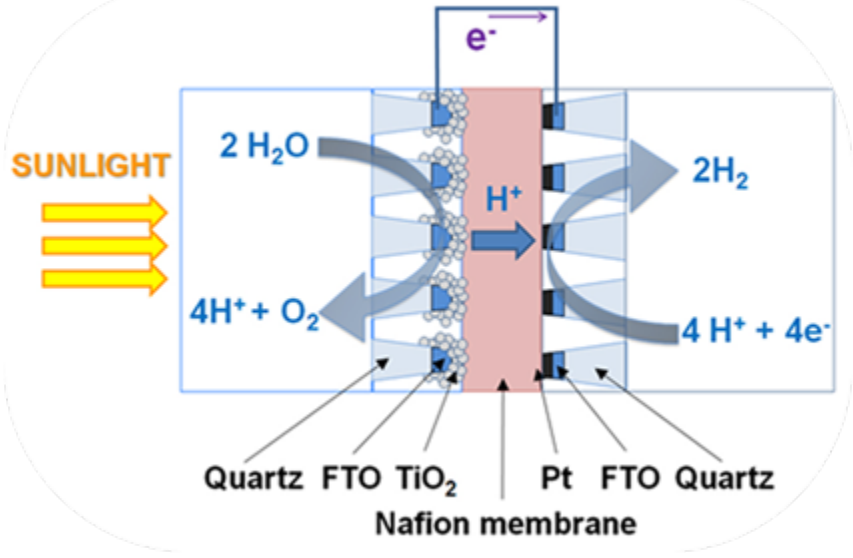
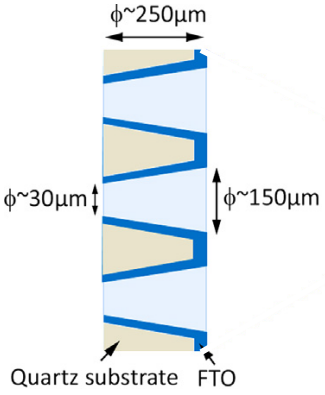
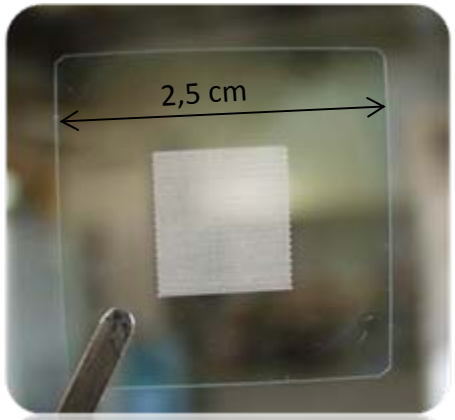
Novel PEC reactor







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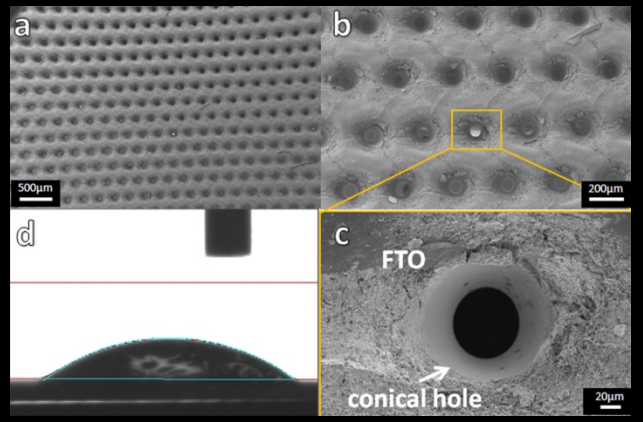

