2022「中技社科技獎學金」

2022 CTCI Foundation Science and Technology Scholarship

境外生研究獎學金

Research Scholarship for International Graduate Students

Physicochemical Modification of Graphene-based Membranes with Controlled Ionic and Molecular Separation for Wastewater Treatment and Desalination

利用物理化學法改質石墨烯基質薄膜控制離子與分子分離並應用於廢水處理與海水淡化

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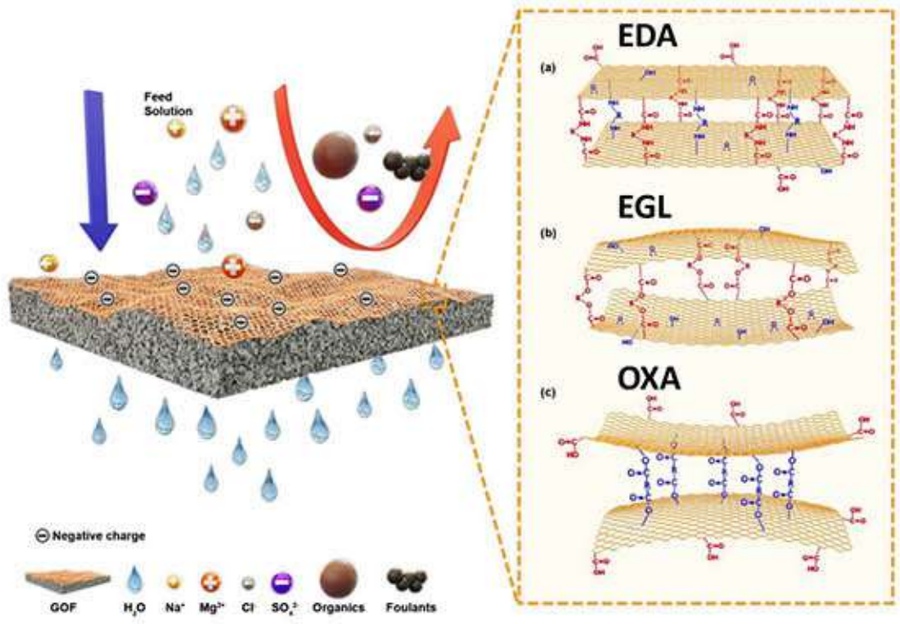
ABSTRACT

Graphene oxide (GO), a material that is proven to have favorable attributes in different applications is continuously being researched and employed in membrane-based separations including nanofiltration, but challenges including instability in aqueous environment, resulting to redispersion and swelling, as well as the difficulty in controlling the ion transport are still matters for concern. In this research, we addressed these problems by covalently crosslinking GO with different monomers of the same chain lengths, including ethylenediamine (EDA), ethylene glycol (EGL), and oxalic acid (OXA) to tailor specific crosslinking site, in able to subsequently improve the stability of the membranes while tuning the *d*-spacing for controllable transport of ions and molecules. These membranes produced via pressure-assisted filtration were subjected to physicochemical investigations where it revealed that surface properties including hydrophilicity and charge, as well as the membrane free volume were altered and each played a crucial role in their separation performance. The nature of crosslinker dictated the site where crosslinking happens (GO's edges or basal planes) and influenced the passage of species, especially the fast water permeation. The membrane crosslinked with OXA has displayed an excellent pure water permeability that could reach up to ~39.6 L m^{-2} h^{-1} at a pressure of 6 bar, a rejection for Na_2SO_4 of around 93%, and rejection of organic dyes, methylene blue and methyl orange of >99%. Moreover, the membranes were observed to have a stable performance in various operating conditions, and exhibited an outstanding antifouling property and chlorine resistance that are essential qualities needed for desalination in realistic conditions.

