Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information

An ultrathin support layer based on carbon nanotubes/polyvinyl alcohol for forward osmosis membranes with outstanding water flux

Hsi-Yuan Juan[a], Shivam Gupta[a], Chi-Young Lee[a], Yi-Ting Lai*[b,c,d], and Nyan-Hwa Tai*[a,e]

[a]Department of Materials Science and Engineering,

National Tsing Hua University Hsinchu, 300, Taiwan, ROC.

[b]Department of Materials Engineering, [c]Center for Plasma and Thin Film Technologies,

[d]Biochemical Technology R&D Center, Ming Chi University of Technology,

New Taipei City, 24301, Taiwan, ROC.

[e]Institute of Analytical and Environmental Science,

National Tsing Hua University Hsinchu, 300, Taiwan, ROC.

Corresponding author E-mail:

laieating@mail.mcut.edu.tw (Prof. Yi-Ting Lai)

nhtai@mx.nthu.edu.tw (Prof. Nyan-Hwa Tai)

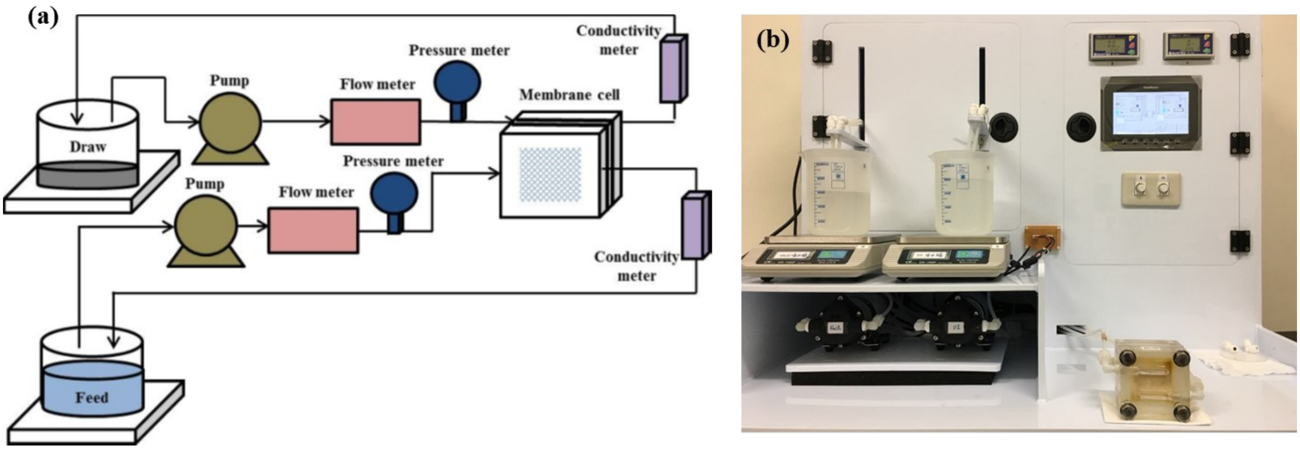

Fig. S 1 (a) The schematic diagram and (b) photo of proposed lab-scale cross flow setup for the FO testing system.

Table S 1 The calculated mechanical properties of the TCF membranes.

	Young's modulus (MPa)	**Tensile strength (MPa)**	**Elongation (%)**
V_0 (CNTs)	1076	13.69	1.57
$V_{0.25}$	1032	25.58	4.38
$V_{0.5}$	735	11.91	3.39
$V_{0.75}$	805	9.14	1.3
$V_{0.25}$-D70	1514	31.52	4.67

* V_x: x represents the PVA concentration in CNTs/PVA dispersion (wt%). Dy: y presents the addition of PDA dispersion (mL).

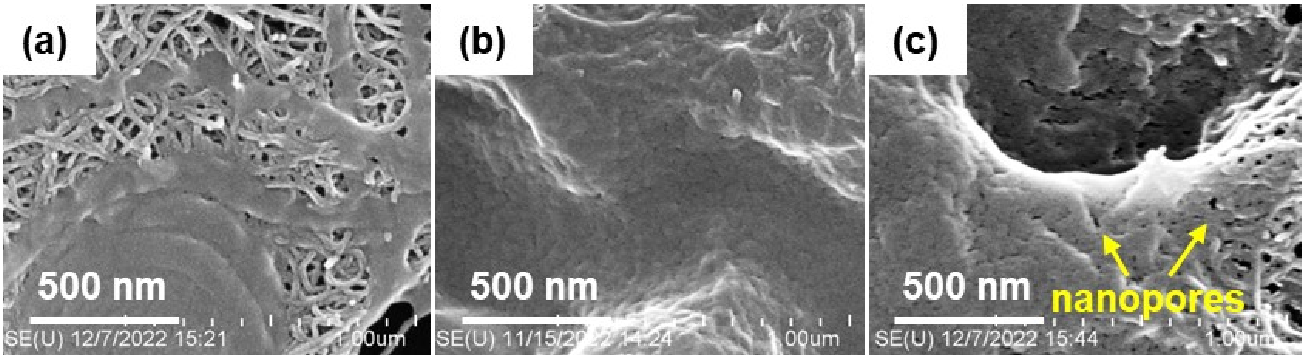

Fig. S 2 FESEM images of the CNTs/PVA support layers containing PVA with concentrations of (a) 0.25 wt%, (b) 0.5 wt5, and (c) 0.75 wt%. The yellow arrows point out the formation of nanopores.