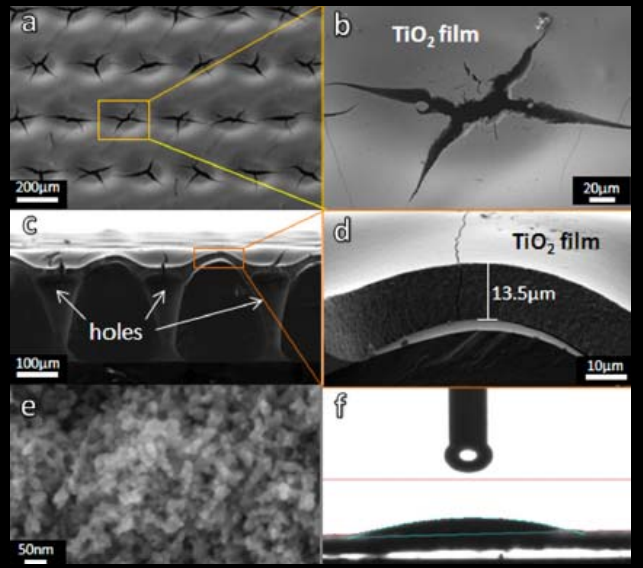

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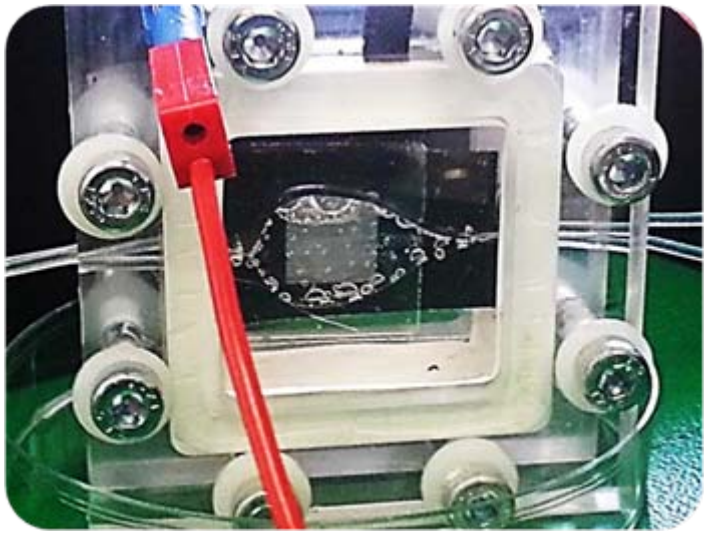

