"LOW COST" CATION EXCHANGE MEMBRANES FOR REVERSE ELECTRODIALYSIS: PREPARATION, CHARACTERIZATION AND OPTIMIZATION

M. Aquino[1,2], A.H. Avci[1], S. Santoro[1], E. Curcio[1]

[1]*Department of Environmental and Chemical Engineering DIAm UNICAL, University of Calabria.* Via P. Bucci CUBO 45A, 87036 Rende (CS) Italy

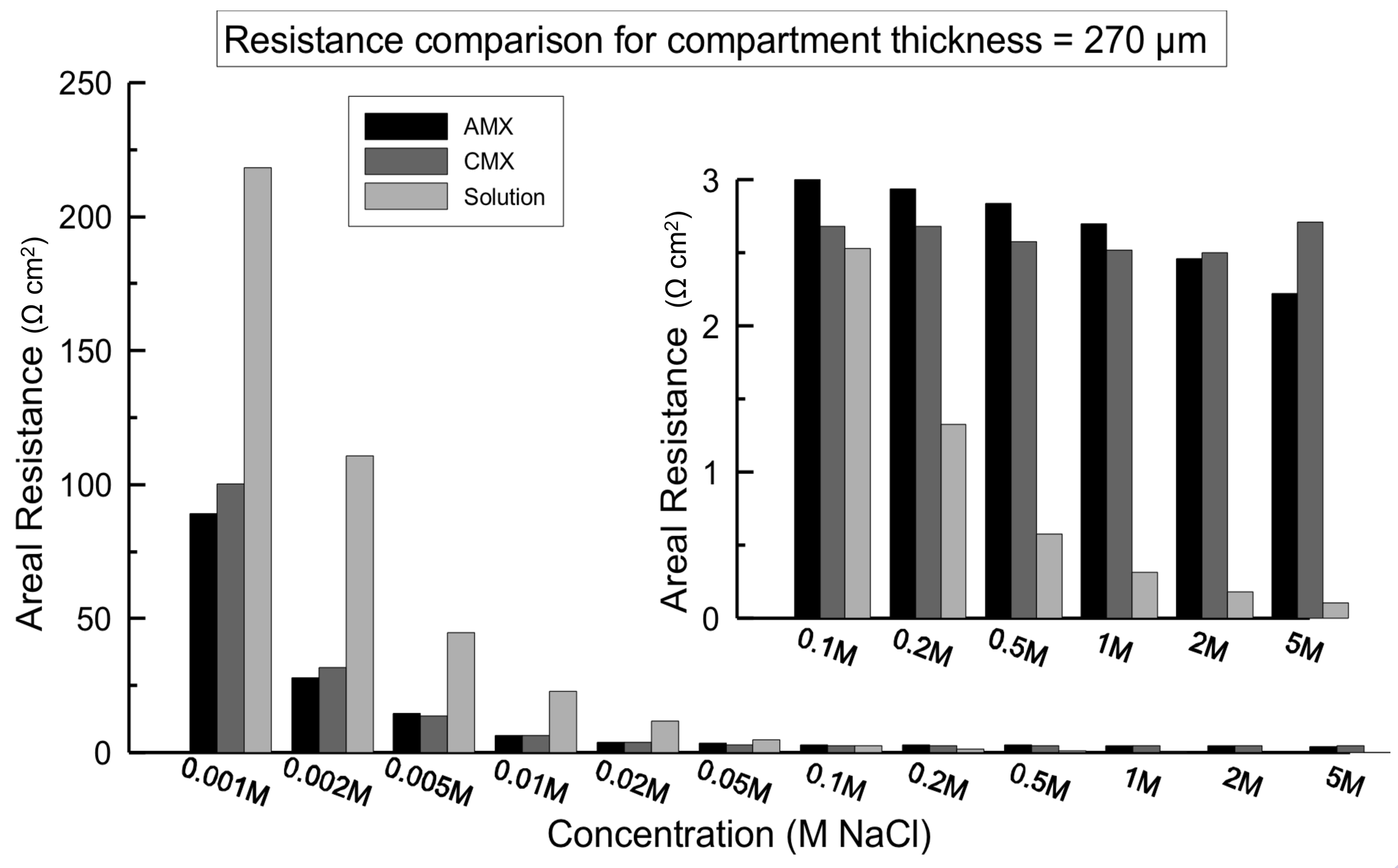
[2]*Department of Biology, Ecology and Earth Science DiBEST UNICAL,University of Calabria.* Via P. Bucci CUBO 45A, 87036 Rende (CS) Italy

