Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information

Elevated salt transport of antimicrobial loose nanofiltration membranes functionalized with copper nanoparticles via a fast bioinspired deposition

Junyong Zhu,[a] Adam Uliana,[ab] Jing Wang,[ac] Shushan Yuan,[a] Jian Li,[a] Miaomiao Tian,[c] Kenneth Simoens,[a] Alexander Volodin,[d] Jiuyang Lin,*[e] Kristel Bernaerts,[a] Yatao Zhang[c] and Bart Van der Bruggen*[a]

[a] *Department of Chemical Engineering, KU Leuven, Celestijnenlaan 200F, B-3001 Leuven, Belgium*
[b] *Department of Chemical Engineering, The Pennsylvania State University, University Park, PA 16802, United States*
[c] *School of Chemical Engineering and Energy, Zhengzhou University, Zhengzhou 450001, China*
[d] *Laboratory of Solid-State Physics and Magnetism, Department of Physics and Astronomy, KU Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium*
[e] *School of Environment and Resources, Qi Shan Campus, Fuzhou University, No. 2 Xueyuan Road, University Town, 350116 Fuzhou, Fujian, China*

*Corresponding authors:
E-mail (J. Lin): linjiuyang@126.com
E-mail (B. Van der Bruggen): bart.vanderbruggen@kuleuven.be

Fig. S1 Digital photos of membrane holder for membrane modification in this work

The membrane holder used in this work can be also used for interfacial polymerization. This simple device includes a supporter (to avoid contact with the solution), a seal (o-ring, to avoid solution leakage), a clamp with a screw (to fix membrane onto the holder) and a ring wall (to be a container). The PDA solution will be poured in this device with a fixed membrane; the bottom side of membrane cannot contact with the solution. Afterwards, the holder will be shaken for a while, followed by a static condition to let it self-polymerize and settle down onto the membrane surface. For co-deposition, the preparation process is similar with one-step route.

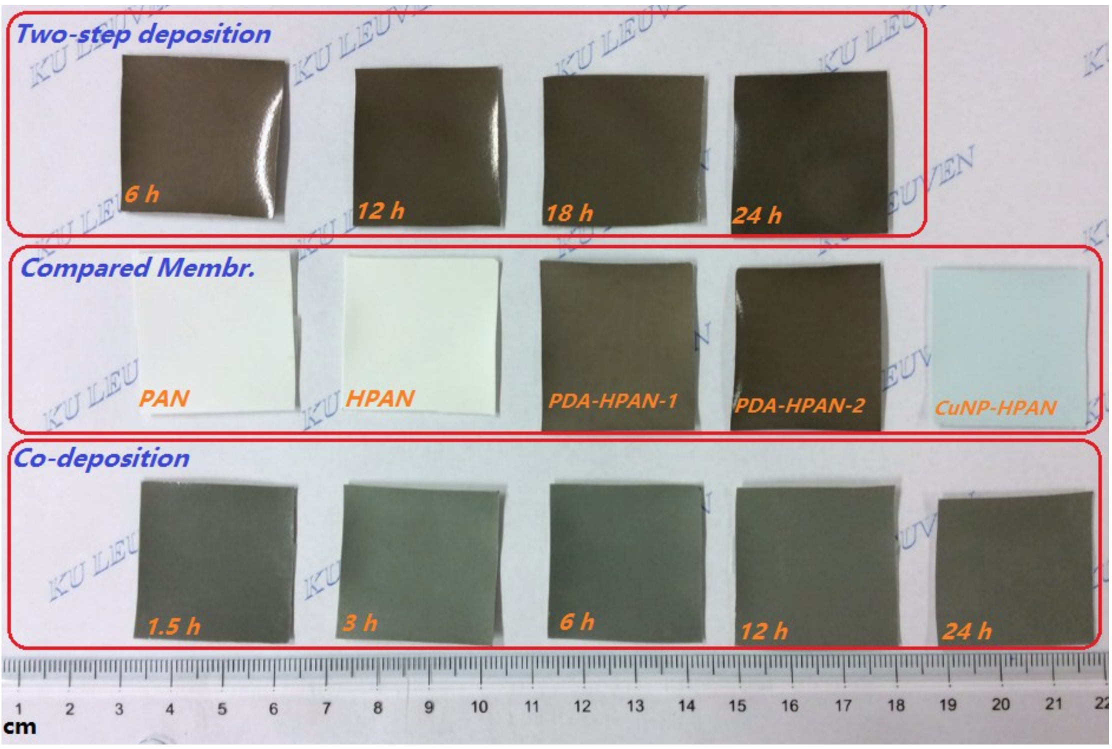

Fig. S2 Photo images of the pristine and modified membranes.

