

Supporting Information File

**Interlocked Graphene oxide provides Narrow Channels for Effective
Water Desalination through Forward Osmosis**

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Characterization of $\text{Mg}(\text{OH})_2$

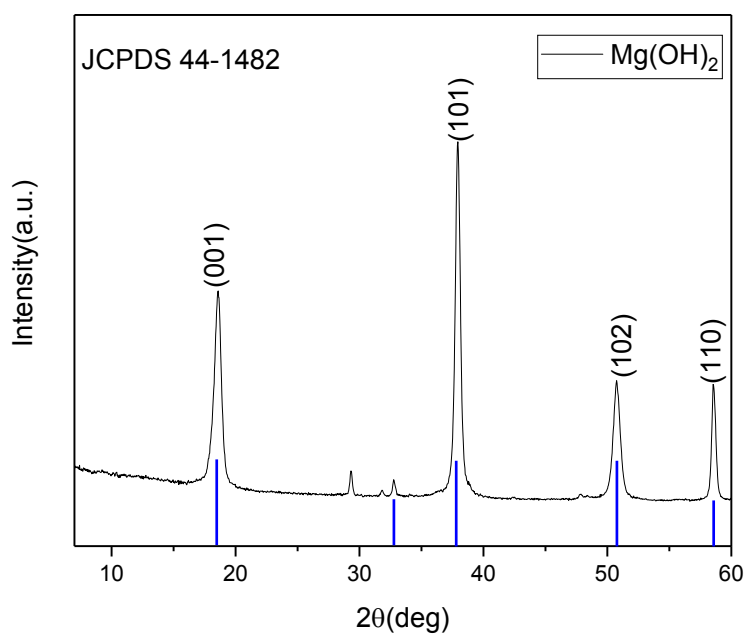


Figure S1 -XRD characterization of as prepared $\text{Mg}(\text{OH})_2$.

Elements	Atomic percentage (%)
C	47.6
O	45.3
Mg	6.9

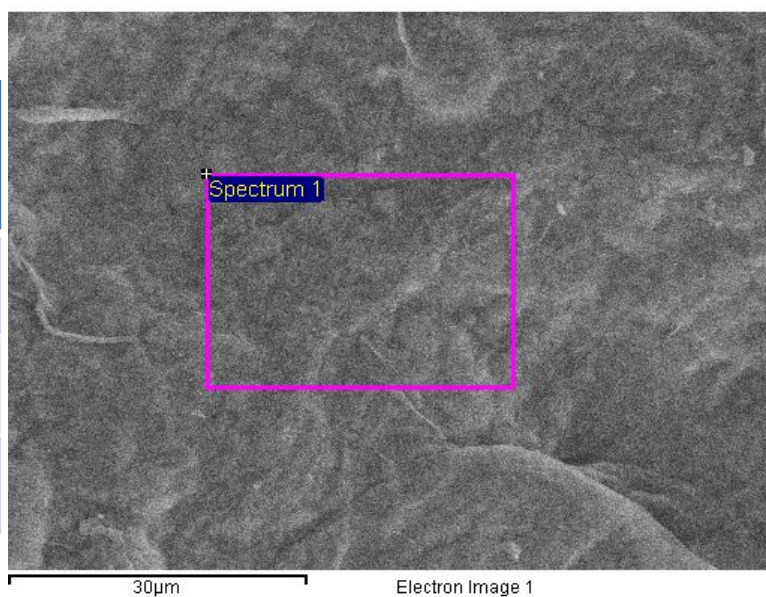


Figure S2. EDX analysis of GOM membrane. The available content of Mg is 6.9 wt % in GOM.