Corresponding Author e-mail: marco.aquino@unical.it

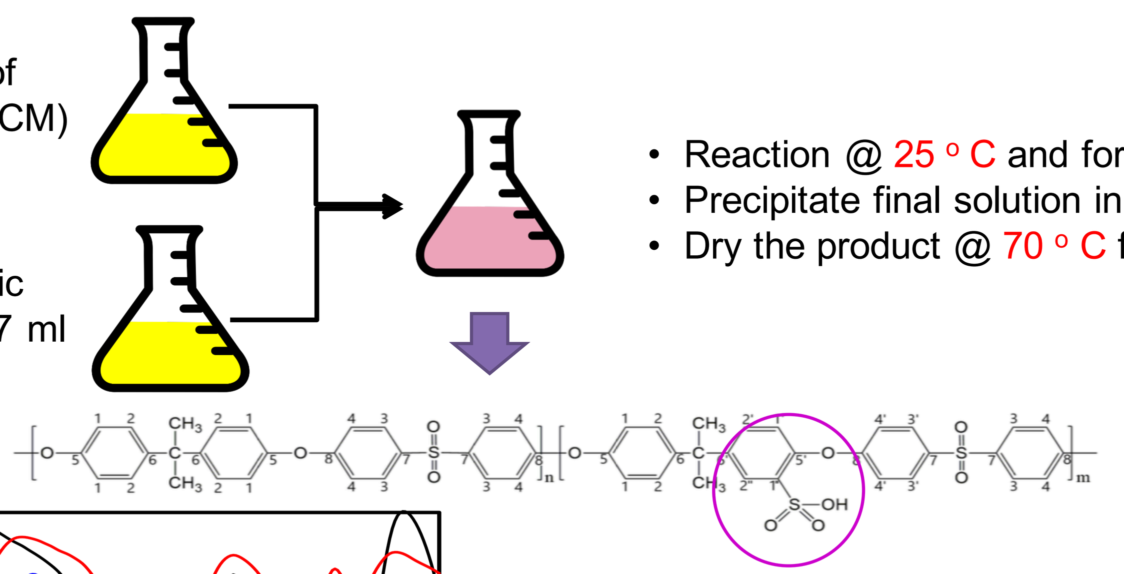
Introduction

Reverse Electrodialysis (RED) is an emerging technology able to convert the Gibbs free energy of mixing solutions into electric power, thus exploiting the salinity gradient established between two solutions having different concentrations [1]. RED, based on the use on Ion Exchange Membranes, allows of the production of the so-called "Blue Energy" or Salinity Gradient Power (SGP) [2].

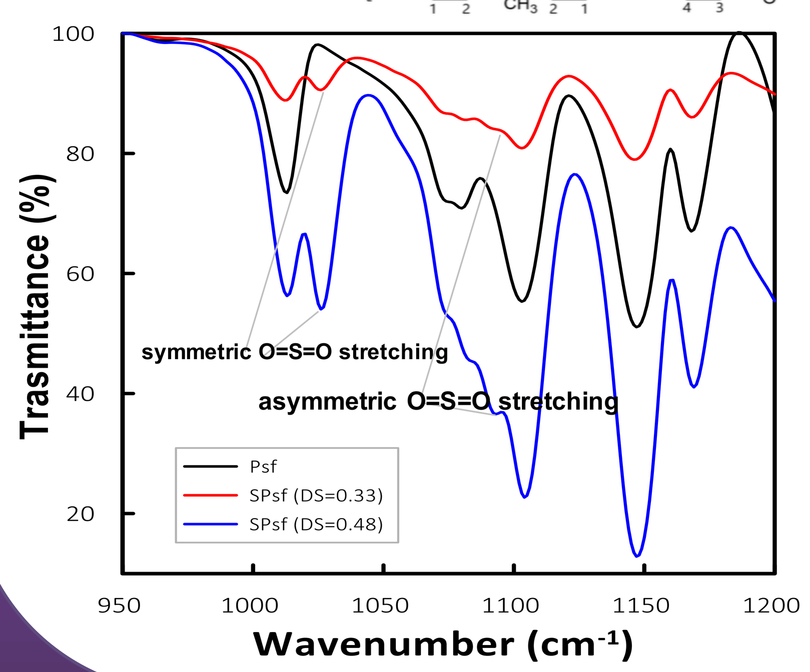
One of the main limitations to the commercialization of RED is the high membrane cost. In this respect, sulfonation of low cost commercial Polysulfone (PSf) was carried out in order to graft negatively charged groups onto the polymer structure. In the subsequent step, Cation Exchange Membranes (CEMs) were prepared by using the sulfonated polysulfone (S-PSf).

