Ion conductance of graphene oxide/tungsten disulfide composite membranes

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In the search for alternatives to polymer-based membranes for industrial applications, laminar graphene oxide (GO) membranes are regarded as potential candidates for applications such as desalination and purification due to their exceptional permeation rates and high selectivity [1,2]. In this study we explore the effects of incorporating tungsten disulfide (WS_2) nanoparticles into laminar GO membranes. Therefore, ion transport properties were investigated with the aim to enhance membrane ion conductance by modifying the membrane structure.
Morphology of the composite membranes was analysed using Raman spectroscopy, X-ray diffraction and scanning electron microscopy, allowing detailed examination of structural changes upon incorporation of WS_2. Ion transport properties were assessed using electrochemical impedance spectroscopy and cyclic voltammetry. Adding even small amounts of WS_2 (1%) to the composite lead to a significant decrease in membrane density and ionic resistance compared to its pure GO counterpart. Analysis of the membrane morphology revealed changes in the stacking of GO sheets due to the incorporation of WS_2 nanoparticles, possibly creating new pathways for ion transport, leading to an improved ion conductance.
At higher WS_2 concentrations, a faradaic resistance that was possibly introduced by charge trapping and that dominated ion kinetics, emerged. With these findings we demonstrate the potential of two-dimensional composites to tailor membrane properties and enhance performance for various applications.

[1] X. Jin *et al.*, Adv. Mater. 32 (2020) e1907580
[2] R. R. Nair *et al.*, Science 335 (2012) 442–444

Figures

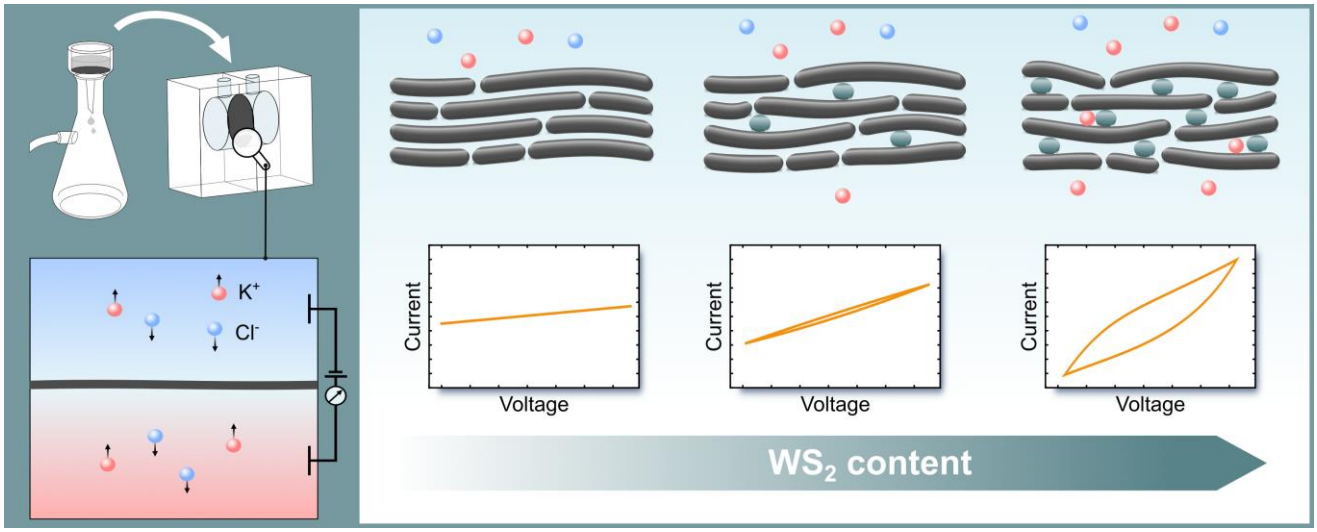

Figure 1: Graphical overview of the ion transport properties in GO/ WS_2 composite membranes. The incorporation of WS_2 nanoflakes modifies the membrane morphology, leading to enhanced ion conductance and the emergence of a faradaic component.