Application of graphene oxide membranes for proton transport and nanoconfined water

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Understanding mass transport through nanopores and nanochannels is essential for advancing membrane-based separation technologies. Graphene and its derivatives-such as graphene oxide (GO) and reduced graphene oxide (rGO)-are atomically thin, two-dimensional materials with exceptional physical and chemical properties. The ease of fabricating GO into membranes offers a practical advantage over conventional materials in separation applications. GO has emerged as a highly promising membrane material due to its unique two-dimensional structure and abundance of functional groups. The hydrophilicity and chemical reactivity of these functional groups enable GO to interact with a wide range of ions and molecules. This versatility supports the design of membranes with tunable porosity and selectivity. In membrane form, GO sheets are stacked into multilayers, creating tortuous pathways for molecular transport. These pathways involve both horizontal transport along the plane of the GO sheets and vertical transport through the interlayer spaces. Consequently, mass transport through GO membranes can be modulated by tailoring either the in-plane sheet characteristics or the interlayer structure. Lateral transport is governed by flake size and surface chemistry, while vertical transport can be controlled via interlayer spacing and membrane thickness. In this presentation, I will explore the applications of GO-based membranes. These include: investigating the mechanism of ultrafast proton transport in relation to structural evolution during drying; and employing GO-based nanopores to study nanoconfined water and its temperature-dependent phase transitions.

References

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