Graphene Oxide Liquid Crystal Membranes in Protic Ionic Liquid for Nanofiltration

<table>
<thead>
<tr>
<th>Item Type</th>
<th>Poster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Mahalingam, Dinesh; Wang, Shaofei; Nunes, Suzana</td>
</tr>
<tr>
<td>Download date</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>
Graphene Oxide Liquid Crystal Membranes in Protic Ionic Liquid for Nanofiltration

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Graphene Oxide (GO) liquid crystals have been mostly reported as dispersion in water and organic solvents (e.g. Kim et al., Angew. Chem. Int. Ed. 2017, 56, 3042; Majumder et al., Nat. Commun. 2016, 7, 10891). They can provide highly ordered, regularly stacked nanochannels and lead ultrafast water transport and precise molecular sieving of solvated molecules. The main challenge is to obtain thin and robust layers with high water permeance and selectivity. We report GO liquid crystals from protic ionic liquid and exploit the self-assembled sheets to prepare nanofiltration membranes.


Objective
Preparation of nanofiltration membranes from GO liquid crystal dispersions in a protic ionic liquid (ethylammonium nitrate, EAN).

Method
Membrane Preparation

Figure 1. Scheme showing GO liquid crystal dispersion in EAN cast on a polymer support using a doctor blade and immersed in acetone to obtain nanofiltration membranes.

GO Characterization

SEM
AFM
X-ray Diffraction
FT-IR Spectroscopy

GO Liquid Crystals

Polarized light microscopy: Birefringence as an evidence for the formation of lyotropic liquid crystals of GO platelets orienting in a preferential direction.

Rheology

GO Liquid Crystal Membranes

GO nematic liquid crystal layer cast on porous support

Results and Discussion

Water Permeance and Dye Rejection

99% Rejection of dyes with molecular weight = 697 g/mol

NMR of protic ionic liquid
Raman Spectroscopy
UV-vis Spectroscopy

Conclusions
• We report stable dispersion of lyotropic GO liquid crystals in ionic liquid, employing EAN as a solvent, confirmed by polarized optical microscopy and rheology
• EAN promotes a H-bond gel-like network even at concentrations as low as 9 mg/mL, facilitating casting and formation of a stable GO layer
• GO liquid crystal membranes are stable and exhibit superior permeance and selectivity for nanofiltration

Acknowledgments
King Abdullah University of Science and Technology, Water Desalination and Reuse Center (KU-WDRC), King Abdullah Center for Science and Technology (KACST), King Abdullah University of Science and Technology, Water Desalination and Reuse Center (KU-WDRC), King Abdullah Center for Science and Technology (KACST)

Reference