Supplementary Information

Turbostratic Nanoporous Carbon Sheet Membrane for Ultrafast and Selective Nanofiltration in Viscous Green Solvent

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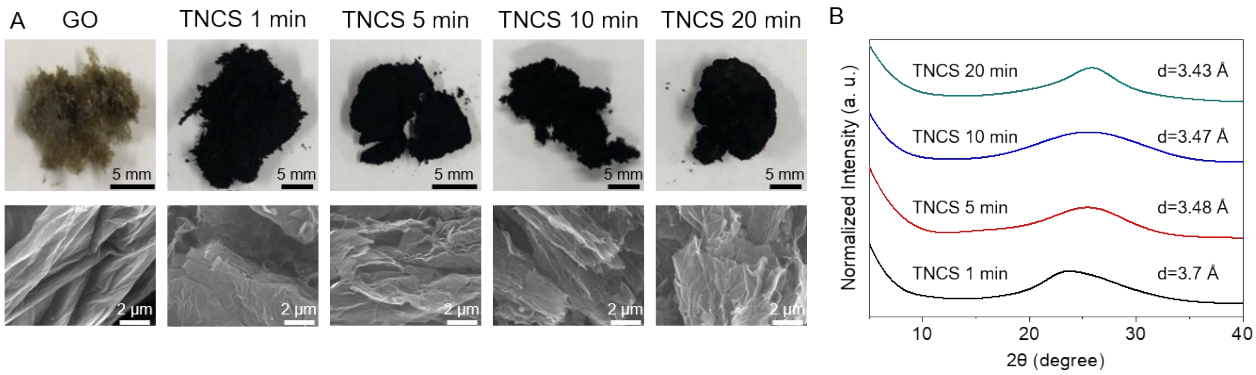

Figure S1. (A) Photographs and SEM images of GO and TNCS powder depending on the duration of thermal treatment from 1 min to 20 min at 650 °C, respectively. **(B)** Corresponding XRD patterns of TNCS powders.

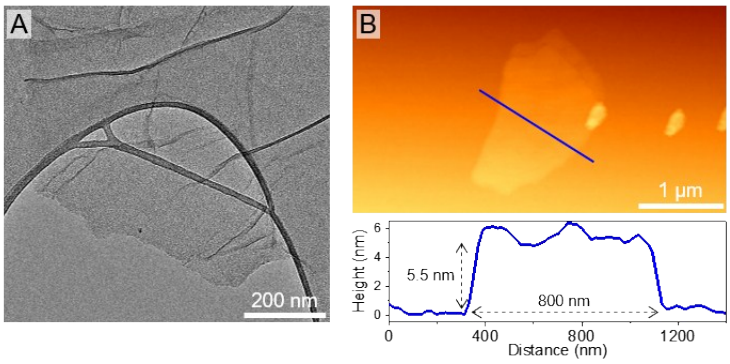

Figure S2. (A) TEM image of an exfoliated TNCS. **(B)** AFM image of an exfoliated TNCS with a height profile.

Figure S3. The contact angles of various solvents of GO and TNCS membrane. Enhanced oleophilic property is observed from TNCS membrane attributing to the removal of oxygen groups after rapid thermal treatment.

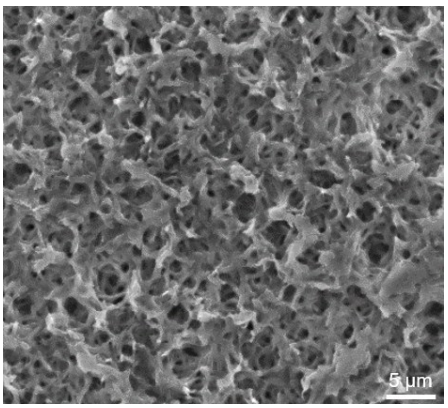

Figure S4. Top-view SEM image of commercial nylon filter (Whatman, pore size 200 nm).