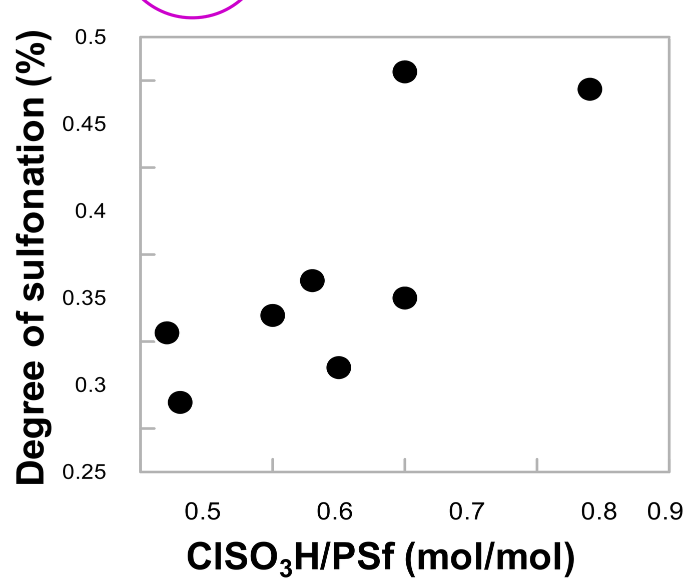


1.PSf sulfonation



- Reaction @ 25 °C and for 4 h
- Precipitate final solution in 4M NaCl (1000 ml)
- Dry the product @ 70 °C for overnight