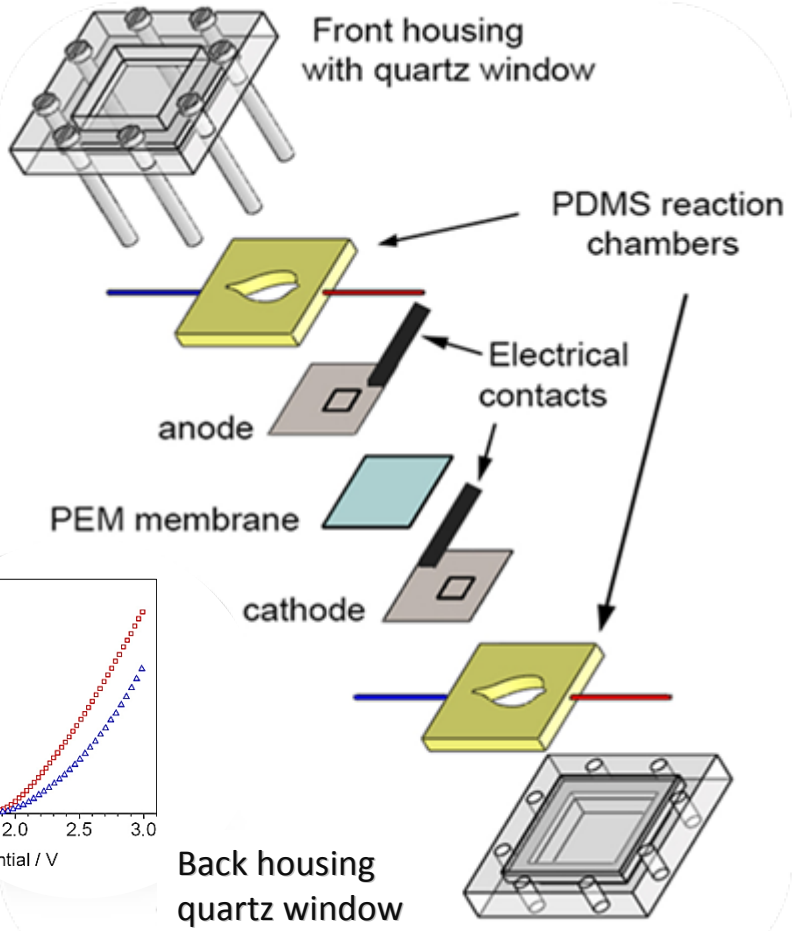

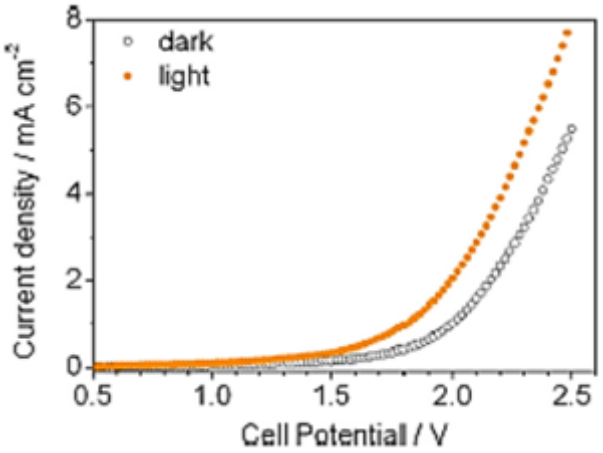

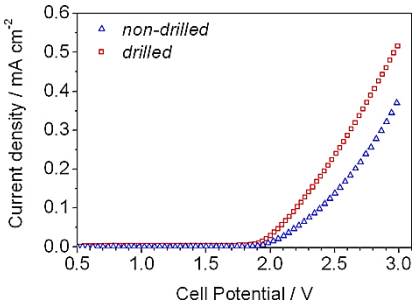

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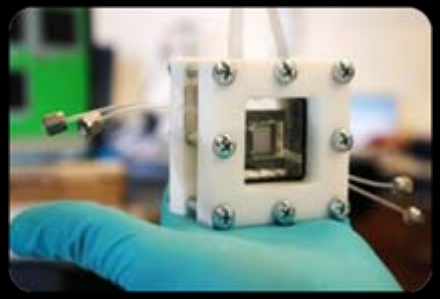
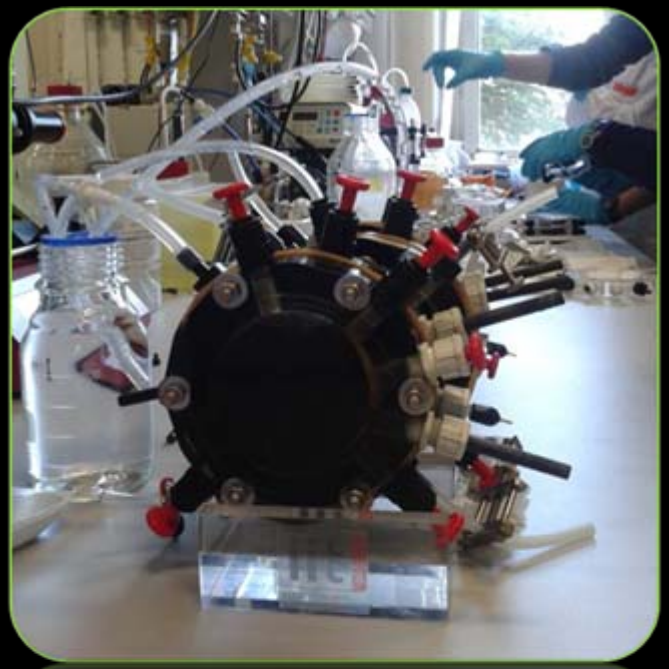
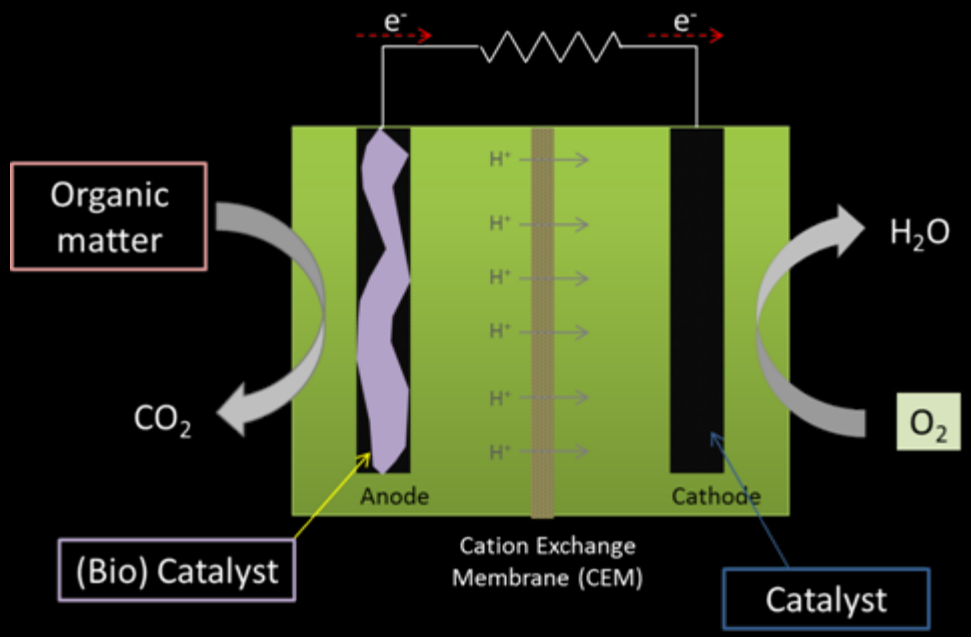