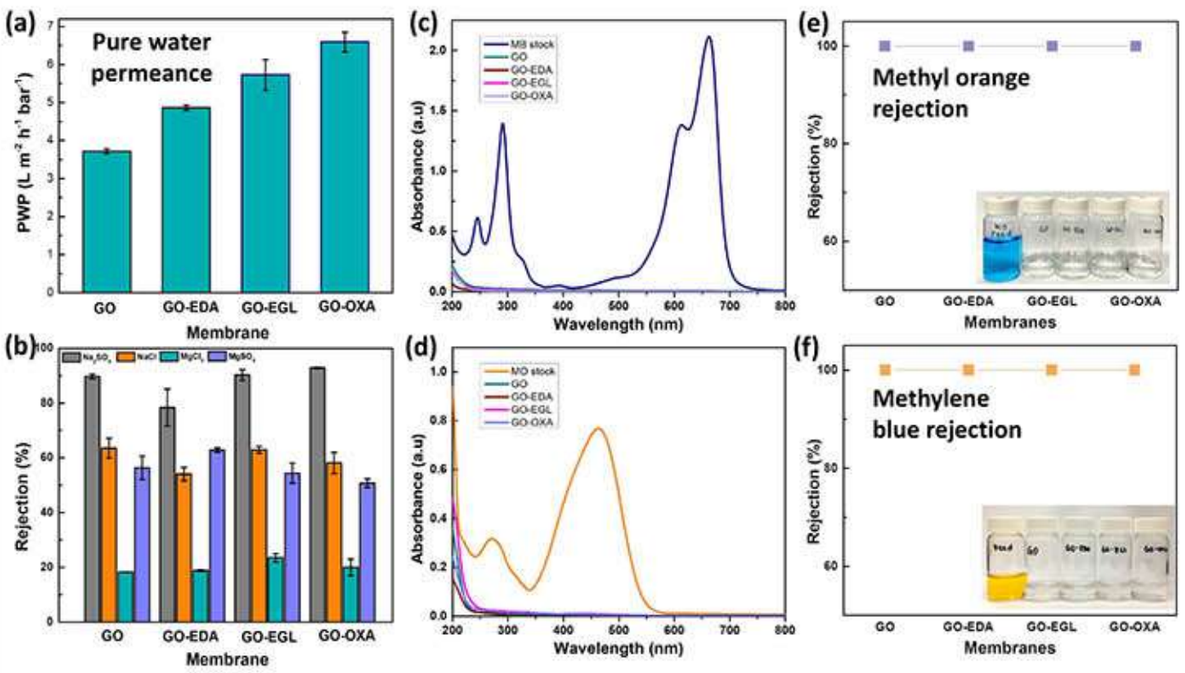
SCHEMATIC DIAGRAM

GO was crosslinked with different crosslinking agents and GOF were fabricated using pressure-assisted filtration to tune its physicochemical properties and desalination capability.



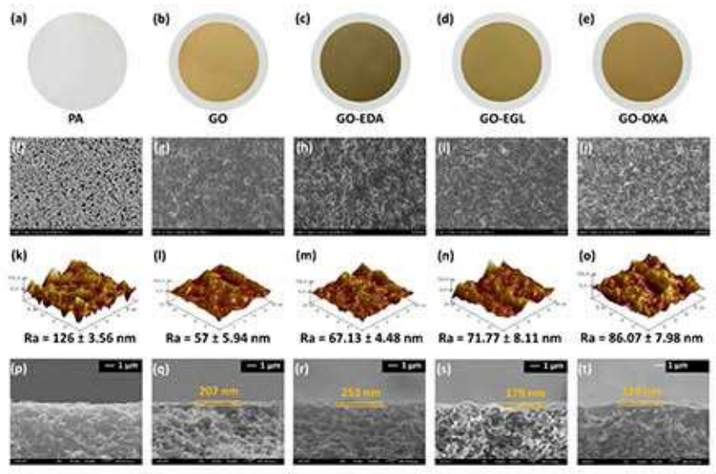
MEMBRANE PERFORMANCE

Permeance and rejection of GOFs toward different salt ions and dye molecules were examined using a laboratory scale cross-flow set-up consisting of four cells connected parallel to each other.