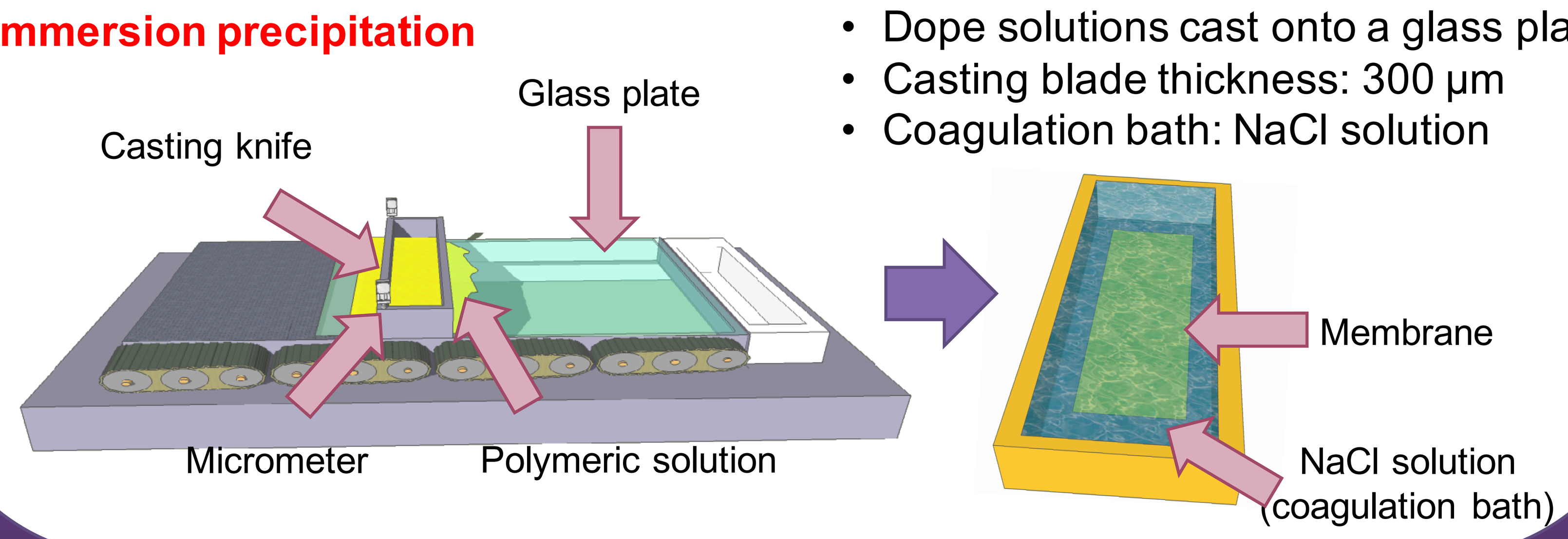


2.Membrane Preparation

Membrane	Solvent DMF (g)	Polymer SPSf DS=0.33(g)	Polymer SPSf DS=0.48(g)	method of preparation
S1	3	1	-	immersion precipitation
S1 D	3	1	-	solvent evaporation
S2	3	-	1	immersion precipitation
S2 D	3	-	1	solvent evaporation

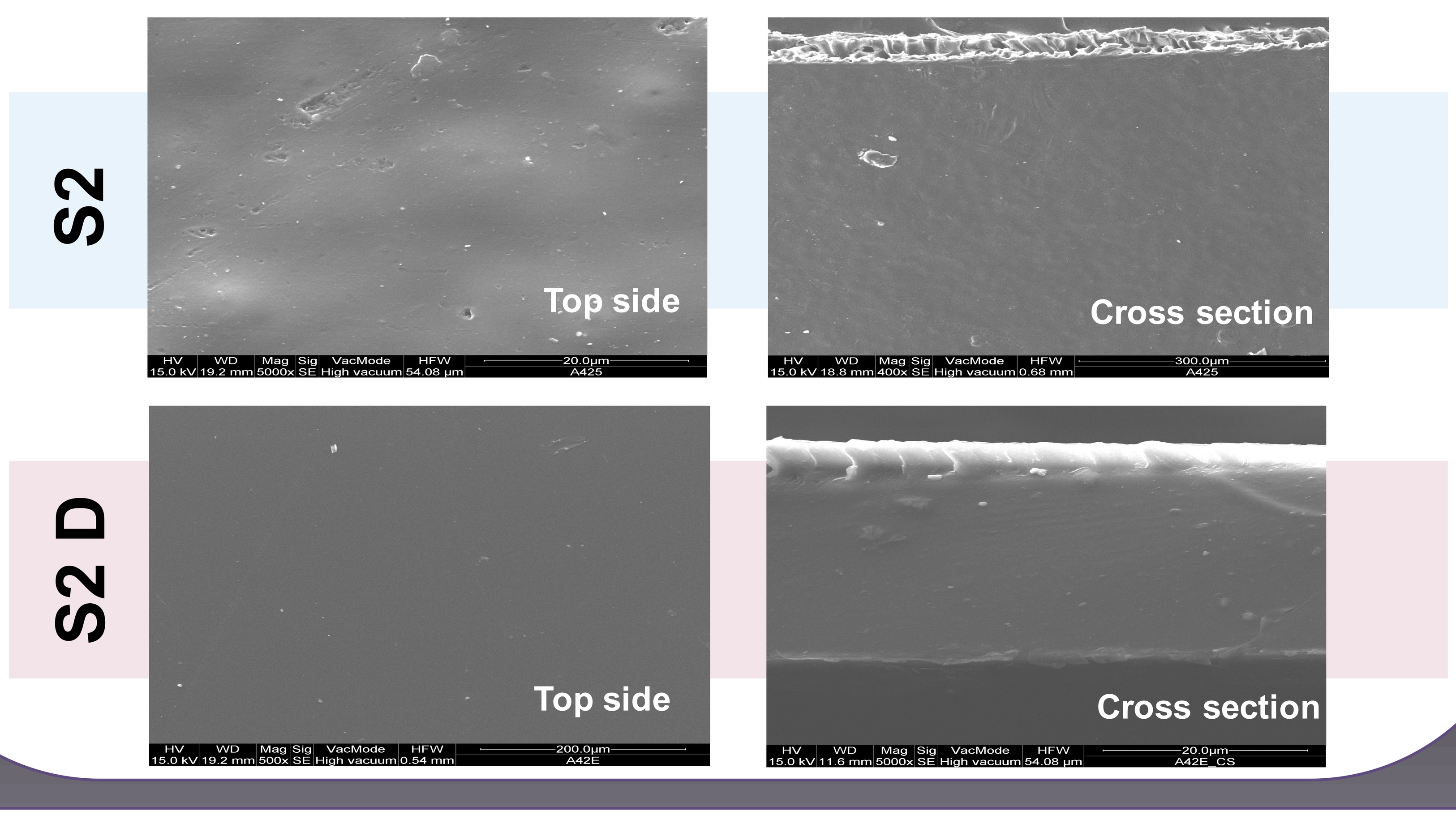
Immersion precipitation

- Dope solutions cast onto a glass plate
- Casting blade thickness: 300 μm
- Coagulation bath: NaCl solution



