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Supporting Information

Reduced Graphene Oxide – metal nanoparticles composite membranes for environmental separation and chloro-organic remediation

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1 Scanning electron microscope (SEM) images of polyvinylidene fluoride (PVDF) commercial membrane:

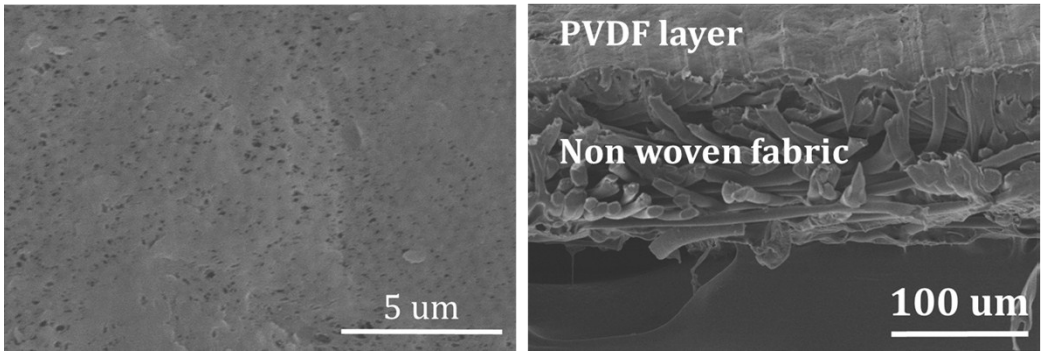

Figure S1: *SEM images of PVDF substrate used in this study. PVDF substrate was obtained from Nanostone Water Co. Trade name: PV200. The substrate consisted of thin PVDF active layer (110 um thick) coated on polysulfone substrate and had a pore size of 90-120 nm*

2 Experimental setup:

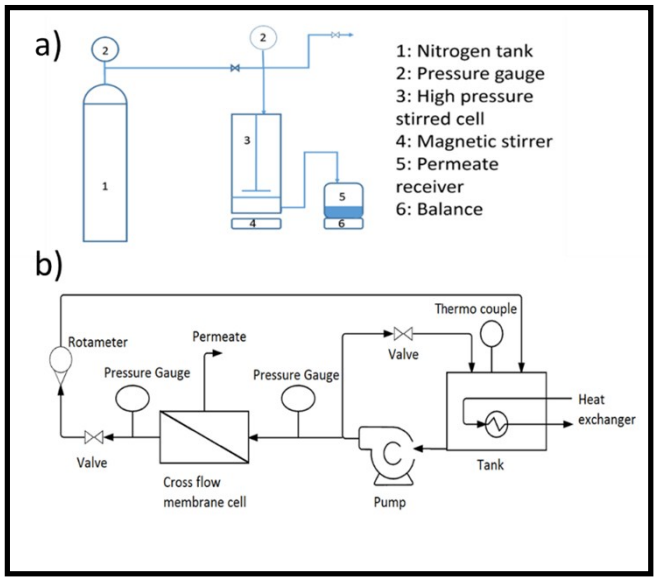

Figure S2: *Experimental setup for filtration experiment operated in a) dead-end and b) Cross-flow. Dead-end filtration cell: Sterlitech HP4750. Crossflow filtration cell: Sterlitech CF016D.*

3 Optical images of GO membranes:

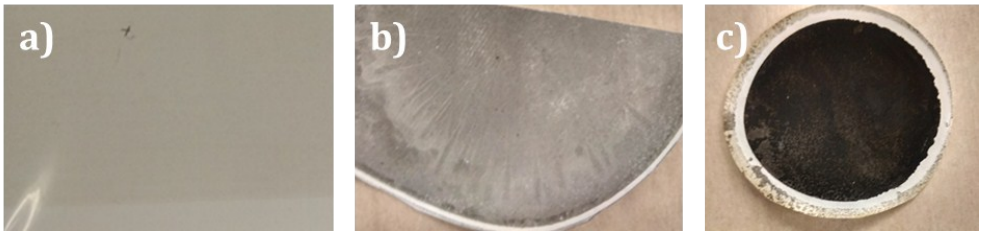

Figure S3: *Optical images of graphene oxide-based membranes at various stages of synthesis. a) Air-dried GO membrane, b) GO membrane after thermal incubation at 90 ^{o}C for 24 hours, and c) Iron palladium nanoparticles embedded nanocomposite GO membranes.*