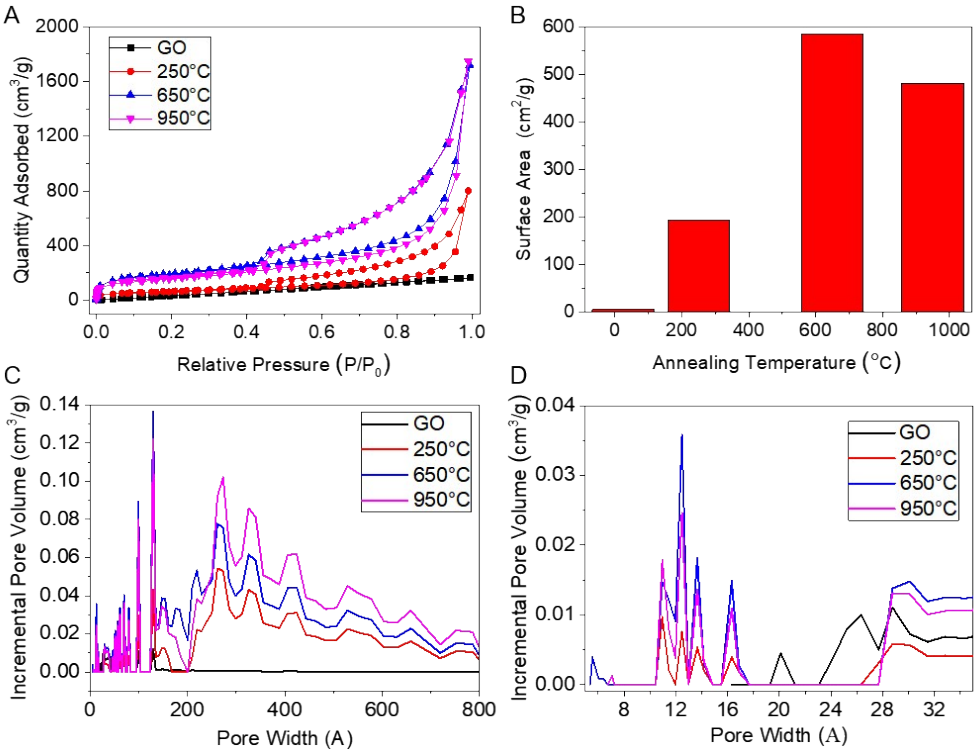

Figure S5. (A) Ar adsorption-desorption isotherms of GO and TNCSs depending on the temperature of thermal treatments. The isotherm was obtained at 87 K. The thermal treatments were conducted for 10 min at each temperature. **(B)** Surface areas of GO and TNCS samples were calculated by using the BET equation. **(C)** and **(D)** Pore-size distribution (PSD) of GO and TNCS samples. PSD was obtained by NL-DFT method. Micropores are observed from the TNCS samples after thermal treatment, while not observed from GO.