Bioelectrochemical device

Direct conversion of the chemical energy available in low grade fuels, as organic substrates, into electricity by the use of bio-catalysts as enzymes and whole bacteria.





Microbial fuel cells can directly harvest chemical energy from environmental and waste waters.

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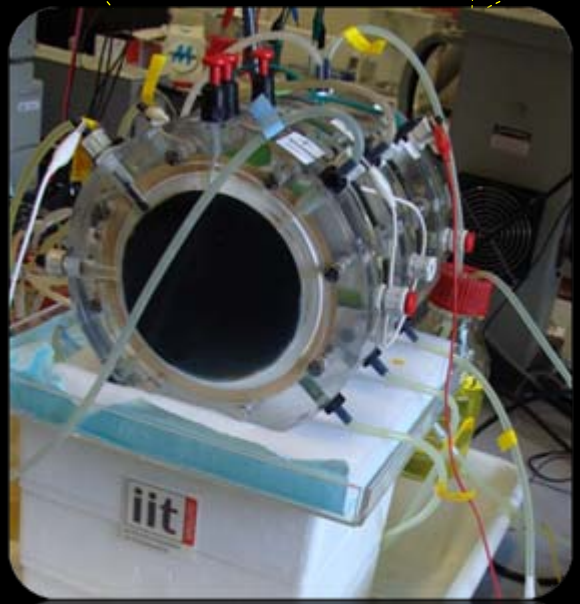
Why are MFCs so appealing