4 Energy dispersive spectra of nanocomposite GO layer

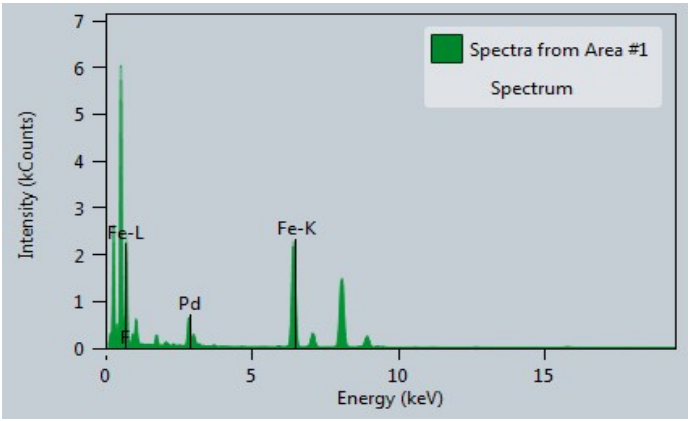

Figure S4*: Energy dispersive spectrum of nanocomposite rGO layer functionalized with Fe/Pd nanoparticles obtained for functionalized GO layer in TEM.*

5 X-ray photoelectron spectra for the top surface of the nanocomposite GO membrane:

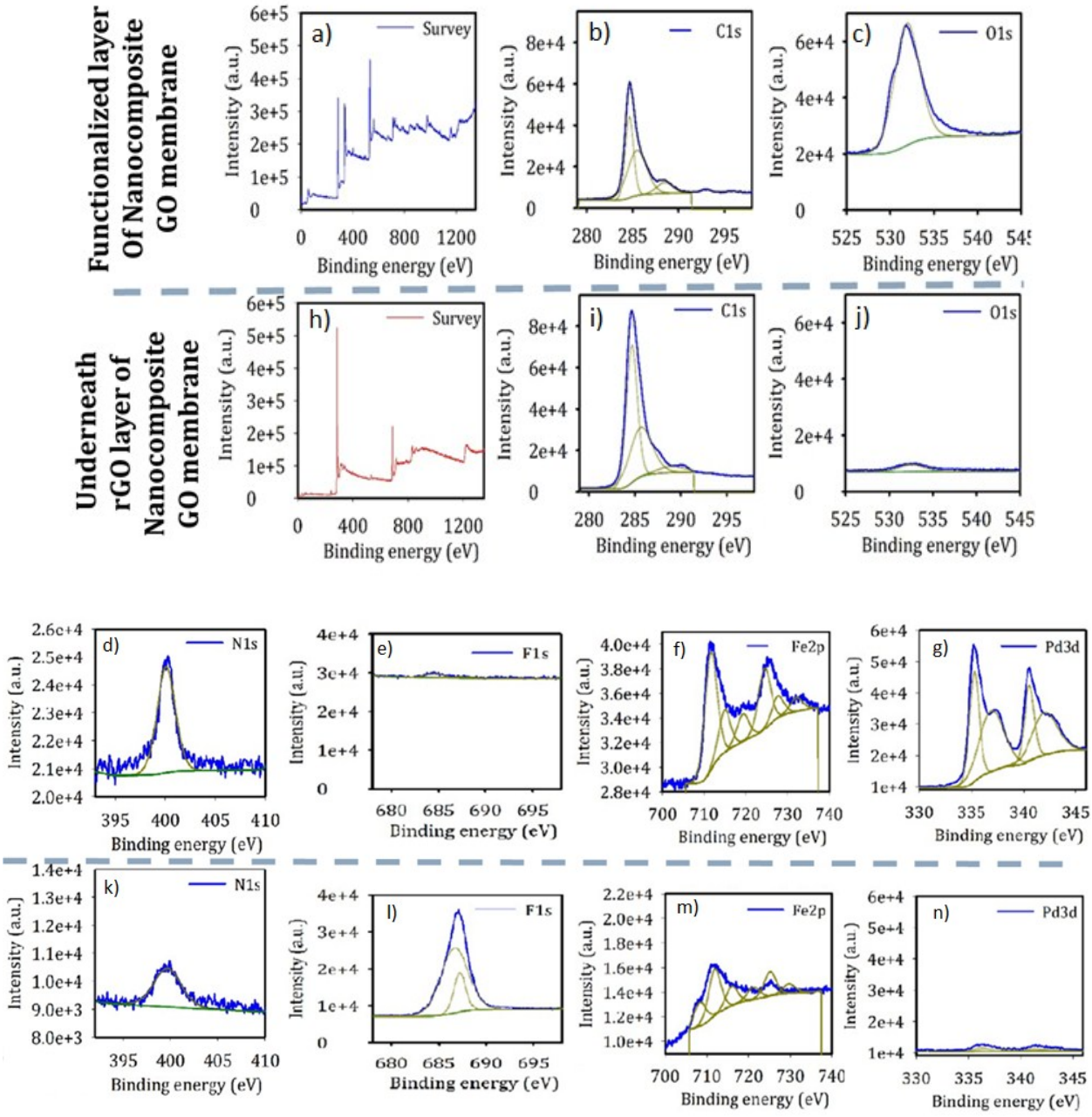

Figure S5: *XPS spectra of the functionalized layer and underneath the rGO layer of the nanocomposite rGO membrane embedded with