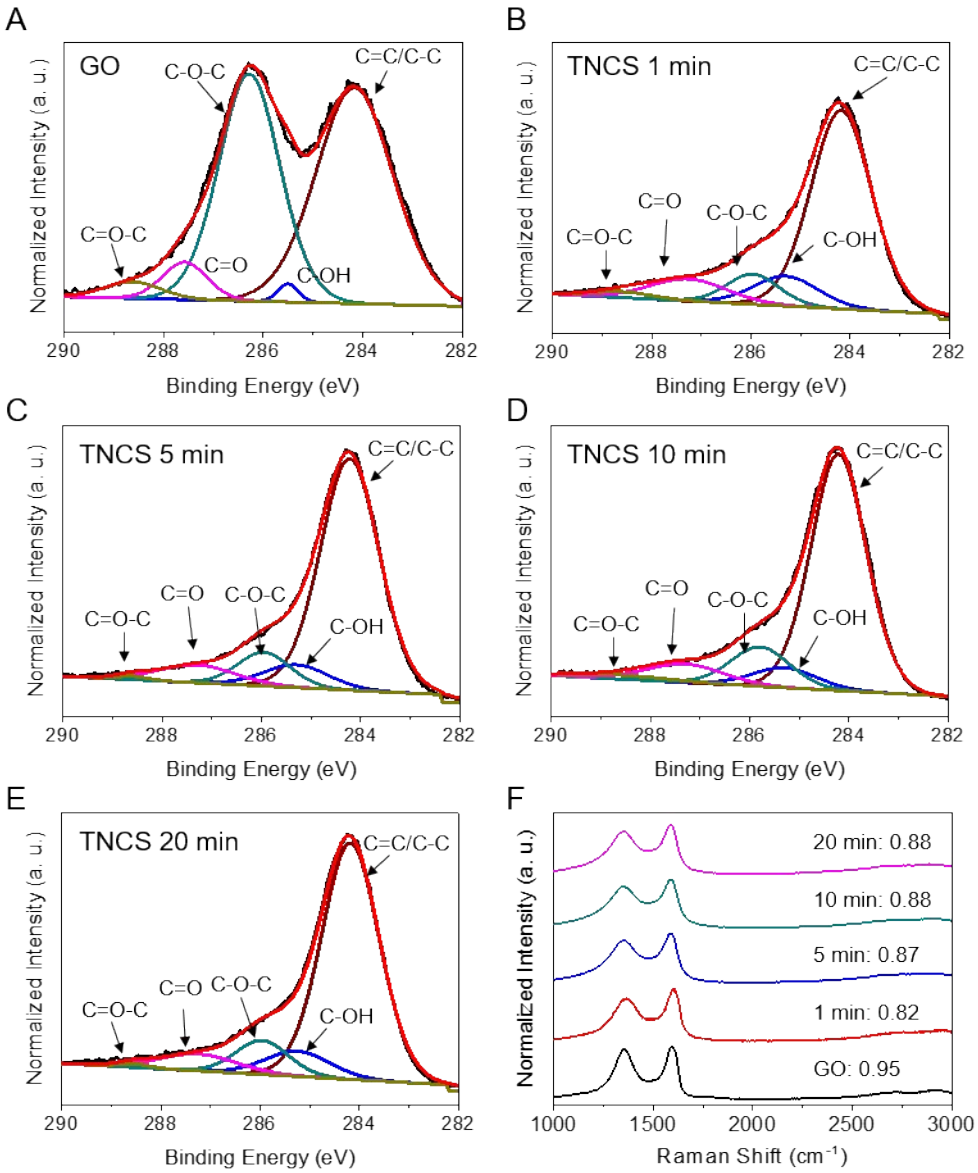

Figure S6. (A)-(E) C1s XPS spectra of GO and TNCS with thermal treatment times of 1, 5, 10, and 20 min at 650 °C, respectively. **(F)** Raman spectra of GO and TNCS samples. The numbers in **(F)** indicate the D-band/G-band intensity ratio. Thermal treatments were conducted at 650 °C.