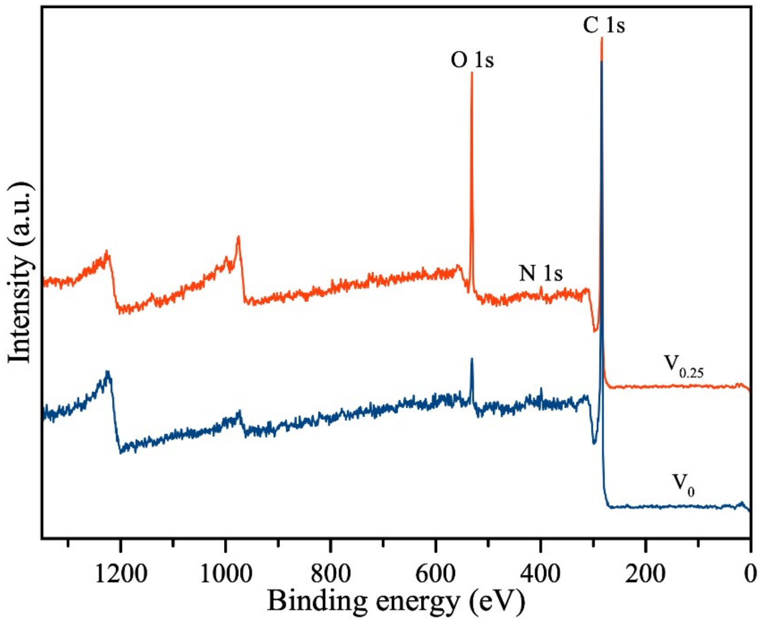

Fig. S 3 XPS survey spectra of the V_0 and $V_{0.25}$ support layer. The presence of the small nitrogen peak is caused by the residual surfactant in CNTs dispersion.

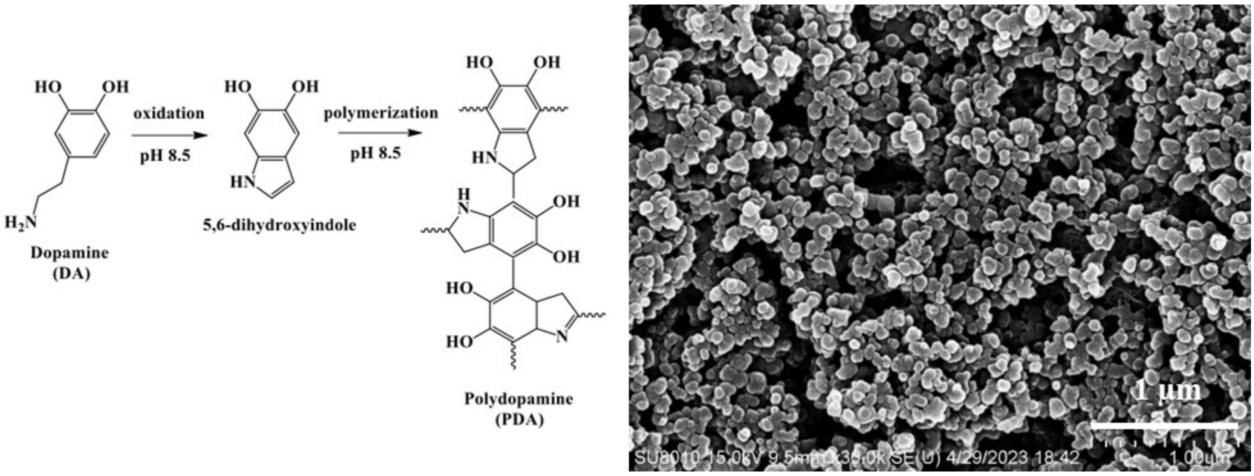

Fig. S 4 The polymerization of PDA and the uniformly distributed PDA nanoparticles on $V_{0.25}$-D70 surface.

