

## Supporting information.

### Structure of graphene oxide membranes in solvents and solutions.

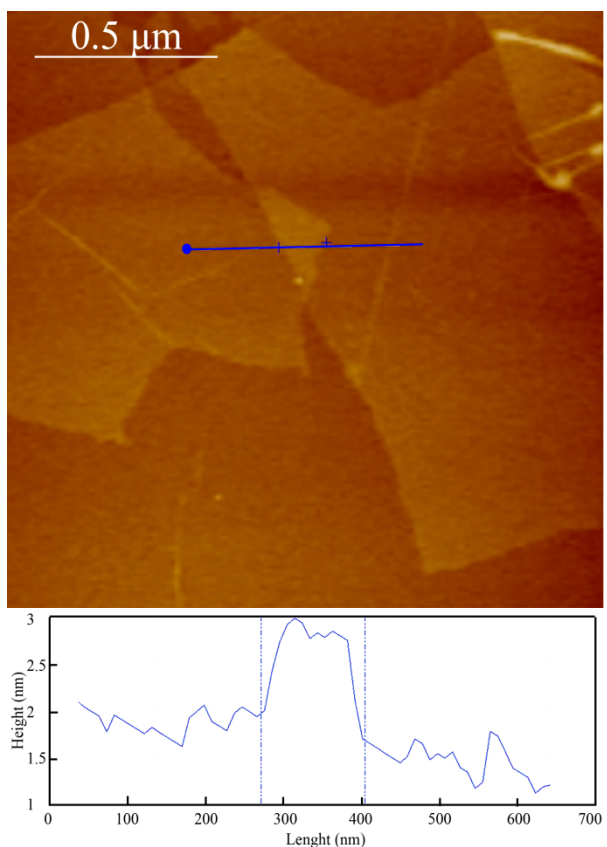
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#### 1. AFM images of overlapped graphene oxide flakes.

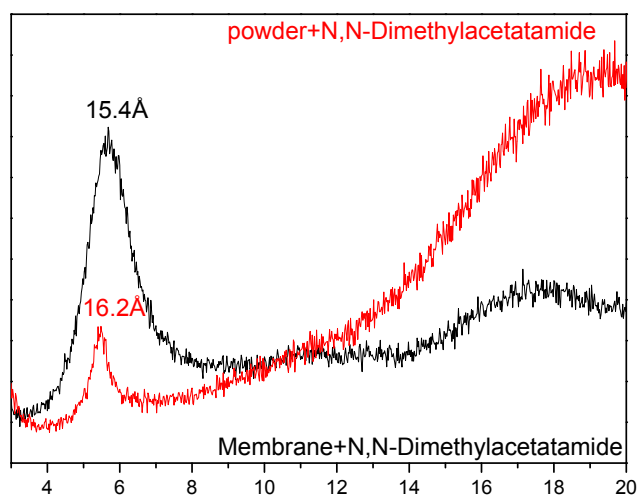


**Figure 1S** Solution of GO was drop casted over Si surface. The AFM image shows regions of flake overlap and height profiles across the overlap (blue line).

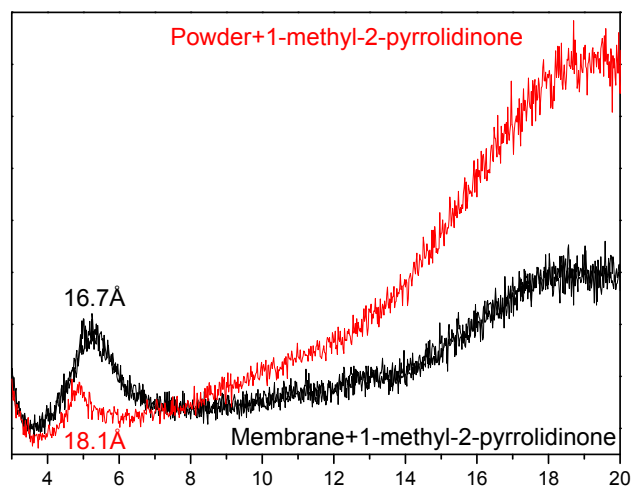
## 2. Additional XRD data for GO membranes immersed in liquid solvents.

