**ABSTRACT**.

**Large-Area fabrication of Graphene-based Membranes by Shear Alignment of Discotic Nematic Liquid Crystals of Graphene Oxide**

Graphene-based membranes demonstrating ultra-fast water transport, precise molecular sieving of gas and solvated molecules, have been considered for a host of applications in desalination, gas separation and pervaporation; however scale-up of these membranes to large-areas remains an unresolved problem. Here we are going to present that the discotic nematic phase of graphene oxide (GO) can be shear aligned to form highly ordered, continuous, thin films of multi-layered GO on a support membrane by an industrially-adaptable method to produce large-area in less than 5 seconds. The pseudoplastic, shear thinning fluid of the nematic phase of GO promotes membrane formation by enhancing wetting and spreading at high shear rates, while resisting dewetting at low shear rates. Pressure driven transport data demonstrate high retention (> 90%) for charged and uncharged organic probe molecules with a hydrated radius above 5 Å as well as modest (30-40%) retention of monovalent and divalent salts. The highly ordered graphene sheets in the membrane plane make organized channels and enhance the permeability of the membrane ($71 \pm 5$ l $m^{-2}$ $hr^{-1}$$bar^{-1}$ for 150 ±15 nm thick membranes). Benchmarking experiments with a highly established commercial nanofiltration membrane demonstrate around 9 times higher water flux at comparable retention values and excellent flux recovery by chemical cleaning.