MFCs can combine energy production and water treatment

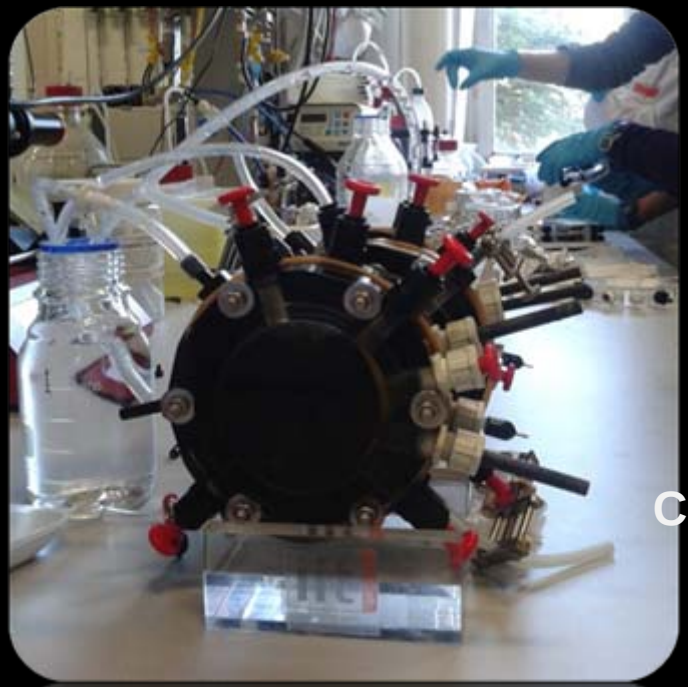


Key elements

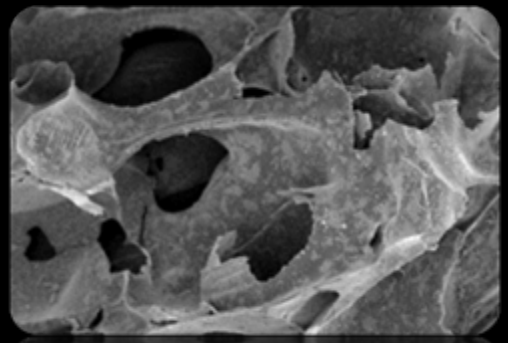
Bio-catalysts

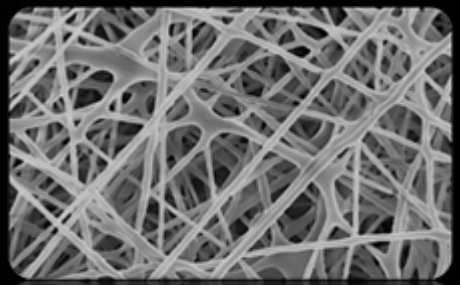
Optimization of exolectrogenic communities

