Pioneering Graphene Membrane: A Sustainable Ion Exchange Breakthrough within the IntelWATT EU Initiative

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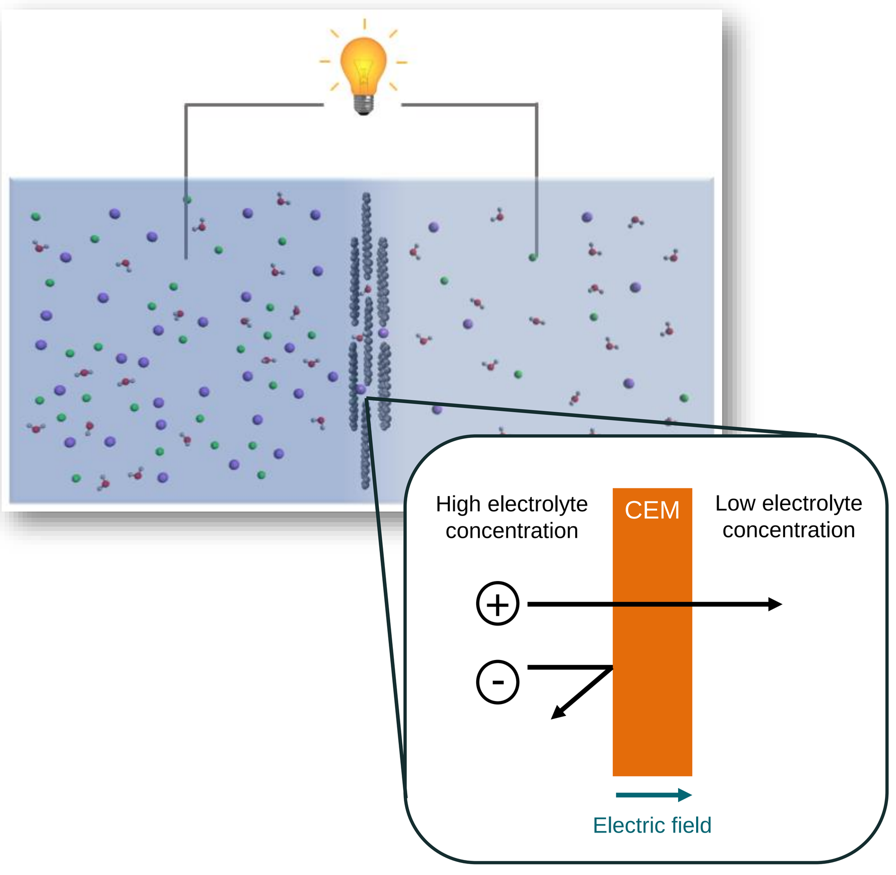
Introduction

Reverse electrodialysis (RED) arises as an eco-friendly technology exploiting the Nernst potential difference between two water streams to produce electricity.

Nevertheless, the feasibility of this technology depends on the performance of the **ion-exchange membranes** (IEM), main actors of this process.

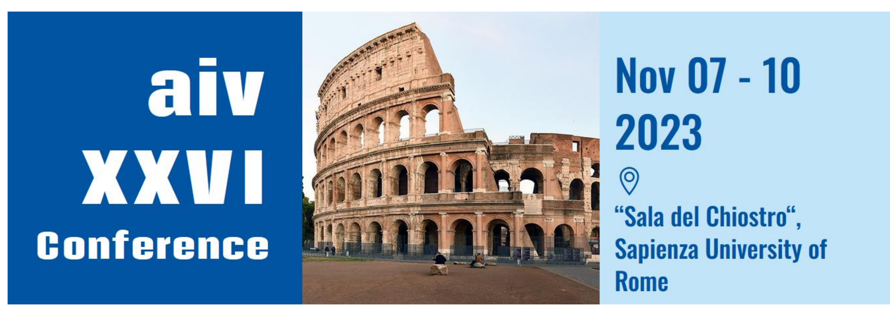
Energy harvesting



Motivation

2D materials show promising properties to be applied in ion exchange membranes for RED due to their great transport properties, low resistance, impressive mechanical strength, and antifouling characteristics. [1]

Graphene oxide (GO) membranes have been proposed in this study as they are naturally negatively charged thanks to their oxidized functional groups, have good mechanical strength, low cost, and facile synthesis. [2]