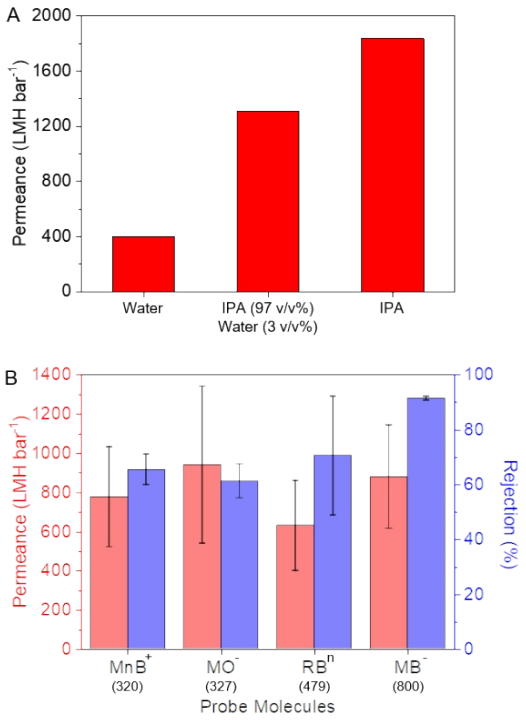

Figure S7. (A) Permeance of pure water, IPA, and IPA/water mixture (97 vol./vol.% and 3 vol./vol.%, respectively). **(B)** Nanofiltration performance of TNCS membrane when DI water was used as a solvent. Dyes were dissolved in DI water with a concentration of 10 mg L^{-1} and filtered at 5 bar. Superscripts represent the electrical charge of each dye.

Compared to the aqueous dye solvents, dyes smaller than 500 g mol^{-1} (MnB, MO, RB) were less rejected with IPA solution (**Figure S7B**), possibly indicating the lower electrostatic interaction between the membrane and dye molecules in the absence of water.

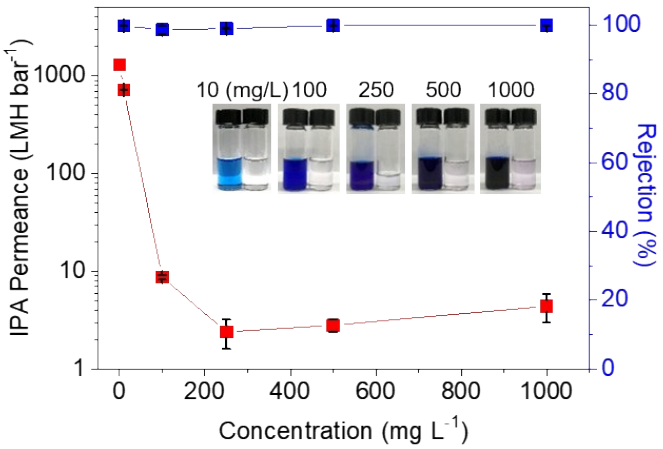

Figure S8. IPA nanofiltration results of TNCS membranes depending on the concentration of methyl blue (molecular weight: 800 g mol^{-1}) from 10 to 1000 mg L^{-1}.

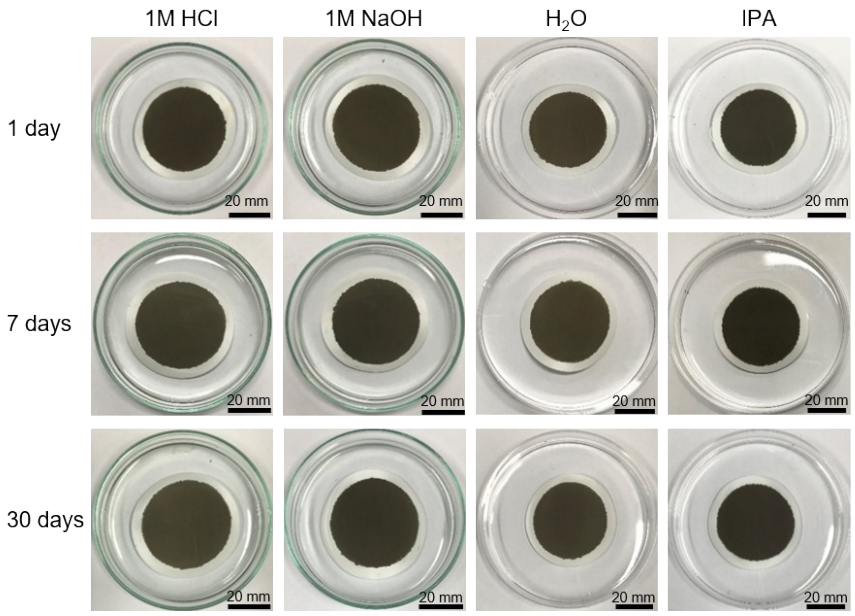

Figure S9. Stability of TNCS membranes in 1 M HCl, 1 M NaOH, water, and IPA for 1 day, 7 days, and 30 days, respectively. Nylon filters were used as porous supports.