Characterization of GQDs

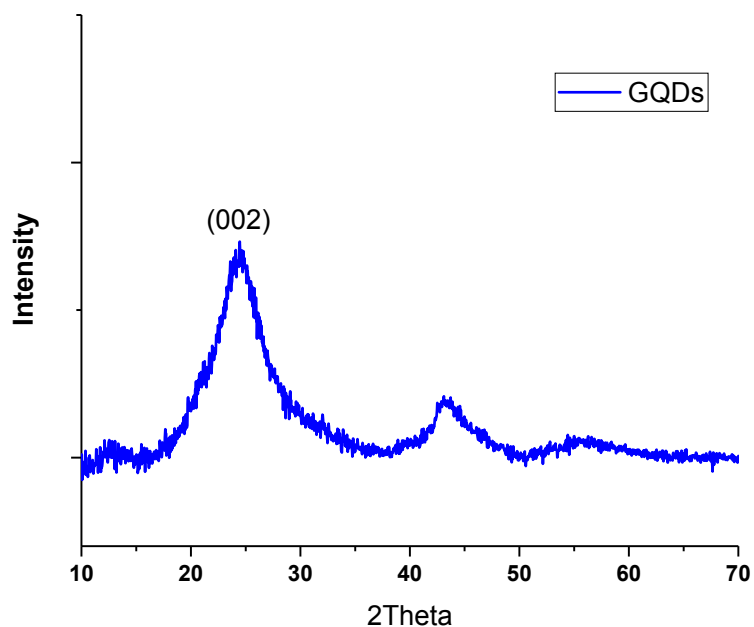


Figure S3 -XRD pattern of as prepared GQDs. In graphene oxide quantum dots, we notice a peak at $2\Theta=24.2$ which corresponds to characteristic graphene oxide quantum dots(002) with d spacing 3.6 Å .The peak is broad due to the small size of GQDs.