Fe-Pd nanoparticles. (a,b,c,d,e,f,g) and (h,i,j,k,l,m,n) shows the spectra for binding energies at the membrane surface and underneath GO layer for Survey, carbon, oxygen, nitrogen, fluorine, iron, and palladium, respectively.*

6 BET characterization of nanoparticles:

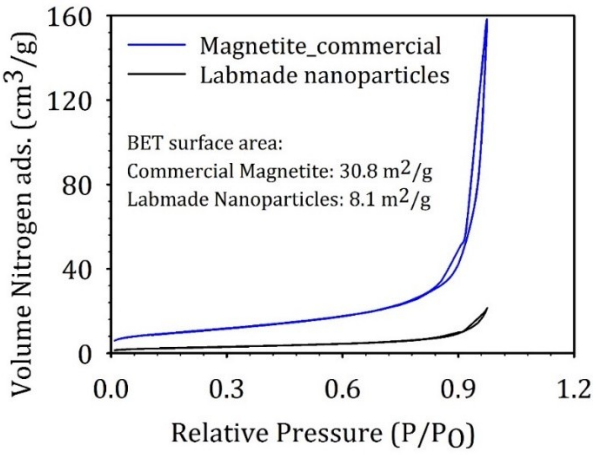

Figure S6: *BET surface area analysis of lab-made iron nanoparticles (zerovalent) and commercial magnetite nanoparticles. Commercial magnetite nanoparticles were purchased from Sigma Aldrich*