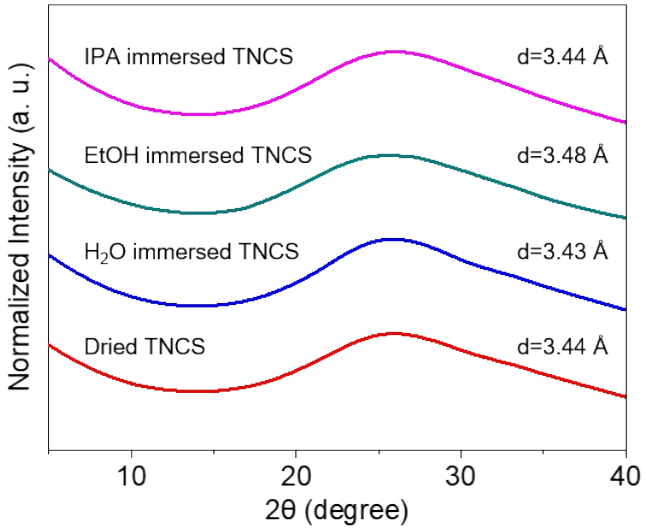

Figure S10. XRD patterns of TNCS membranes on the AAO filter. The membranes were dried in oven at 60 °C for 1 day and immersed in water, ethanol, and IPA for 1 day, respectively.

Table S1. A comparison of organic solvent nanofiltration performance of TNCS membrane with previous membranes.

Membrane	Solvent	Permeance (LMH/bar)	Rejection (%)	Molecular weight cut-off (g/mol)	Ref.
X-PBI	IPA	1.87	90.43 (Tetracycline)	444.435	1
PAN/PEI composited with carbon dots	IPA	3.15	99 (PEG 1000)	709	2
sPPSU/0.3HPEI-WDC	IPA	3	99.9 (RosB)	600	3
PEG400/cPI 1:2 50W	IPA	5.91	99.64 (RosB)	748	4
2% PEI2K-10	IPA	11.8	99.9 (RosB)	485	5
NH2-MWCNT/P84 MMM (M2)	IPA	1.4	98.1 (Eosin Y)	648	6
PAN/PEI-Ti3C2Tx-NH2	IPA	3	96 (PEG800)	200	7
PAN-H/PPy IPA (4%)	IPA	3.12	97 (RosB)	973.67	8
PAN/PEI-TMC-PDMS	IPA	3.78	95 (PEG600)	600	9
$(PDDA/HPE)_1$	IPA	1.8	96 (RosB)	1017	10
PAR-TTSBI/PI	IPA	7	99.5 (RosB)	408	11
PAR-BHPF/PI	IPA	8	99 (RosB)	408	11
PDDA/SPEEK	IPA	1.98	98 (AF)	585	12
Shear-aligned GO	IPA	130	95.5 (Tannic acid)	973.67	13
Acetylene-10W-35nm DLC	Ethanol	84.13	99.6 (Fluorescein-4-isothiocyanate)	<182.22	14
MPD-3%-1min-ACT	Methanol	52.22	99.9 (Naphthalene brown)	<389.39	15
HPEI/S-rGO-18	Methanol	77	100 (EB)	319.85	16
HLGO-8nm	Methanol	7.5	99% (CG)	<249	17
44-GO-0.5BA-T	Methanol	3.5	95% (AF)	500	18
Turbostratic nanoporous carbon sheet	**IPA**	**1839**	**99% (NBB)**	**600**	**This work**

Supplementary References

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