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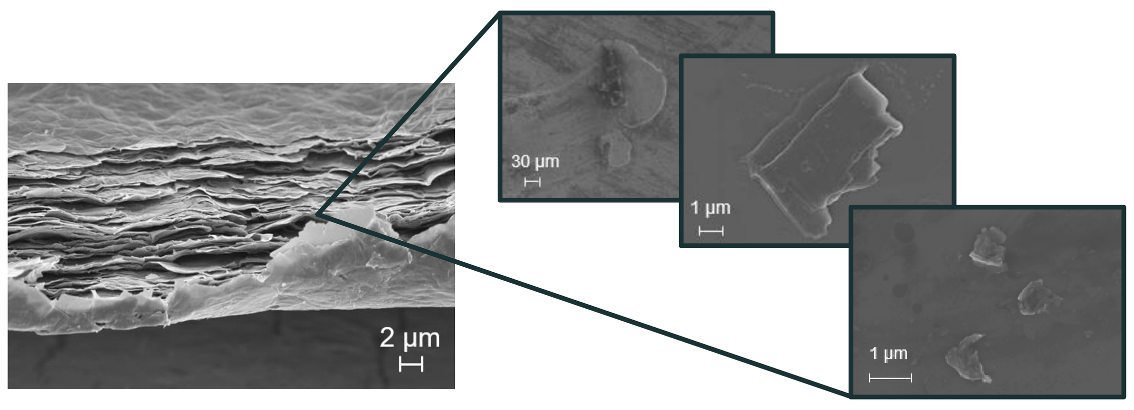
FABRICATION AND OPTIMIZATION OF MEMBRANES

Self-standing GO membranes

- Scalable fabrication method by Dr. Blade technique
- Chemical stability in acidic and basic media, organic solvents and high saline concentrations

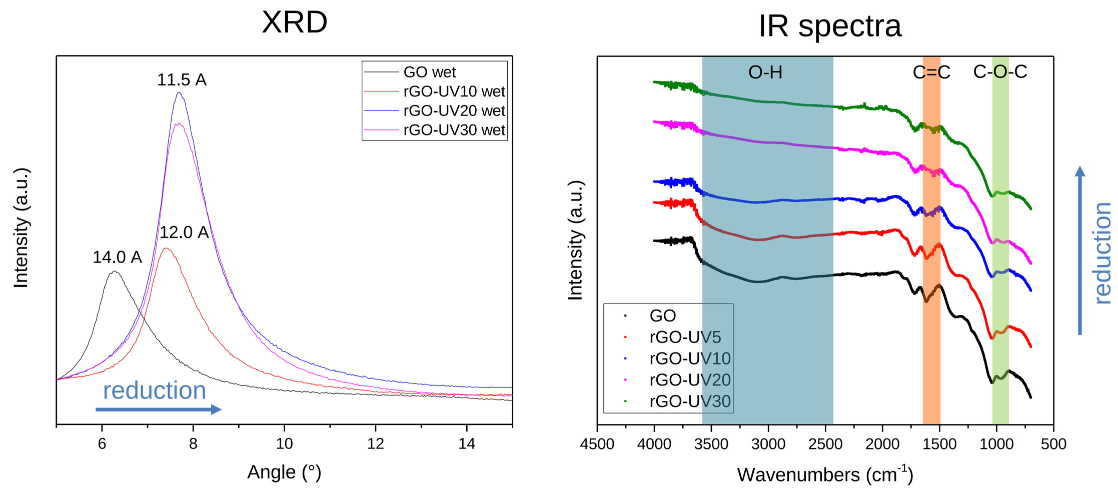
FESEM

- High stacking of GO flakes
- Size exclusion of flakes



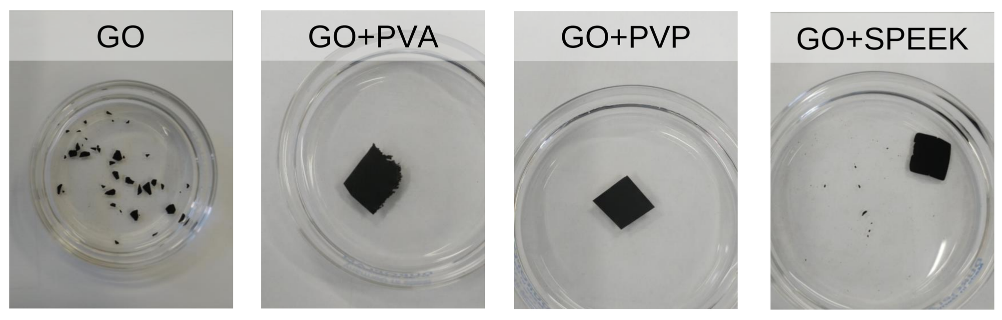
GO reduction

- UV irradiation of membranes caused a shrinking of the channels due to GO reduction.