Reactor Design



Catalysts and electrodes



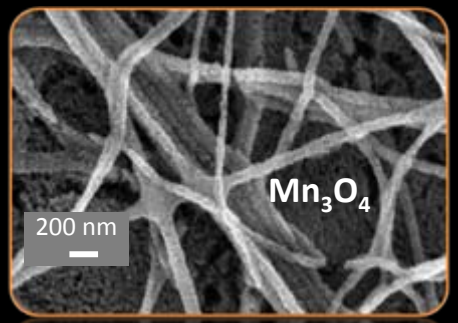


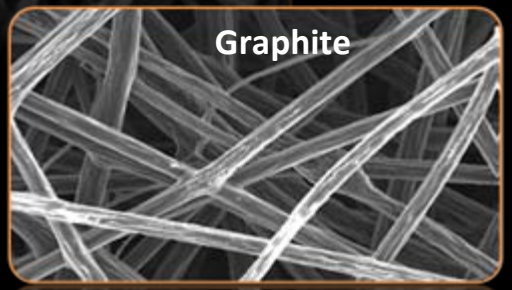
Nano structured materials

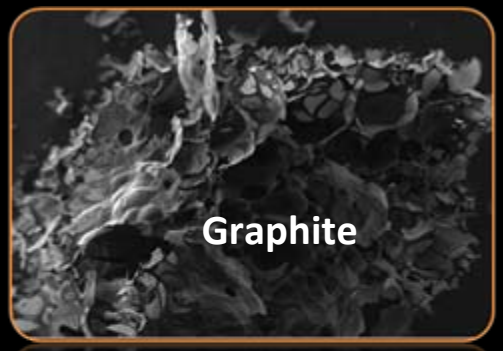
Inorganic catalysts

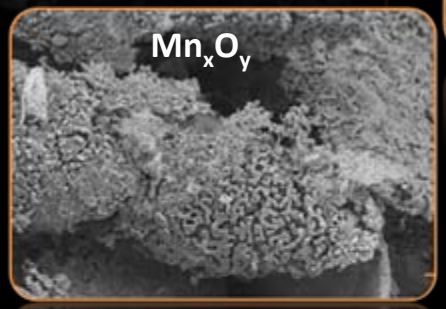
Electrodes

Nanofibers

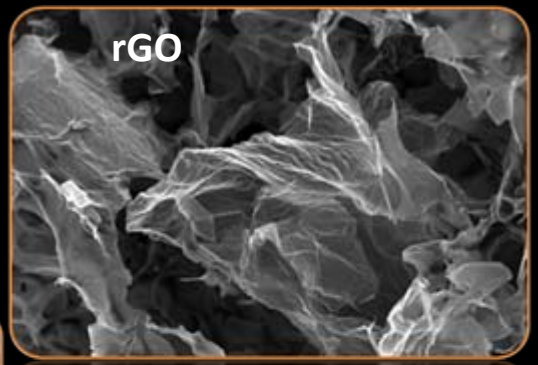








Aerogels



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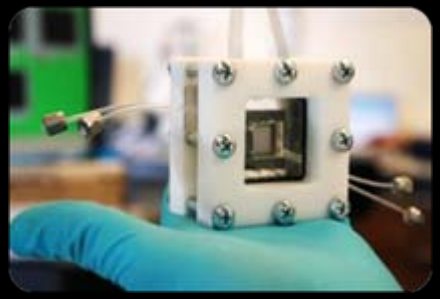
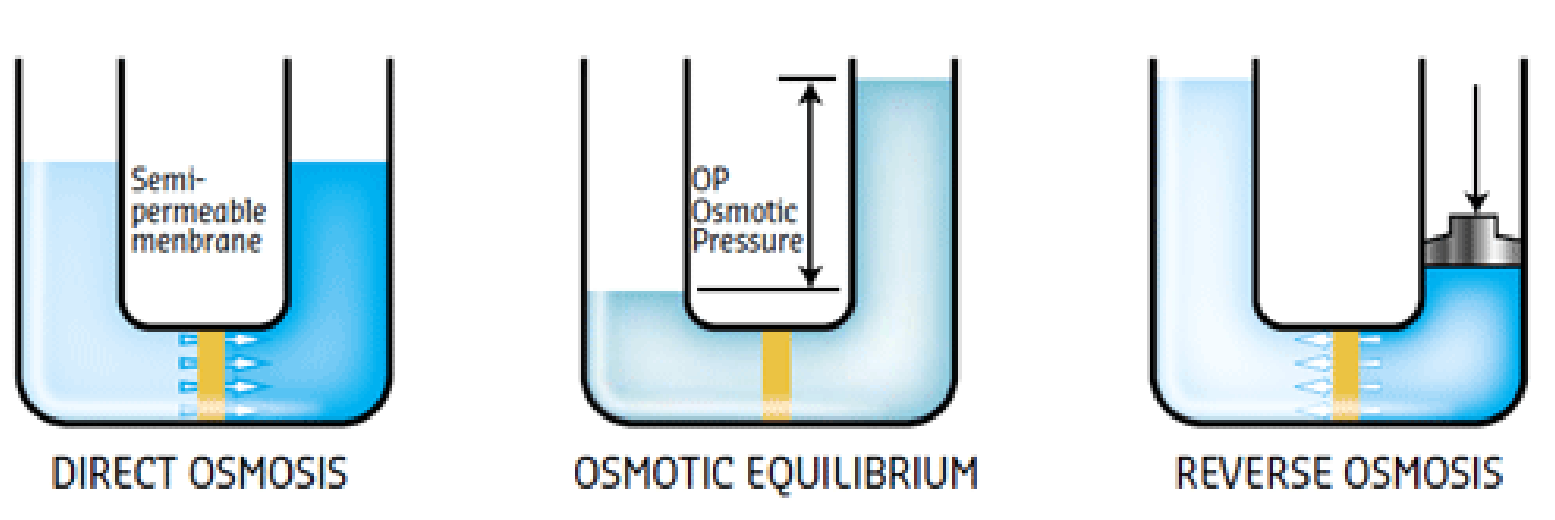


Fresh water from RO

Reverse osmosis (RO): by applying a pressure difference in excess of the osmotic pressure, pure water flows from high solute concentration side to the low solute concentratio side → separation of fresh water is achieved