7 Persulfate decomposition by zerovalent iron:

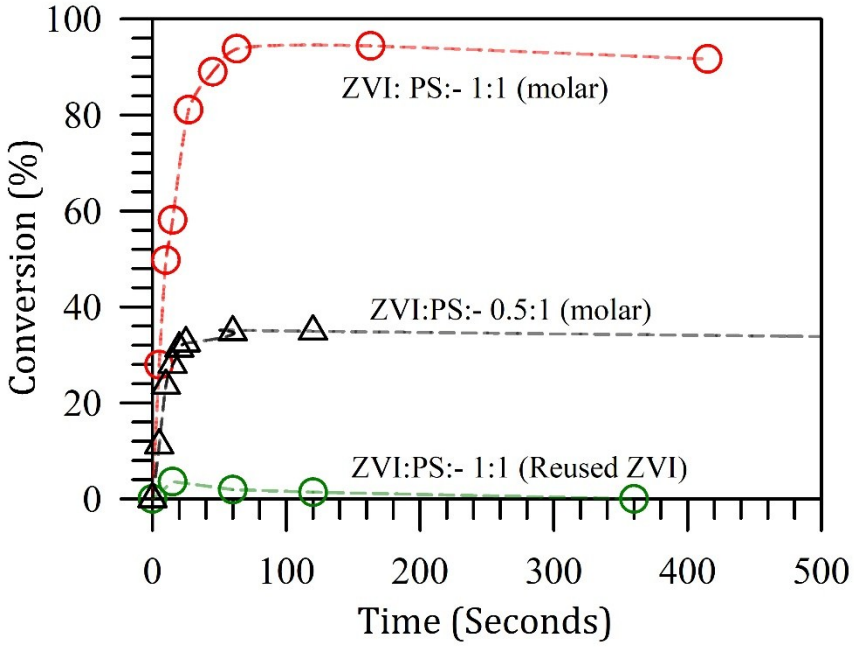

Figure S7: *Persulfate activation by zerovalent (ZVI) iron in solution phase (with dispersed nanoparticles) and batch mode operation. [persulfate feed]=2mM, Initial pH: 7, Temp: 23^{O}C*

8 Persulfate decomposition by iron-based nanoparticles:

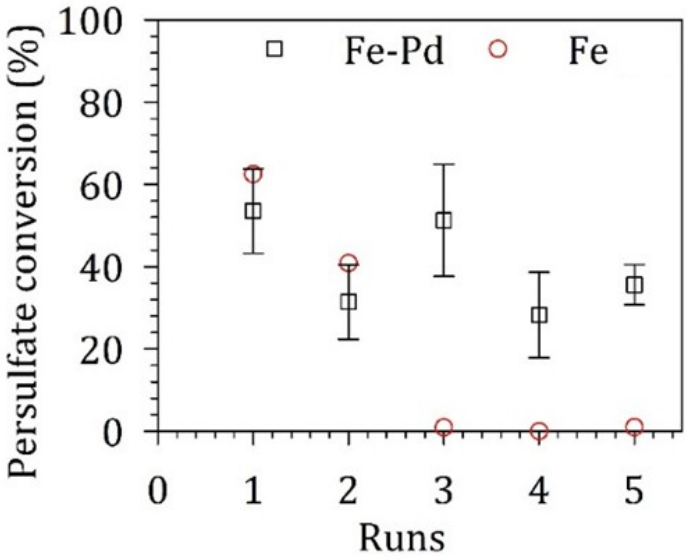

Figure S8: *Persulfate decomposition by iron and iron-palladium bimetallic nanoparticles. [Persulfate_feed]=2 mM, [Fe]=2 mM, for Fe-Pd bimetallic nanoparticle, Pd wt%=10, initial pH: 7, temp: 23^{O}C.*

9 The flux of nanocomposite membranes during persulfate activation

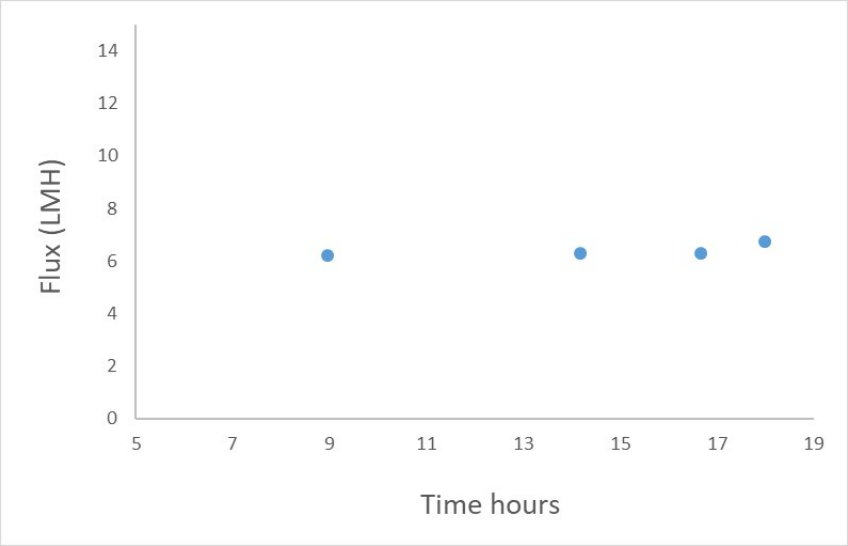

Figure S9: Flux of nanocomposite rGO membranes at 1.4 bar pressure during filtration of persulfate solution shown in figure 5