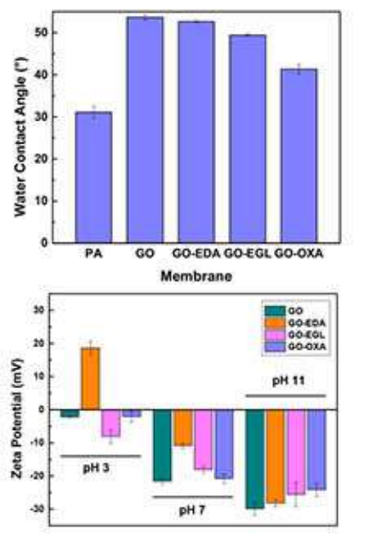


PHYSICOCHEMICAL PROPERTIES

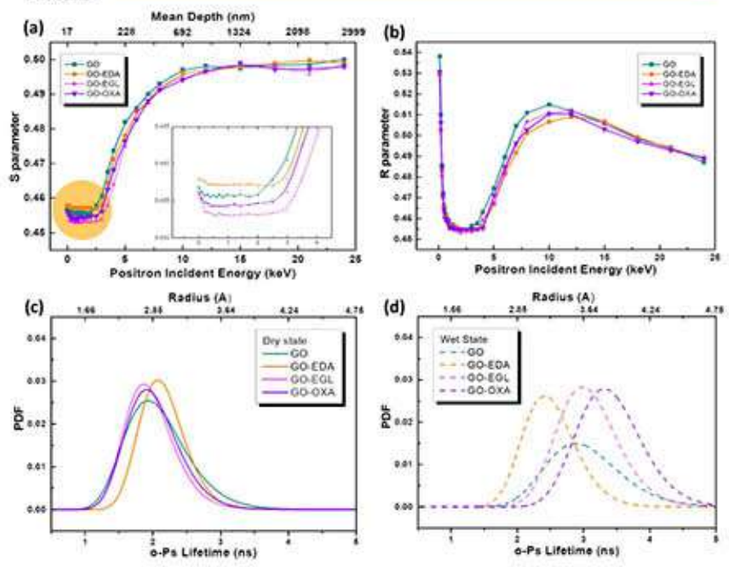
SEM and AFM



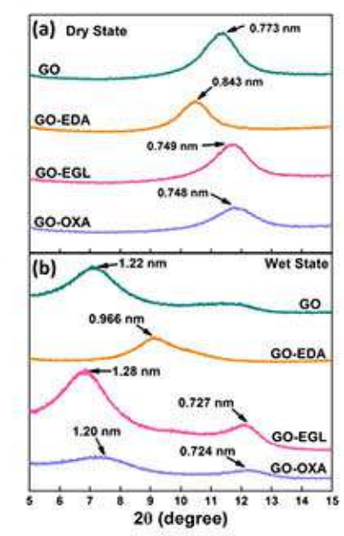
WCA and Zeta Potential



PALS



XRD



SELECTED JOURNAL PUBLICATIONS

1. **Austria, H. F. M.**, Lecaros, R. L. G., Hung, W. S.*, Tayo, L. L., Hu, C. C., Tsai, H. A., Lee, K. R., Lai, J. Y.. Investigation of salt penetration mechanism in hydrolyzed polyacrylonitrile asymmetric membranes for pervaporation desalination. Desalination, 463, 32-39.(2019) SCI journal (Water Resources)
2. **Austria, H. F. M.**, Subrahmanya, T.M., Setiawan, O., Widakdo, J., Chiao,Y. H., Hung, W. S.*, Wang, C. F., Hu, C. C., Lee, K. R., Lai, J. Y.. A review on the recent advancements in graphene-based membranes and their applications as stimuli-responsive separation materials. Journal of Materials Chemistry A, 9, 21510-21531.(2021) SCI journal (Materials Science, Multidisciplinary)
3. Widakdo, J., Wu, P. W., **Austria, H. F. M.**, Hung, W. S.*, Yu, P. J., Wang, C. F., Hu, C. C., Lee, K. R., Lai, J. Y.. Dual functional GO-Ag incorporated nanocomposite pervaporation membrane with alcohol dehydration performance and enhanced antibacterial property. Materials Today Chemistry, 24, 100985.(2022) SCI journal (Materials Science, Multidisciplinary)
4. Subrahmanya, T. M., Widakdo, J., **Austria, H. F. M.**, Hung, W. S.*, Kurkuri, M. D., Wang, C. F., Hu, C. C., Lee, K. R., Lai, J. Y.. Flow-through in-situ evaporation membrane enabled self-heated membrane distillation for efficient desalination of hypersaline water. Chemical Engineering Journal, 139170.(2022) SCI journal (Engineering, Chemical)