Table S1 Surface modification parameters corresponding to the assigned membranes. The two-step deposition membranes were first modified with PDA, then rinsed with DI water, and subsequently functionalized with CuNPs.

Membrane	PDA deposition time (h)	CuNP deposition time (h)	Co-deposition time (h)
PDA-HPAN-1	0.5	-	-
PDA-HPAN-2	6	-	-
CuNP-HPAN	-	24	-
NF-1	0.33	24	-
NF-2	0.5	12	-
NF-3	0.5	18	-
NF-4	0.5	24	-
Co-NF-1	-	-	1.5
Co-NF-2	-	-	3
Co-NF-3	-	-	6
Co-NF-4	-	-	12
Co-NF-5	-	-	24

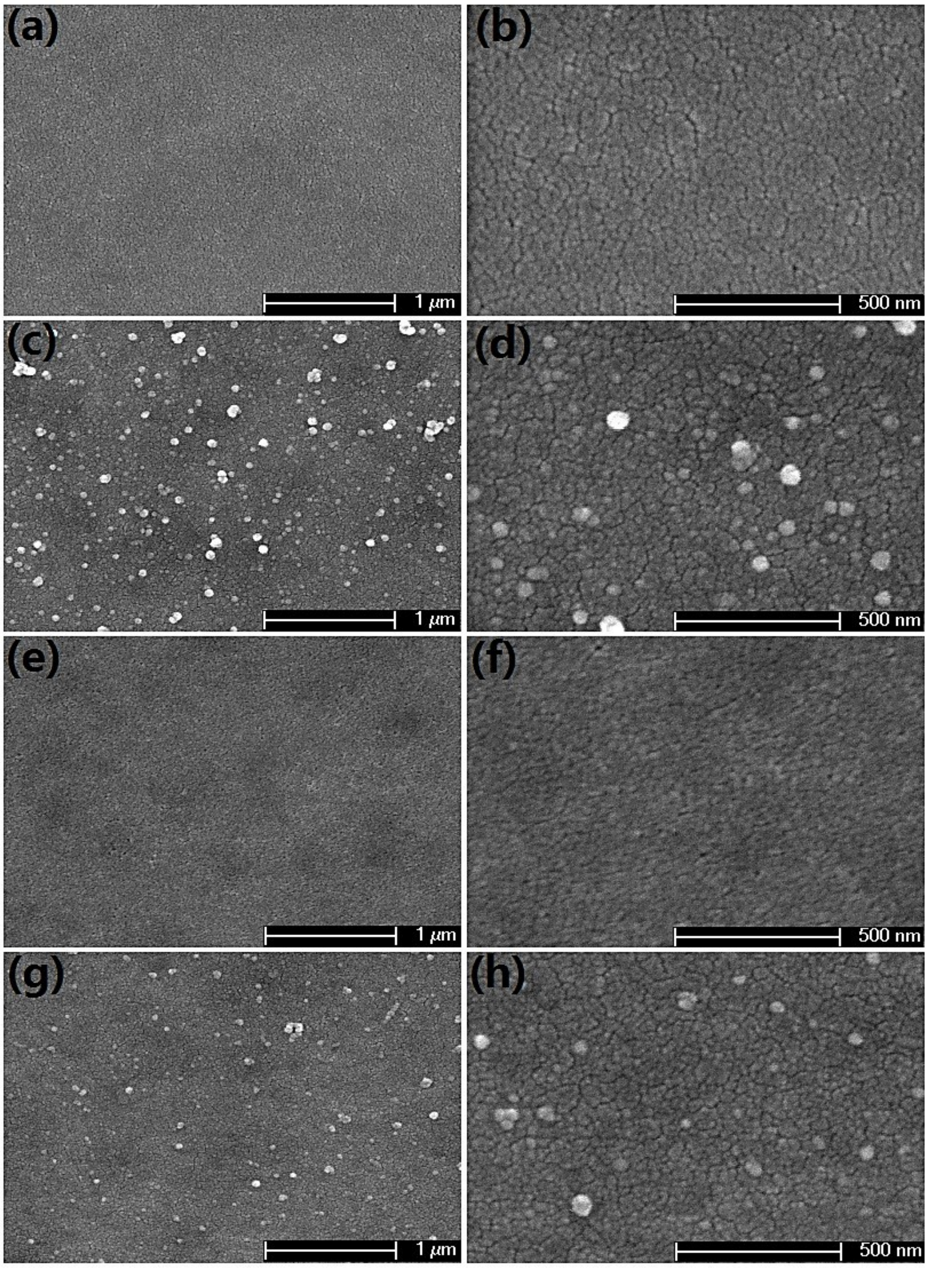

Fig. S3 Surface SEM images of pristine and modified membranes in different magnifications: (a, b) PAN, (c, d) CuNP-HPAN, (e, f) PDA-HPAN-1, and (g, h) PDA-HPAN-2.