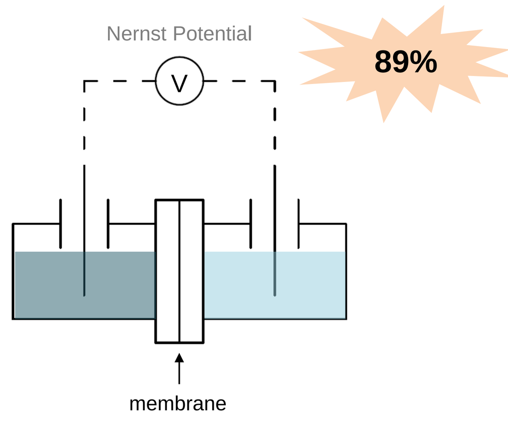
Composites with polymeric binders

- Polymeric binders were inserted into the membrane matrix to reinforce its structure in wet state.

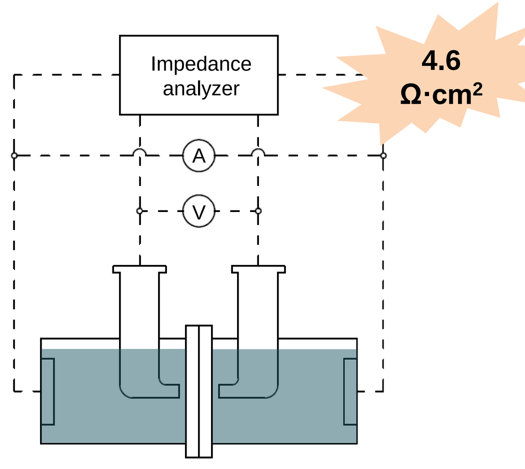


ELECTROCHEMICAL CHARACTERIZATION

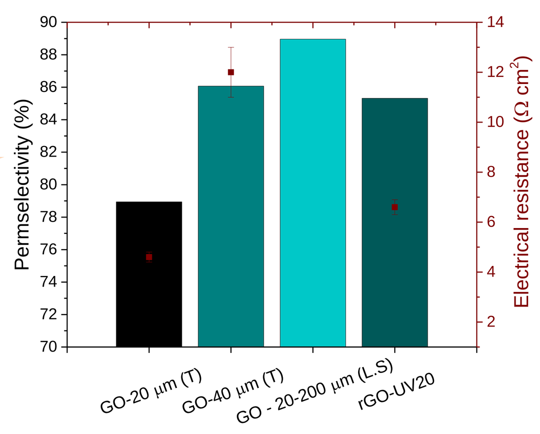
Permselectivity



Electrical resistance

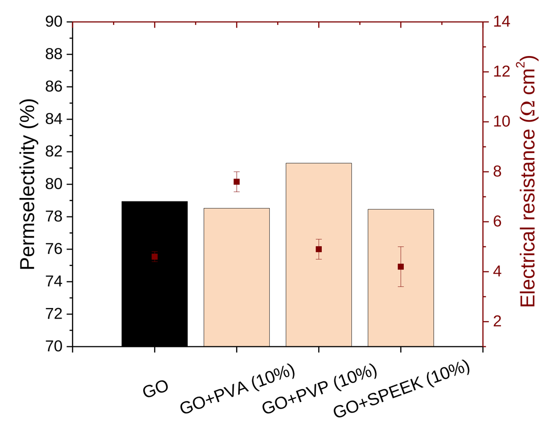


- There is a trade-off between permselectivity and electrical resistance.
- PVP and SPEEK presence does not significantly affect neither permselectivity nor electrical resistance.



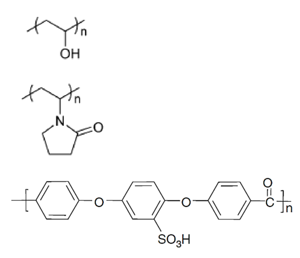
GO membranes comparison

- Thickness
- Lateral size of flakes
- UV irradiation (reduction)



Composite membranes comparison

- PVA
- PVP
- SPEEK



Conclusions and Future Outlook

Scalable **graphene oxide-based membranes** have been fabricated for **reverse electrodialysis** applications.
UV irradiation has been proposed as a **chemical-free reduction mechanism**. Results showed a permselectivity increase by almost 10% even though electrical resistance increases.
The use of **binders** was proposed in order to strengthen the **mechanical stability** of the membranes being the composite with PVP the most performant in terms of mechanical stability, permselectivity and electrical resistance.
Further studies will involve the development of a GO-based anion exchange membrane and its study on a real RED stack system.

Bibliography

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