3.CEMs Characterization

Membrane	Thickness (μm)	Permselectivity α	Resistance (Ω cm²)	IEC (meq·g⁻¹)	Charge Density (mol L⁻¹)
S1	150	0.07	0.37	-	-
S1 D	40	0.99	629	0.71	4.9
S2	170	0.02	0.31	-	-
S2 D	80	0.98	9.95	1	5.1

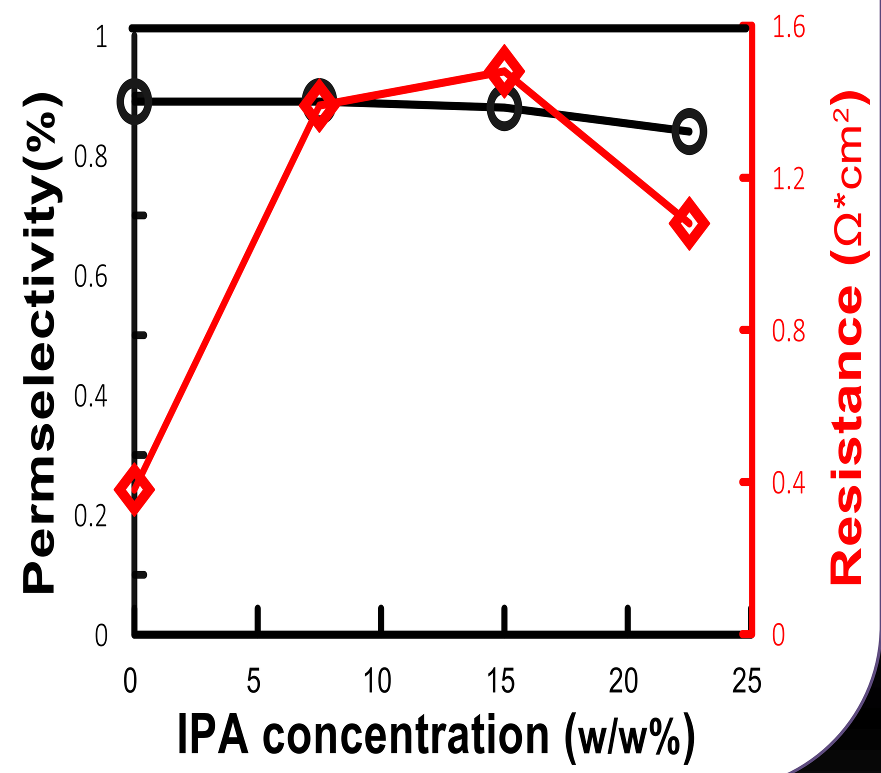


4.Membranes optimization

In order to enhance the electrochemical properties of CEMs, IPA was added the dope solution.

Membrane	Solvent (DMF)/ Cosolvent (IPA)/ Polymer (SPSf DS=0.48) (w/w%)
S21	75/0/25
S22	67.5/7.5/25
S23	60/15/25
S24	52.5/22.5/25

- Coagulation bath: isopropyl alcohol (IPA)



Conclusions

- PSf was successfully sulfonated to prepare novel asymmetric integral CEMs for application in RED.
- The most promising CEMs resulted from SPSf dissolved in mixture of 67,5/7,5/25 DMF/IPA /SPSf with ionic resistance of 1,39 Ω cm² and permselectivity of 0.89.
- Cheap and easy scalable sulfonation and membrane preparation procedures at lab-scale (price of CSA and PSf are 0.56 $ / kg and 2–7.5 $ / kg [3]) open new path for the practical implementation of RED.

Acknowledgment

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[2] *A.H. Avci et al Energy Harvesting from Brines by Reverse Electrodialysis Using Nafion Membranes. Membranes 10 (2020) 168.*
[3] *A.H. Avci et al. Tuning the Electrochemical Properties of Novel Asymmetric Integral Sulfonated Polysulfone Cation Exchange Membranes. Molecules 26 (2021) 265.*