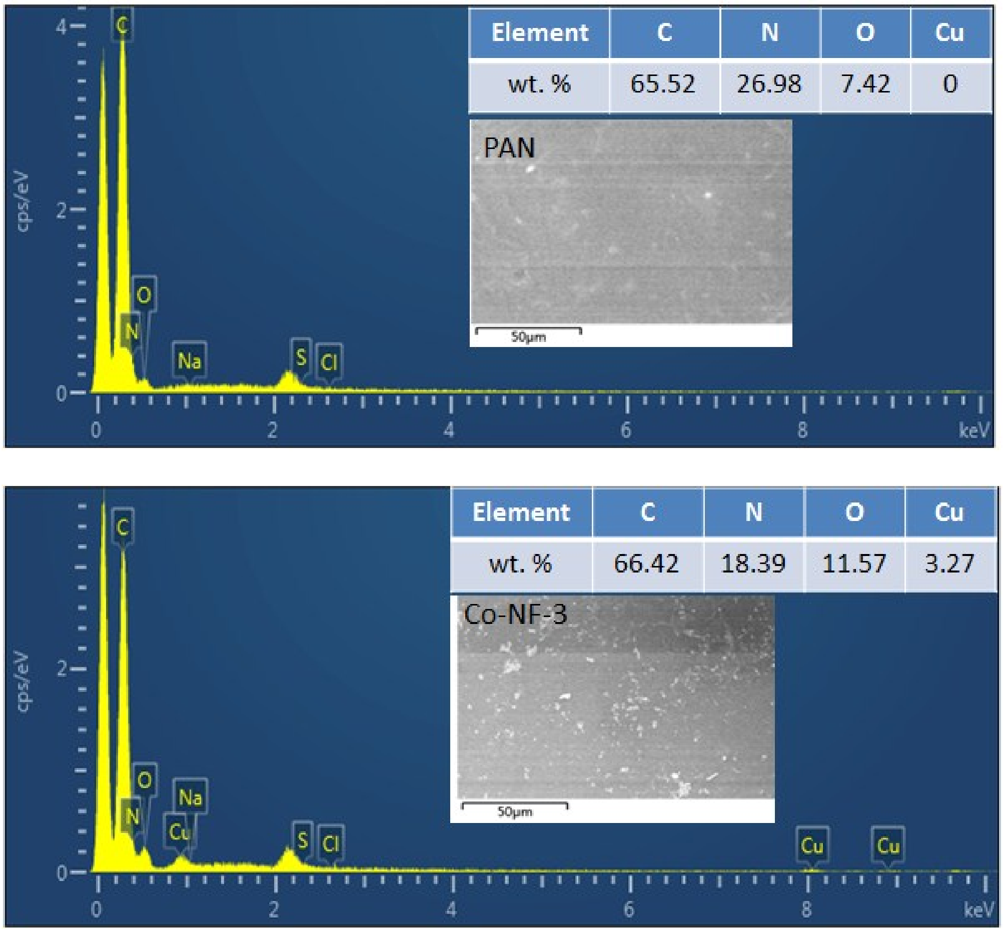

Fig. S4 The elemental analysis of pristine PAN and Co-NF-3 membrane surfaces using EDX and EDS.