Following reviewer suggestion we performed additional tests for precursor graphite oxide powder and GO membrane in two solvents: 1-methyl-2-pyrrolidinone and N,N-dimethylacetamide. Measurements were performed using conventional Siemens Diffractometer with  $\text{CuK}\alpha$  radiation on membrane sample prepared using the same powder and the same methods as for the membrane studied in the main part of the paper. Diameter of initially prepared membrane sample was 25 mm, the sample was cut on 4 pieces with area of about  $1 \text{ cm}^2$ . Solvent was added over the membrane piece and the assemblage was covered by thin plastic foil to prevent evaporation. The scan duration was typically 40 minutes.

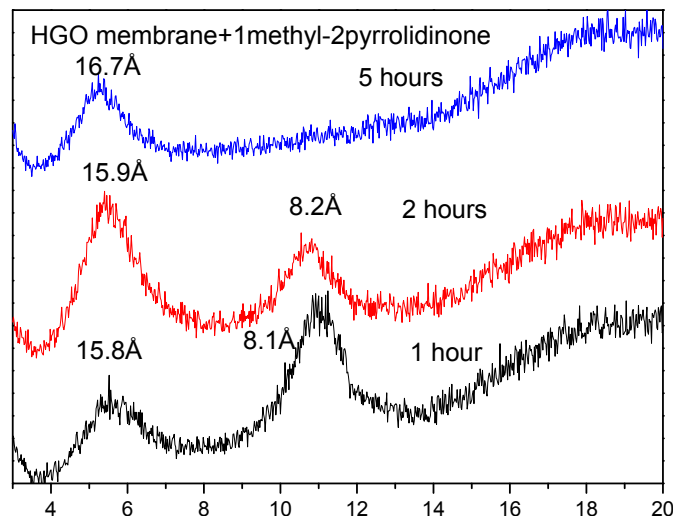
a)



b)



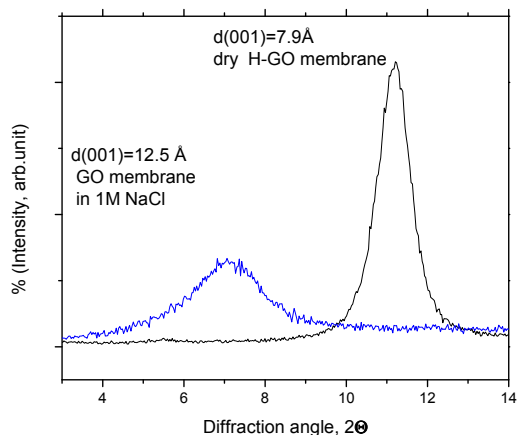
c)



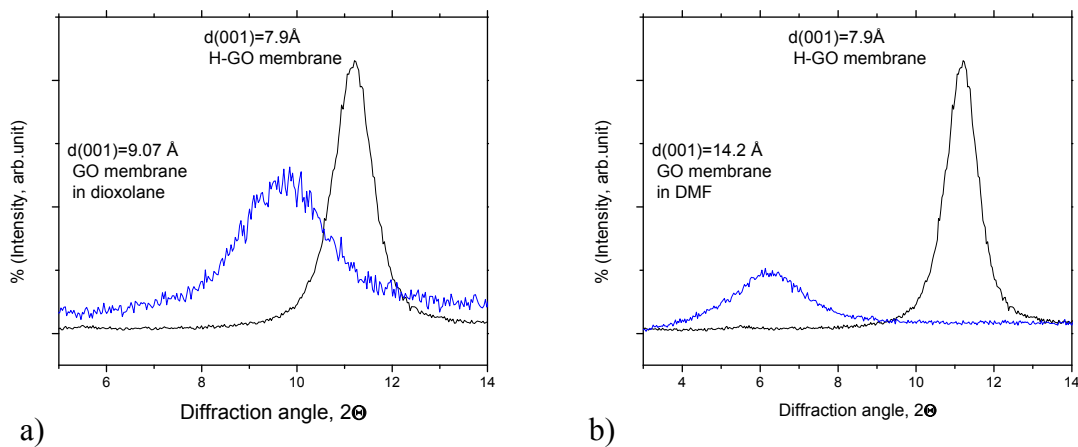
**Figure 2S** XRD patterns recorded from precursor graphite oxide powder and GO membrane sample immersed in liquid a) N,N-dimethylacetamide and b) 1-methyl-2-pyrrolidinone after 5 hours of exposure to solvent and c) 1-methyl-2-pyrrolidinone at various time moments.

