Nanochannelled graphene membranes for effective water purification

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Water security is a pressing challenge for the 21st century. Concerns over clean water supply, and the environmental impact of household, agricultural, and industrial waste waters, make water treatment a world-wide problem requiring a simple and effective solution. While extensive research has advanced the field, the inability of membranes to maintain their performance when treating a wide spectrum of polluted waters remains an important unsolved problem for water desalination and purification.

Recently, graphene-based materials were predicted to offer unprecedented improvements to membrane performance[1]. Pore-engineered chemical vapour deposition (CVD) graphene films have shown promise for next-generation membranes[2], however scale-up has been limited by difficulties in uniformity of nanopore generation[3,4]. Graphene oxide membranes have achieved 97% rejection of 0.1 M NaCl by forward osmosis, but rely upon a sucrose draw solution which is impractical[5]. Other studies using reverse osmosis (RO) achieved only 85% rejection of 0.034 M NaCl with a 5 MPa driving pressure[6].

This talk will present our recent advances in the development of permeable CVD graphene membranes that operate in a membrane distillation (MD) process and are capable of purification of water contaminated by a variety of chemical species (salts, surfactants, oils, acids, bases)[7,8,9]. Water permeation through the graphene membrane is enabled by nanochannels that form through multilayer, mismatched, partially overlapping graphene grains (Figure 1), which is confirmed through a variety of TEM, STEM and EDX mapping characterisation. Real-world capability of our membrane is demonstrated by processing a variety of contaminated waters, notably sea water from Sydney Harbour, with 99.9% rejection of NaCl over 72 hrs.

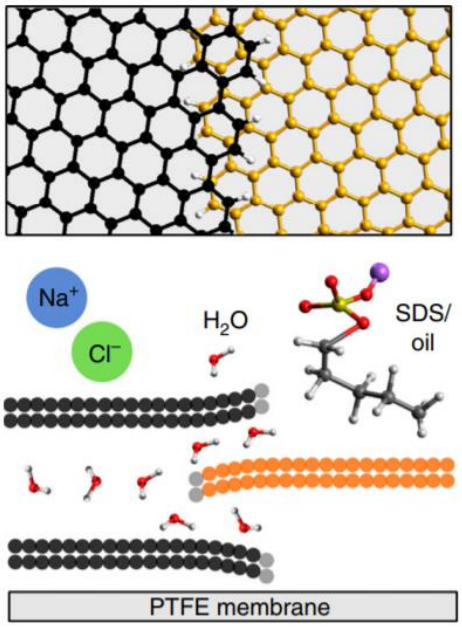

Figure 1: Schematic of nanochannelled graphene membrane.

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