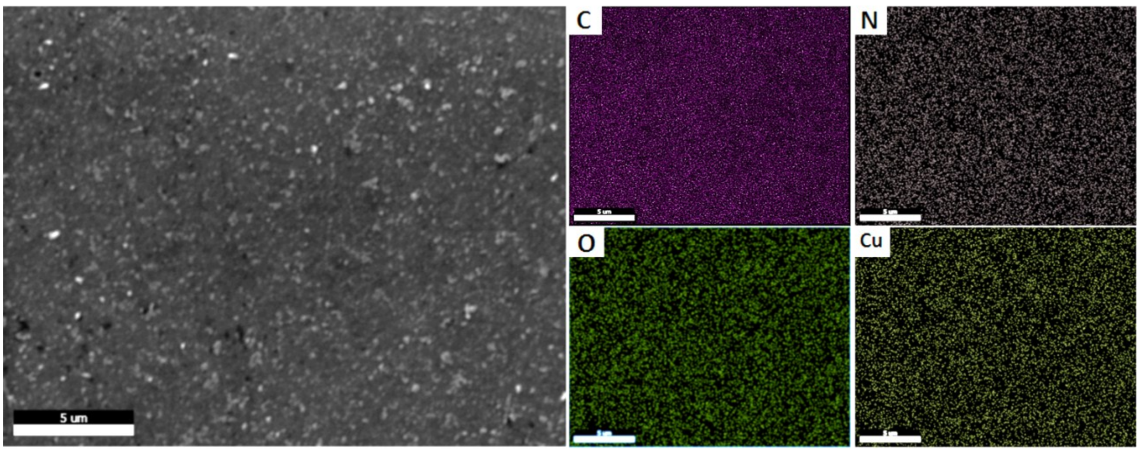

Fig. S5 EDX mapping of the Co-NF-1 membrane.

Table S2 Performance of nanofiltration membranes throughout literature and in this work in the separation of dyes and salts.

Membrane	Dye	Dye retention (%)	PWP[a] (LMH bar^{-1})	Salt rejection (%)	Ref.
CMCNa[b]/PP[c] NF	Methyl blue (799.8 Da)	99.6	10.8	NaCl (0.5 g L^{-1}): 28.8	1
	Congo red (696.7 Da)	99.8		Na_2SO_4 (0.5 g L^{-1}): 85.5	
Polypiperazine-amide NF	Reactive black 5 (991.8 Da)	99.3	~7.0	NaCl (1 g L^{-1}): 66.4 Na_2SO_4 (0.5 g L^{-1}): 98.5	2
Polyvinylamine-TMC[d] NF	Methyl blue (799.8 Da)	98.9	8.5	NaCl (0.5 g L^{-1}): 61.6	3
mHT[e]/PES	Reactive black 5 (991.8 Da)	95.0	6.3	NaCl (0.5 g L^{-1}): ~8.0	4
	Reactive red 49 (576.5 Da)	90.0			
Sepro NF 2A	Congo red (696.7 Da)	99.96	10.5	NaCl (0.5 g L^{-1}): 25.9	5
	Direct red 23 (813.72 Da)	99.95			
Sepro NF 6	Congo red (696.7 Da)	99.93	13.7	NaCl (0.5 g L^{-1}): 10.7	5
	Direct red 23 (813.72 Da)	99.8			
UTC-60	Reactive blue 2 (774.2 Da)	99.9	~ 10.0	NaCl (0.6 g L^{-1}): 30.1	6
GO-PSBMA[f]/PES	Reactive black 5 (991.8 Da)	99.2	~11.98	NaCl (0.5 g L^{-1}): ~4.0	7
	Reactive red 49 (576.5 Da)	97.2		Na_2SO_4 (0.5 g L^{-1}): ~10.0	
Co-NF-2	Direct red 23 (813.72 Da)	99.5	~18.2	NaCl (0.5 g L^{-1}): 3.3	This work
	Congo red (696.7 Da)	99.4		Na_2SO_4 (0.5 g L^{-1}): 25.2	
	Reactive blue 2 (774.2 Da)	99.0			

Notes: [a] PWP denotes pure water permeability; [b] CMCNa denotes sodium carboxymethyl cellulose; [c] PP denotes polypropylene; [d] TMC denotes trimesoyl chloride; [e] mHT denotes modified hydrotalcite with poly(ionic liquid); [f] GO-PSBMA denotes graphene oxide modified with poly(sulfobetaine methacrylate).

REFERENCES:

1 S. Yu, Y. Zheng, Q. Zhou, S. Shuai, Z. Lü and C. Gao, *Desalination*, 2012, **298**, 49-58.

2 S. Yu, M. Liu, M. Ma, M. Qi, Z. Lü and C. Gao, *J. Membr. Sci.*, 2010, **350**, 83-91.

3 M. Liu, Y. Zheng, S. Shuai, Q. Zhou, S. Yu and C. Gao, *Desalination*, 2012, **288**, 98-107.

4 L. Yu, J. Deng, H. Wang, J. Liu and Y. Zhang, *ACS Sustainable Chem. Eng*., 2016, **4**, 3292−3304.

5 J. Lin, W. Ye, H. Zeng, H. Yang, J. Shen, S. Darvishmanesh, P. Luis, A. Sotto and B. Van der Bruggen, *J. Membr. Sci.*, 2015, **477**, 183-193.

6 B. Van der Bruggen, B. Daems, D. Wilms and C. Vandecasteele, *Sep. Purif. Technol.*, 2001, **22-23**, 519-528.

7 J. Zhu, M. Tian, J. Hou, J. Wang, J. Lin, Y. Zhang, J. Liu and B. Van der Bruggen, *J. Mater. Chem. A*, 2016, **4**, 1980-1990.