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Main topic: 1D- and 2D-materials for membranes

Energy issues and environmental problems are forcing the researchers to investigate new ways to harvest energy from renewable sources. Reverse electrodialysis (RED) arises as an alternative technology which converts the Nernst potential between two water streams at different salt concentration into electricity. Nevertheless, the feasibility of this technology depends on the performance of the ion-exchange membranes (IEM), main actors of this process. 2D materials show promising properties to be applied in IEM 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]. One of the novelties of this project is the use of doctor blade technique as a scalable method for GO membranes production for RED application.

This work focuses on the study of the properties of GO membranes in terms of permselectivity and electrical resistance. GO membranes presented good ion selectivity and size exclusion towards monovalent cations, being Na^+ and K^+ the most performant ones. In addition, UV light irradiation has been proposed as an alternative green reduction method. GO reduction increased permselectivity of membranes by 10% due to a decrease of the nanochannels in the GO structure and a reduction of the swelling degree of the membranes. The addition of different binders has also been proposed in order to strengthen the mechanical resistance of membranes, showing no significant differences on the permselectivity measurements.

Electrical impedance spectroscopy was proposed to measure electric resistance of the membranes. Results show a dominant effect of the solution inside the membranes pores. Instead, membranes with binders and treated with UV-light presented a lag in the solution permeation.

Reference 1:
Macha, M., Marion, S., Nandigana, V. V. R. & Radenovic, A. 2D materials as an emerging platform for nanopore-based power generation. Nat. Rev. Mater. 4, 588–605 (2019)

Reference 2:
Ji, J. et al. Osmotic Power Generation with Positively and Negatively Charged 2D Nanofluidic Membrane Pairs. Adv. Funct. Mater. 27, 1–8 (2017)