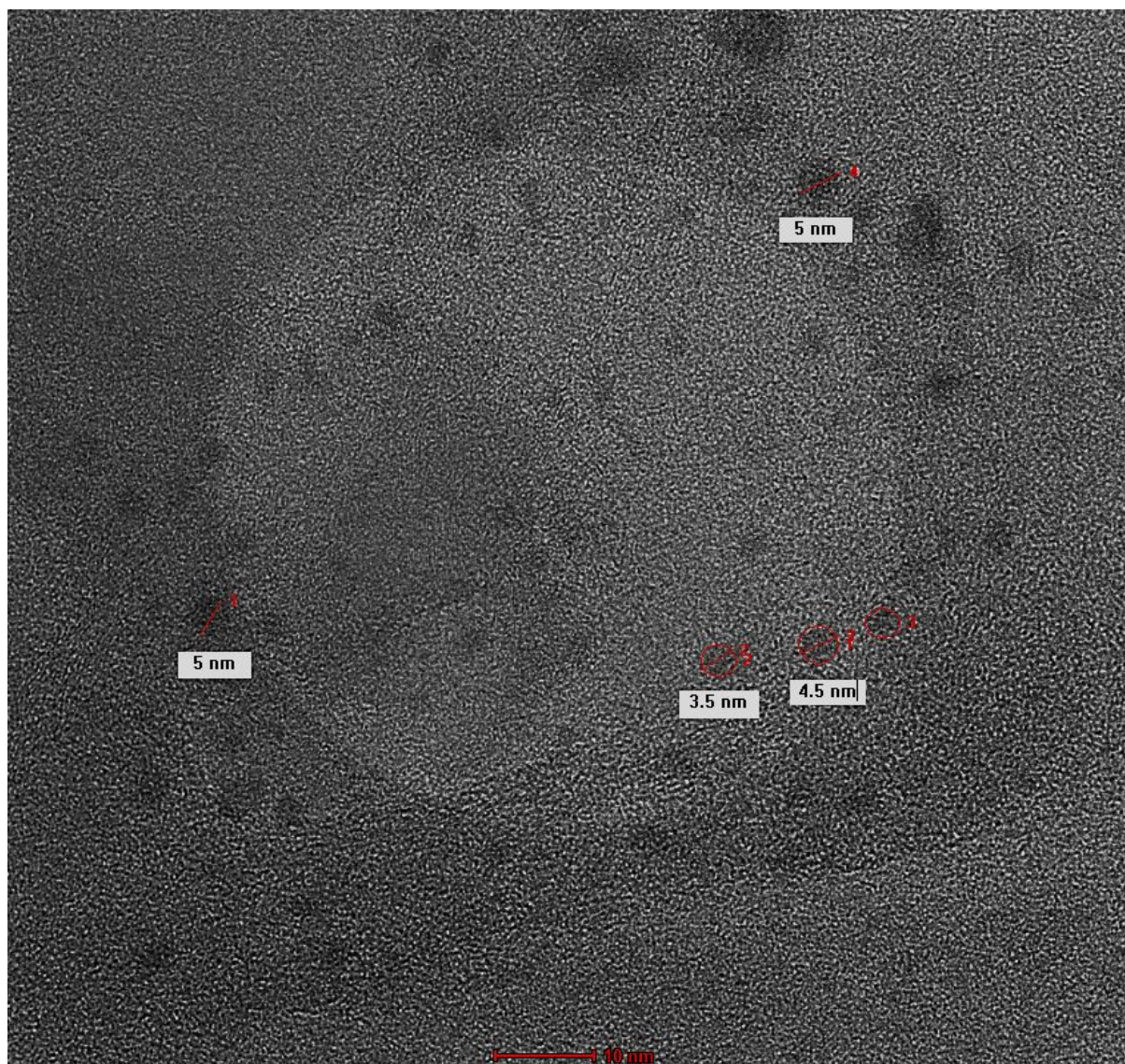


Figure S4. TEM of as prepared GQDs. The average size of quantum dots is 3-5 nm.

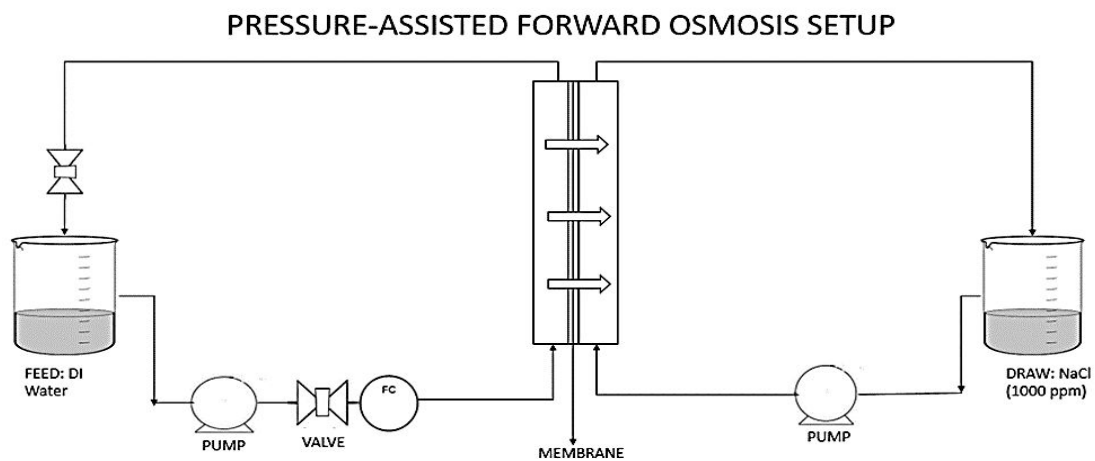


Figure S5. In-house forward osmosis set up with varied pressures and draw solutions.