As shown in Figure 2S, GO membrane got intercalated by in N,N-dimethylacetamide rather rapidly, already after first scan (about 40 minutes for whole angle range) the  $d(001)$  is almost equal to the value observed on powder sample. For 1-methyl-2-pyrrolidinone the intercalation was significantly slower, but after 5 hours it also reached visible saturation and the value of  $d(001)$  for GO membrane was only little lower compared to powder. It can be concluded that both solvents studied here showed Type II swelling.

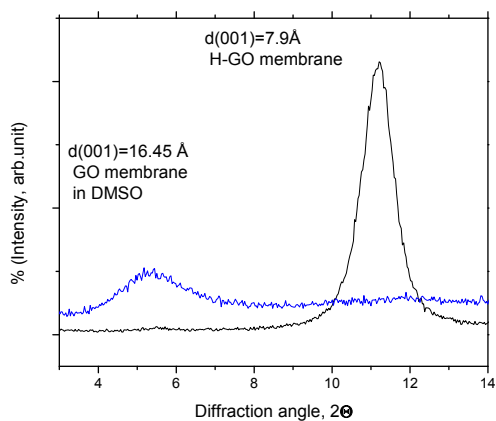
We also performed tests on larger membranes pieces ( $\sim 1 \text{ cm}^2$ ) to demonstrate that saturated swelling state of GO membranes is not affected by size of samples within 1-10 mm samples. Another set of experiments was performed using membrane with diameter of  $\sim 45 \text{ mm}$  after deposition and thickness of  $\sim 2 \mu\text{m}$  which was dried on air for 14 months. Despite very long drying time the membranes kept their ability for swelling and showed inter-layer distances similar to those obtained using synchrotron radiation on smaller pieces of membrane.



**Figure 3S** XRD patterns recorded from sample of membrane dried for 14 months on air and immersed in excess of 1 M NaCl solution.

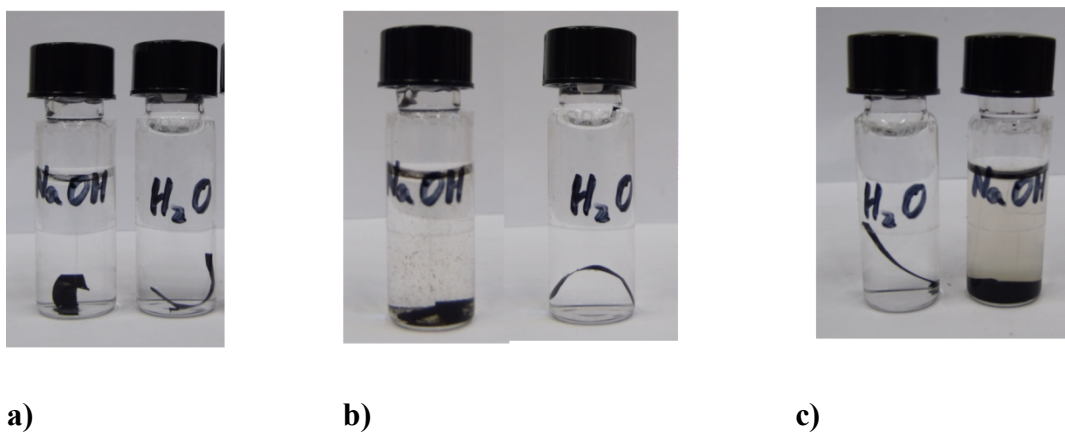


**Figure 4S.** XRD patterns recorded from membranes immersed in a) dioxolane and b) DMF solvents, pattern from dry membrane sample is shown as reference.



**Figure 5S** XRD patterns recorded from membranes swelled in DMSO solvent.

### 3. Stability of GO membranes in H<sub>2</sub>O and NaOH solution.



**Figure 6S** Hummers GO membrane dried on air for 2 month and immersed in H<sub>2</sub>O and NaOH (0.005M) : a) immediately after immersion; b) 24 hours, after light shaking; c) after 2 weeks in solution. The figure shows that membrane is stable in water but dissolves in dilute NaOH.