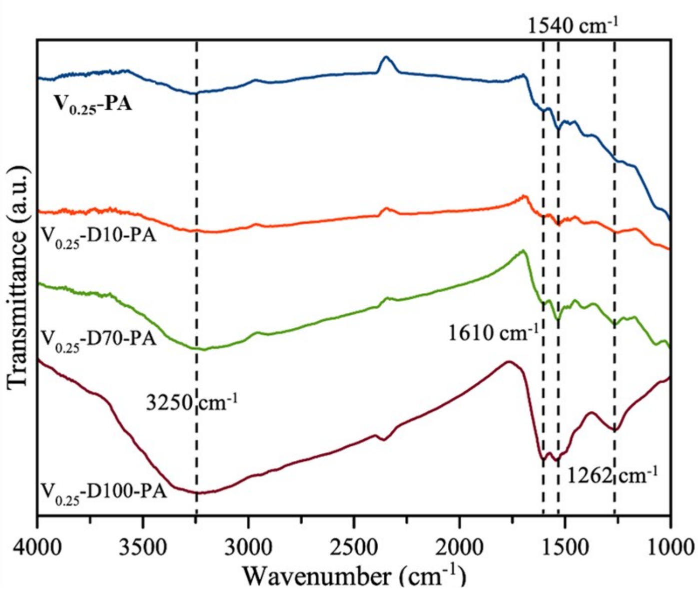

Fig. S 5 The FTIR spectra of the $V_{0.25}$-Dy-PA TFC membranes.

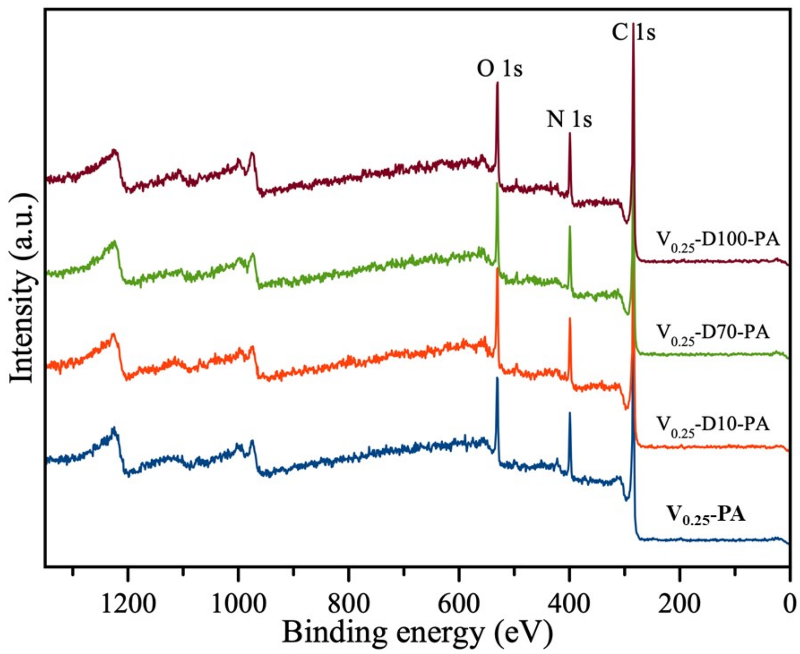

Fig. S 6 The XPS spectra of $V_{0.25}$-Dy-PA TFC membranes.

Table S 2 The FO performance of the proposed $V_{0.25}$-Dy-PA TFC membranes.

Samples	**Jw (LMH)**	**Js/Jw (g/L)**
$V_{0.25}$-(D0)-PA	18.77 ± 0.82	2.77 ± 0.22
$V_{0.25}$-D10-PA	24.30 ± 3.17	1.29 ± 0.07
$V_{0.25}$-D30-PA	35.31 ± 3.54	1.13 ± 0.12
$V_{0.25}$-D50-PA	53.56 ± 5.17	0.40 ± 0.05
$V_{0.25}$-D70-PA	**90.86 ± 8.01**	**0.22 ± 0.02**
$V_{0.25}$-D100-PA	33.74 ± 3.68	0.56 ± 0.04

Table S 3 Comparison of the A, B, and S values of the composite membrane in this study with those from other studies [1].

Membrane	*A* ($L\ m^{-2}\ h^{-1}\ bar^{-1}$)	*B* ($L\ m^{-2}\ h^{-1}$)	*S* (μm)	Reference
$V_{0.25}$-D70-PA	**4.93**	**1.07**	**58.7**	**This work**
eTFC-NC2	5.44	0.52	192	[2]
PAN1500	1.56	0.35	163	[3]
AQP-TFC-HF-PEI	3.66	0.31	172	[4]
HTI CA	0.67	0.40	678	[5]

Reference

1. Tiraferri, A., et al., *A method for the simultaneous determination of transport and structural parameters of forward osmosis membranes.* Journal of Membrane Science, 2013. **444**: p. 523-538.
2. Li, B., et al., *High performance electrospun thin-film composite forward osmosis membrane by tailoring polyamide active layer with polydopamine interlayer for desulfulrization wastewater desalination.* Desalination, 2022. **534**: p. 115781.
3. Han, C., et al., *Improved performance of thin-film composite membrane supported by aligned nanofibers substrate with slit-shape pores for forward osmosis.* Journal of Membrane Science, 2020. **612**: p. 118447.
4. Li, X., et al., *Fabrication of a robust high-performance FO membrane by optimizing substrate structure and incorporating aquaporin into selective layer.* Journal of Membrane Science, 2017. **525**: p. 257-268.
5. Ren, J. and J.R. McCutcheon, *A new commercial thin film composite membrane for forward osmosis.* Desalination, 2014. **343**: p. 187-193.