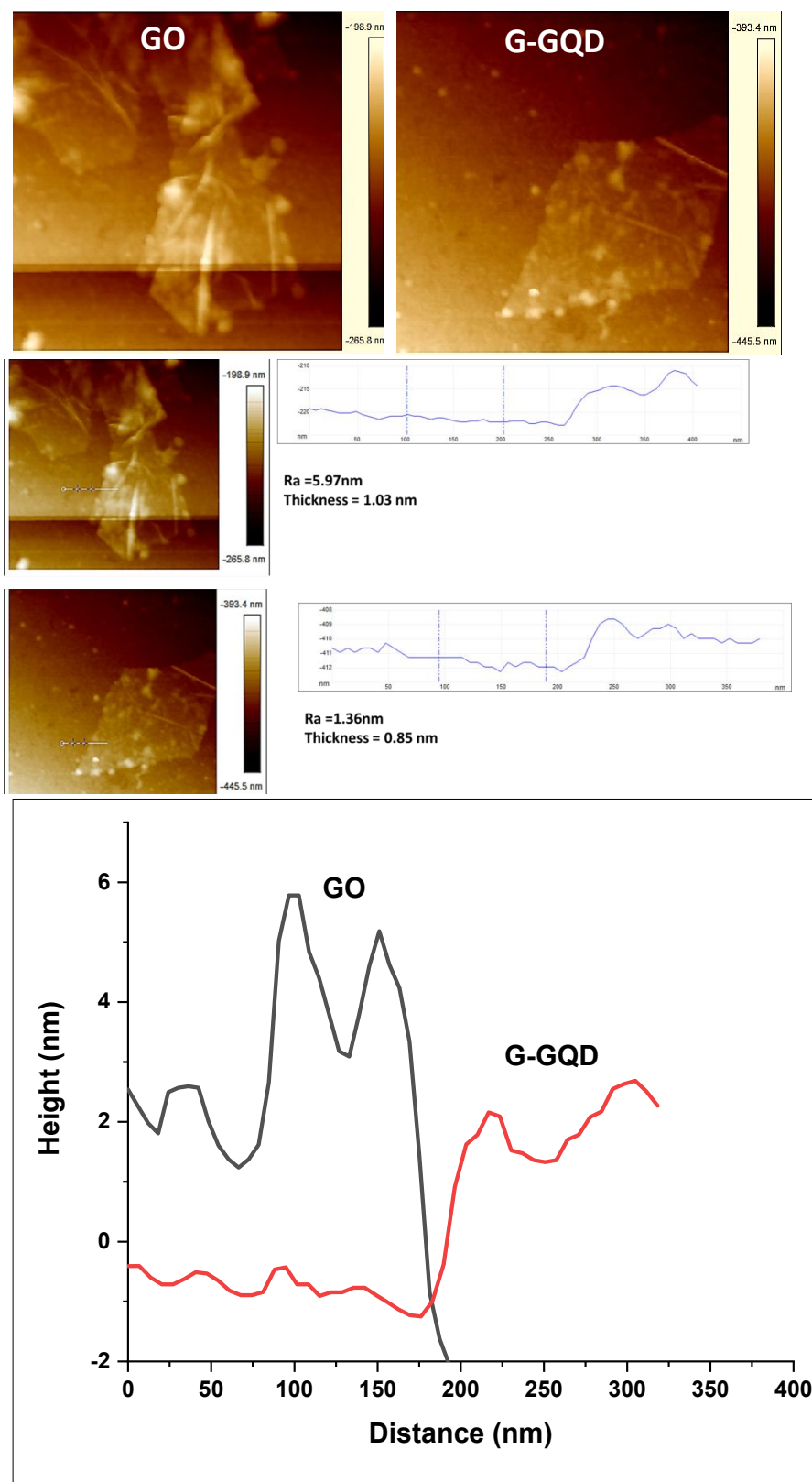


Figure S6. AFM measurements of GO and G-GQD; the corresponding thickness (with respect to the substrate) and the height profiles are shown. Scale bar – 200nm.

