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Water and Ion Sorption, Diffusion, and Transport in Graphene Oxide Membranes Revisited

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Abstract

Graphene oxide (GO) membranes show promising separation performance, including high water permeation rate and rejection of ions or molecules larger than the interlayer distance of adjacent GO sheets. However, the fundamental water and small ion transport properties of GO membranes are still debated due to the heterogeneity of the physical and chemical structures of GO sheets. Here, we report the sorption, diffusion, and permeation properties of water and ions in GO membranes. The water permeability coefficient of GO membranes is in the range 3.0×10^{-7}-1.0×10^{-6} cm^2/sec and strongly depends on the flake size, the oxidation level, and the drying process. This value is not as high as reported in the literature and is similar to that of polymeric materials used for desalination, such as polyamide. Unexpectedly, a high water partition coefficient (0.93) was observed in GO membranes compared to those of other hydrophilic polymers. This contributes to the water permeability based on a solution-diffusion mechanism. Consequently, the water diffusivity of GO membranes is lower than that of hydrophilic polymers with similar water permeability due to the high tortuosity caused by its lamellar structure. In this study, we showed that GO membranes exhibited unique ion selective sorption and permeation behaviors compared to conventional polymeric membrane materials. The physical and chemical modifications of GO membranes strongly affect the transport properties of water and ions, indicating the