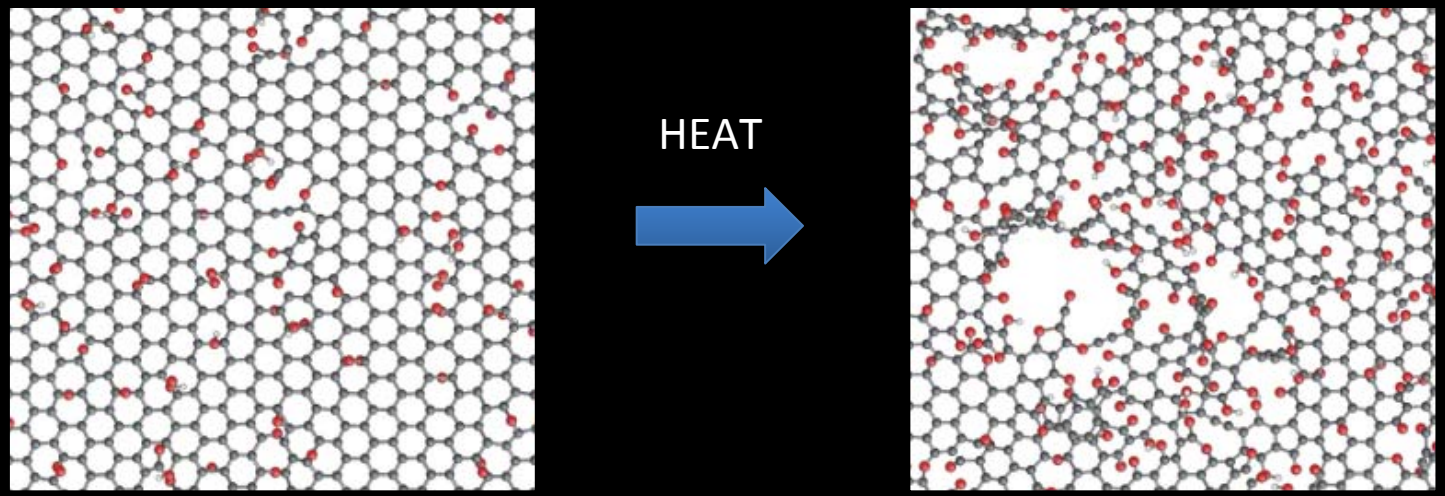


Recent theoretical studies have shown the ability of **porous graphene** to function as efficient RO membrane: fast flow rate, lower applied pressure and efficient salt retention have been predicted [Nanoletters 12, 3602 (2012)].

Fresh water from RO

Large scale application requires the production of controllable size pores (less than 1nm) with a scalable technological technique.

AIM: control pore formation in reduced graphene oxide (GO) by thermal treatment employing a combined theoretical (molecular dynamics – MD) and experimental approach.



Molecular dynamics simulations of pore formation in GO

Contacts: giancarlo.cicero@polito.it

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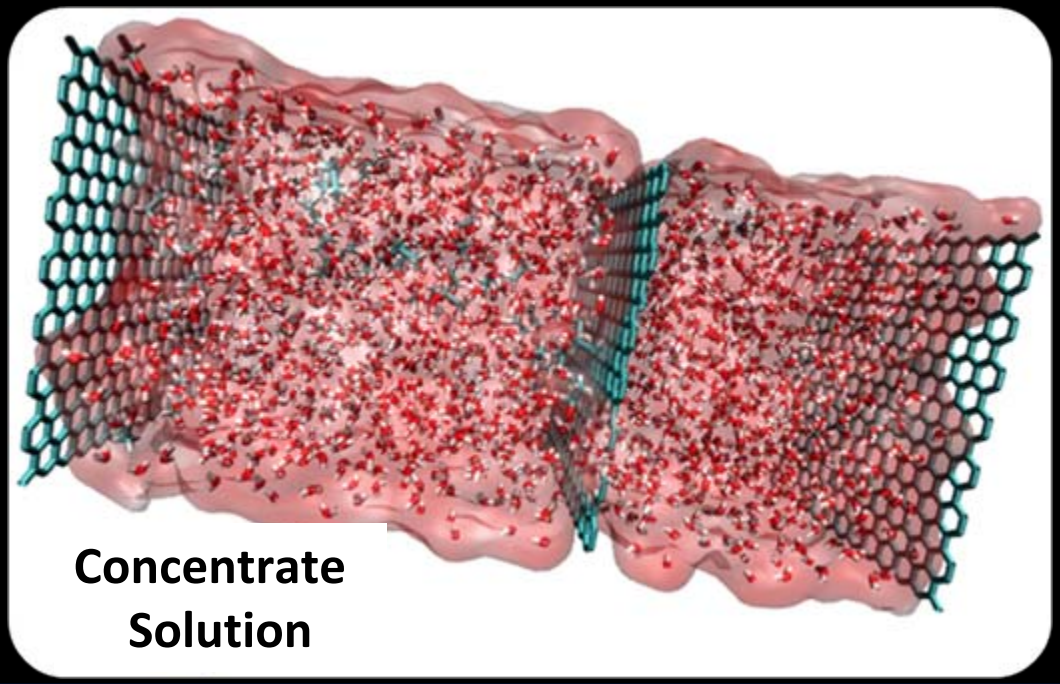

Non-equilibrium Molecular dynamics simulations are used to asses water permeability.