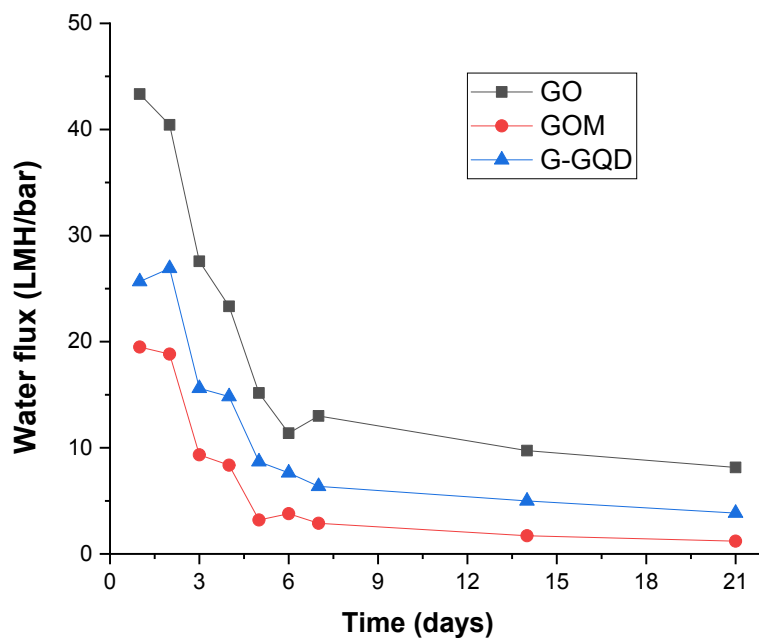


Figure S7. Long term stability studies of GO based membranes up to 21 days.

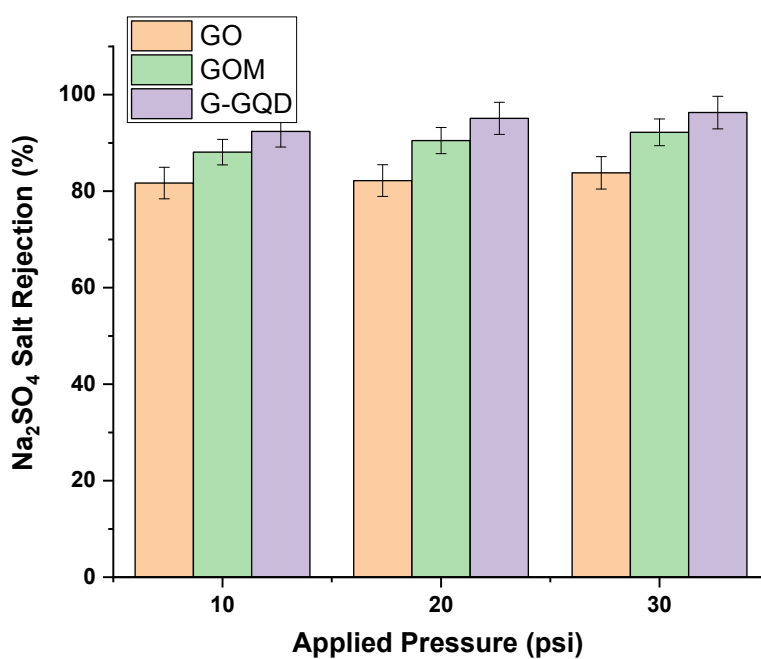


Figure S8. Desalination performance of Na₂SO₄ (2000 ppm) at different pressures of GO, GOM and G-GQD membranes by pressure driven forward osmosis setup.

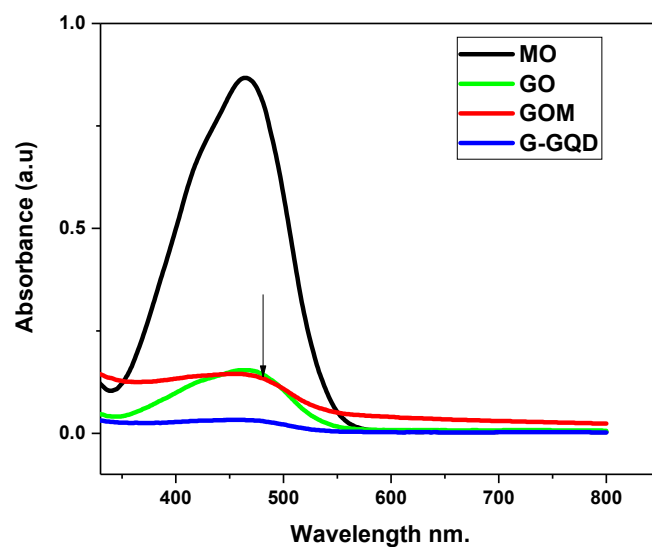


Figure S9. UV-visible spectra of tested GO and modified GO membranes against methyl orange.