10 FTIR and Raman spectra of rGO before and after persulfate exposure.

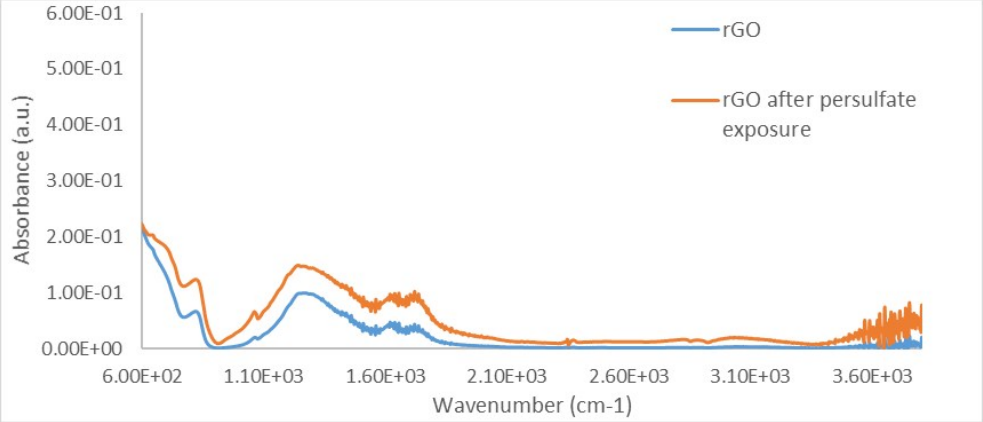

Figure S10: FTIR spectra of rGO before and after 72 hrs of persulfate exposure (7.2 mM) at 50^{O}C

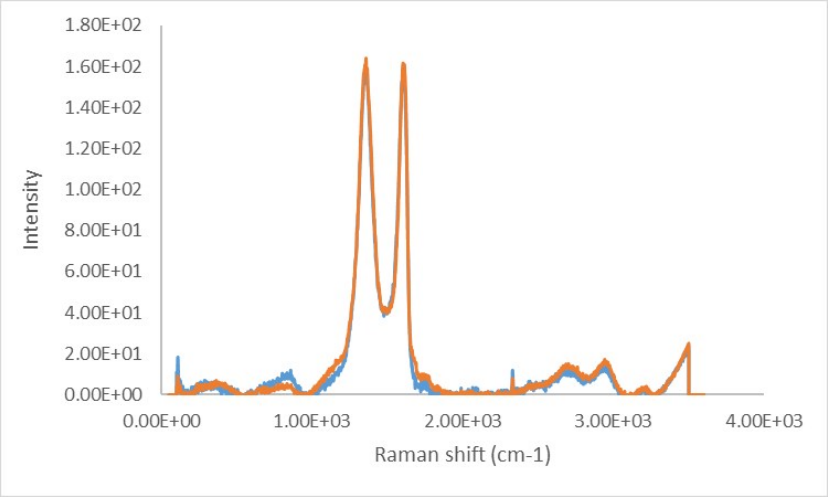

Figure S11: Raman spectra of rGO before and after 72 hrs of persulfate exposure (7.2 mM) at $50^{O}C$