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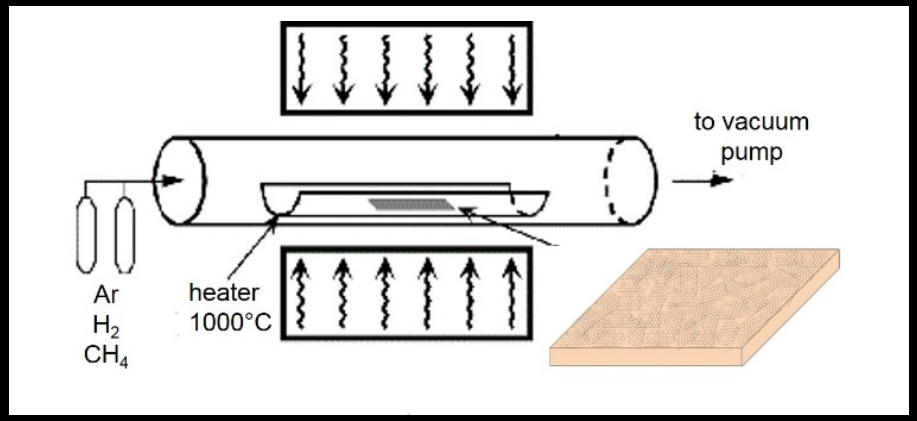
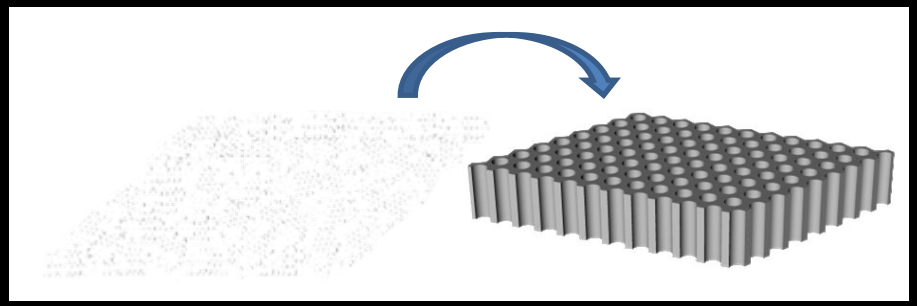
Porous Graphene @ POLITO

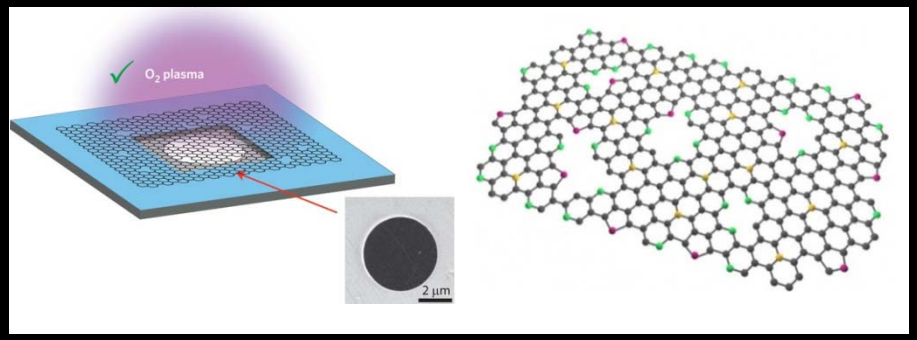
1) Growth of **Single Layer Graphene** on copper substrate by CVD



2) Copper etching and **graphene transfer** on a porous substrate



3) Graphene treatment for the selective creation of **controlled porosity**



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… for your attention