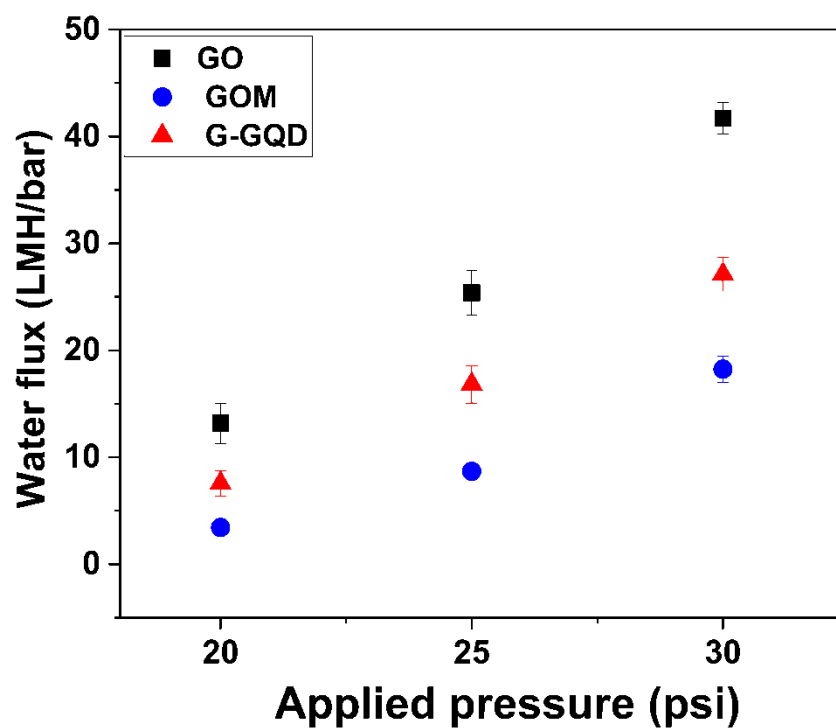


Fig.S10. Pure water permeance at different pressures of GO, GOM and G-GQD membranes by RO cross flow set up.

The 50 nm thick un-crosslinked GO membrane sandwiched between two 100 nm hydrophilic support PVDF membranes show a water permeance of 42 ± 3 LMH at 30 psi. As expected, the water permeance is lowered for crosslinked GOM membrane to 19 ± 5 LMH due to the ionic crosslinking of Mg ions to carboxylic acid groups at the edges of individual GO sheets (Fig. 3a). Concurrently, G-GQD membrane showed enhanced water flux of 27 ± 2 LMH which is though lower than un-crosslinked GO but higher than that of GOM membrane. This increase in permeate flux can be ascribed to the incorporation of GQDs shorten the paths of water permeation route in GO nanochannels. This is further supported by SEM image (Fig. 1f) of G-GQD membrane which possesses higher roughness where water molecules can be contacted through large surface area. The flux of G-GQD membrane is less than pristine GO due to effective crosslinking that leads to non-swelling of the membrane.