11 Analysis of intermediates during TCE oxidation

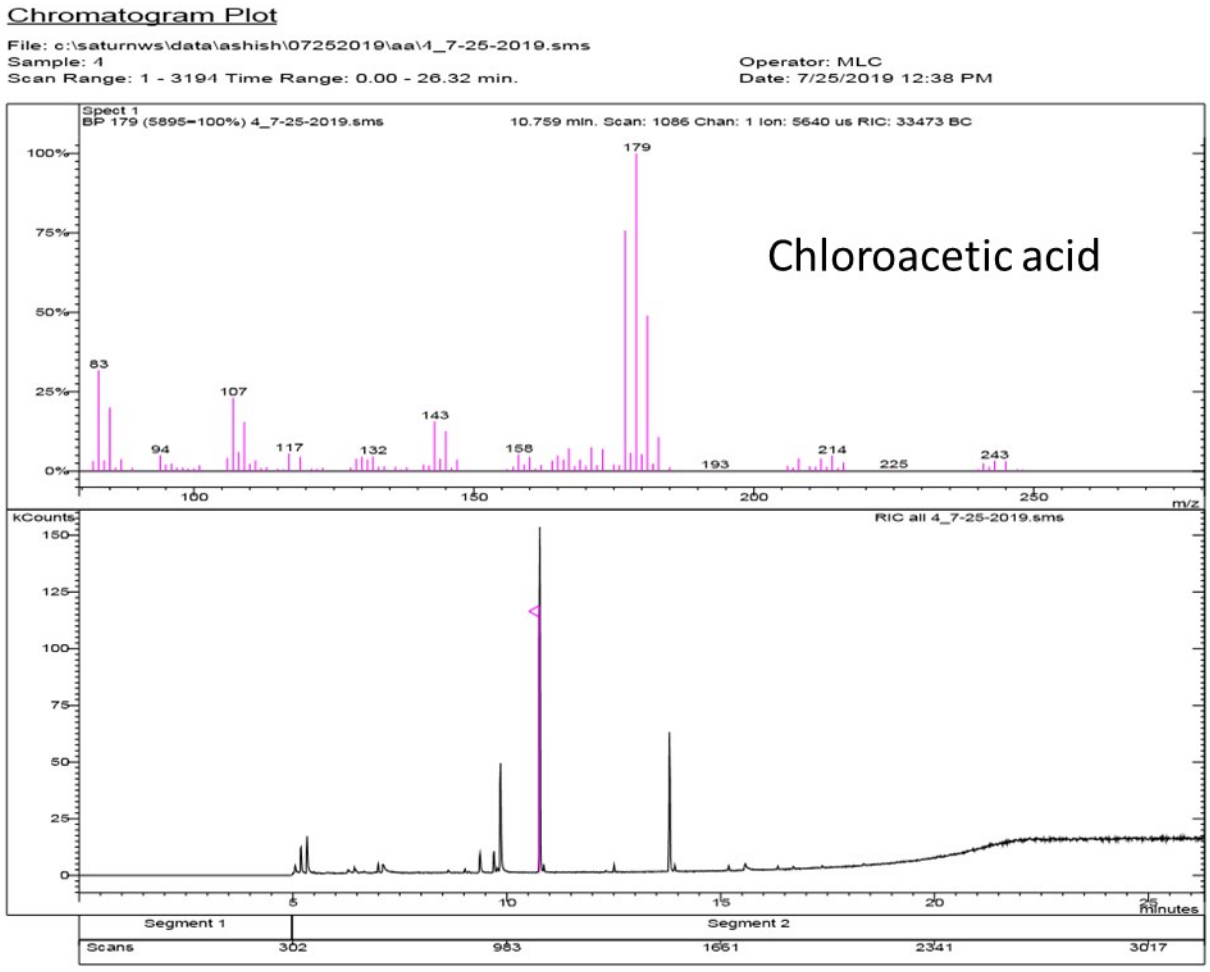

Figure S12: Analysis of TCE oxidation intermediates by GC-MS analysis.

12 Salt retention by nanocomposite rGO membranes

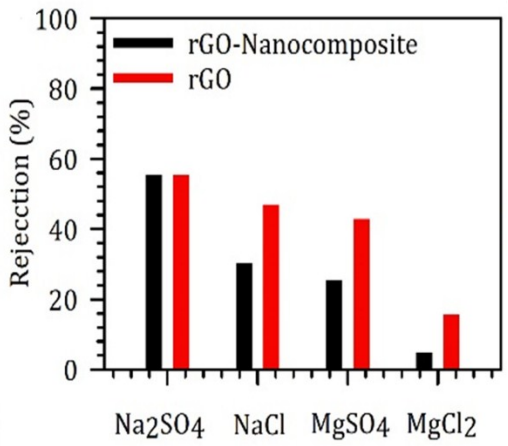

Figure S13: Salt retention by rGO and nanocomposite rGO membranes. Salt retention was measured for 7 mM salt feed at an operating pressure of 6.9 bars and average flux of 15 LMH.