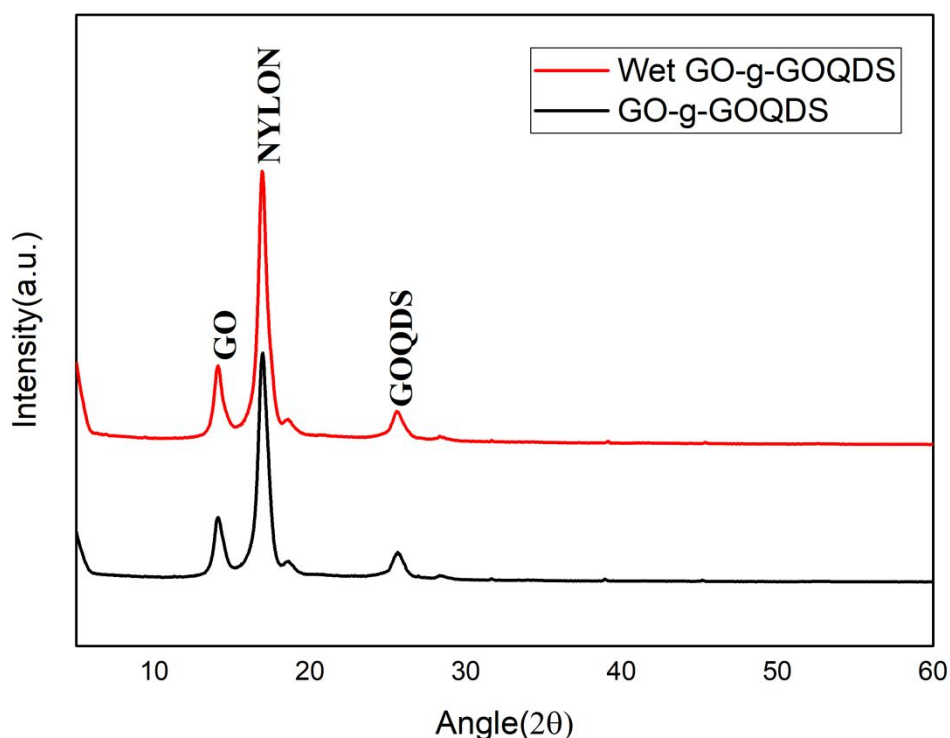


Figure S11. XRD pattern of dry and wet G-GQD membranes.

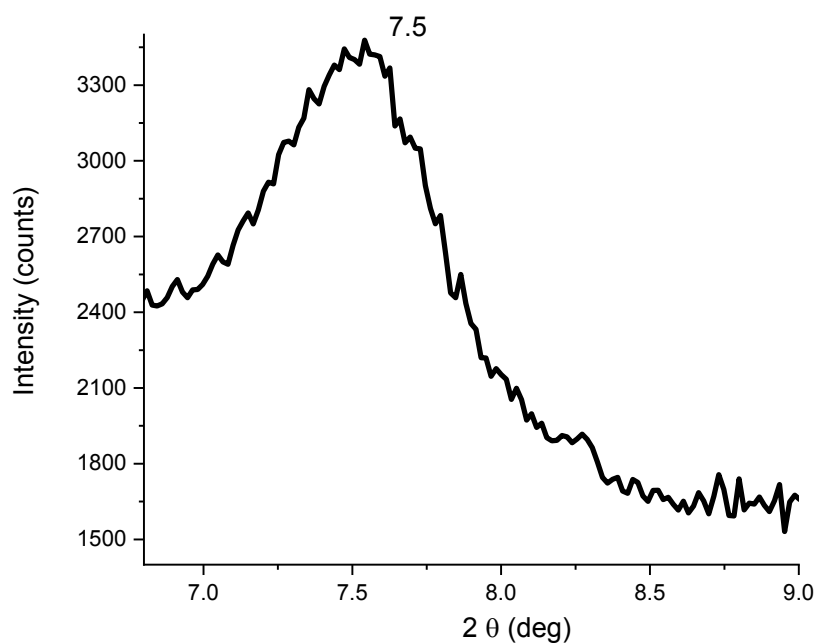


Figure S12. XRD pattern of wet GO membranes.

Calculation of the spacing between graphene oxide sheets:

It can be calculated by the Bragg's law: $\lambda = 2d \sin \theta$ where λ is the wavelength of the X-ray beam (0.154nm), d is the distance between the adjacent GO sheets or layers, θ is the diffraction angle.

As can be seen in Figure 2a, the diffraction peak position is at $2\theta = 10.8^\circ$, representing the (001) plane, which is the spacing between the graphene oxide sheets.

$$d = \lambda / 2 \sin \theta = 0.154 \text{ nm} / 2 \sin(5.41) \text{ thus } d = 0.82 \text{ nm} = 8.2 \text{ \AA}$$

Similarly, the other GO membranes (Table S1).

Membranes	Under dry condition		Under wet condition	
	Corresponding 2 θ (°) of 001	d-spacing (Å)	Corresponding 2 θ (°) of 001plane (wet)	d-spacing (Å)
GO	10.8	8.2	7.5	12.4
GOM	8.8	9.9	6.4	13.5
G-GQD	14.2	6.1	14.1	6