Electronic Supplementary Material

Lignin-based electrospun nanofiber membrane decorated with photo-Fenton Ag@MIF-100(Fe) heterojunctions for complex wastewater remediation

Guodong Tian[1,2], Chao Duan (✉)[1,2], Bingxu Zhou[2], Chaochao Tian[2], Qiang Wang (✉)[1], Jiachuan Chen[1]

1 State Key Laboratory of Biobased Material and Green Papermaking, Qilu University of Technology, Shandong Academy of Sciences, Jinan 250353, China

2 College of Bioresources Chemical and Materials Engineering, Shaanxi University of Science and Technology, Xi'an 710021, China

E-mails: duanchaonba@126.com (Duan C); wangqiang8303@163.com (Wang Q)

1 Fabrication of different ratios of PAN/Lignin electrospun nanofiber membranes

PAN and lignin in different ratios (10:0, 8:2, 5:5, 4:6) were dissolved in DMF solvent, and stirred overnight at 60℃ to obtain uniform PAN/ lignin mixed spinning solution. The PAN/Lignin nanofibers were fabricated using an electrospinning device (Nano, Japan) with a high voltage of 18 V and rate of 0.8 mL/h. The collector was placed 15 cm away under the needle tip and the environmental conditions for spinning are 25%-35% of humidity and 25±2°C. The collected nanofibers were then air dried for 24 h.

2 Characterization and analyses

Scanning electron microscopy (SEM) images were obtained from an S4800 field emission scanning electron microscope (Hatchi, Japan). The energy dispersive spectrometer (EDS, VEGA 3 SBH) was utilized to analyze the elementary composition. Fourier Transform Infrared spectroscopy (FT-IR, VERTEX 70, Bruker Optics

Corporation; Germany) was carried out to study structure and interface a combination of materials. The UV-vis absorption spectra were recorded using a UV-vis spectrophotometer (UV5, Mettler Toledo, Switzerland). X-ray diffraction (XRD) patterns were collected with X-Ray Diffractometer (D8 Advance, Bruker Germany) using Cu Kα radiation with a scanning rate of 4°/min from 5° to 50°. The water contact angles (WCAs) of the membranes in air were evaluated by a contact angle measuring instrument (KRUSS DSA30S, Hake, Germany). Diffuse reflectance spectra (DRS) were obtained by UV-vis spectrophotometer (PerkinEImer, Lambda850, BaSO4 used as the reference). The gas adsorption isotherms of samples were measured using Brunauer-Emmett-Teller (BET) method (Micromeritics Instrument Corporation, Gemini VII Version 2.0) using N_2 as adsorption source at 77 K. All samples were degassed by N_2 blowing at 150℃ for 1 h to remove the humidity and volatile composites before testing. The specific surface area of samples was calculated by N_2 adsorption isotherms at relative vapor pressures of 0.05-0.3 MPa.

3 Figures

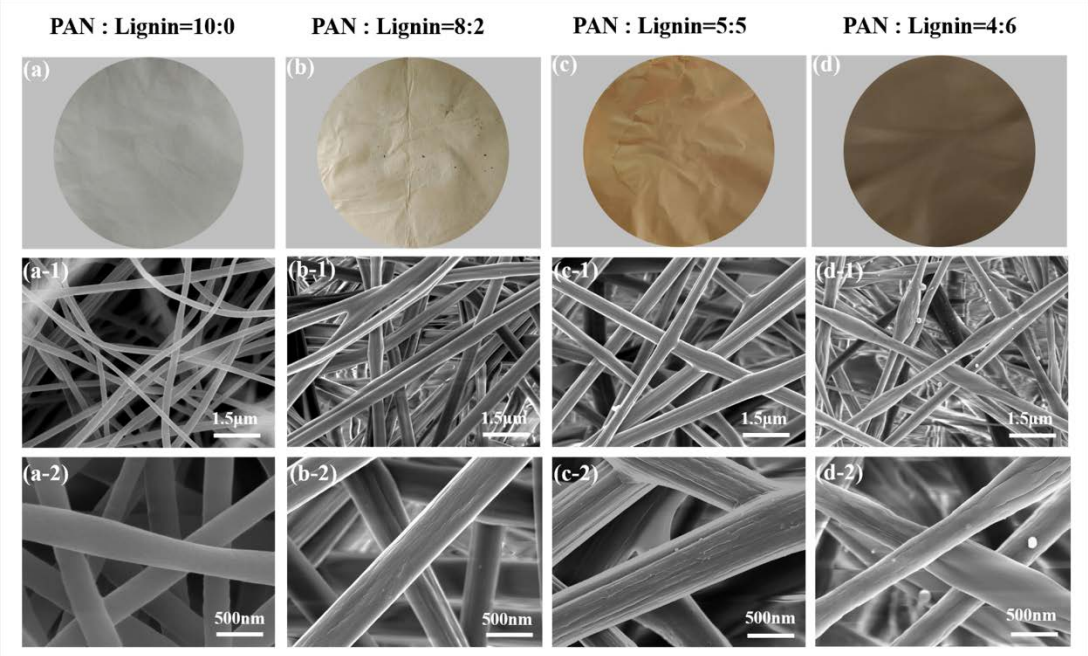

Fig. S1 Photographs and SEM images of PAN and lignin ENM with different ratios (a) 10:0, (b) 8:2, (c) 5:5 (d) 4:6.

Table S1 The weight and weight fraction of each component in Ag@MIL-100(Fe)/LENM.

Components	Weight	Weight fraction
LENM	44.56 mg	39.9%
MIL-100(Fe)	50.24 mg	44.9%
Ag NPs	16.95 mg	15.2%

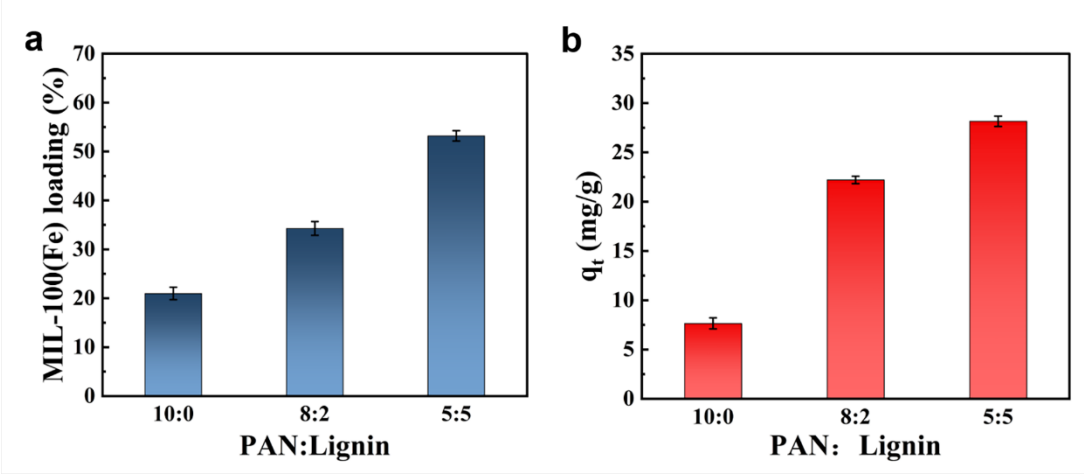

Fig. S2 (a) The loading capacity of MIL-100(Fe) and (b) the adsorption capacity of MB with different ratios of PAN and lignin.

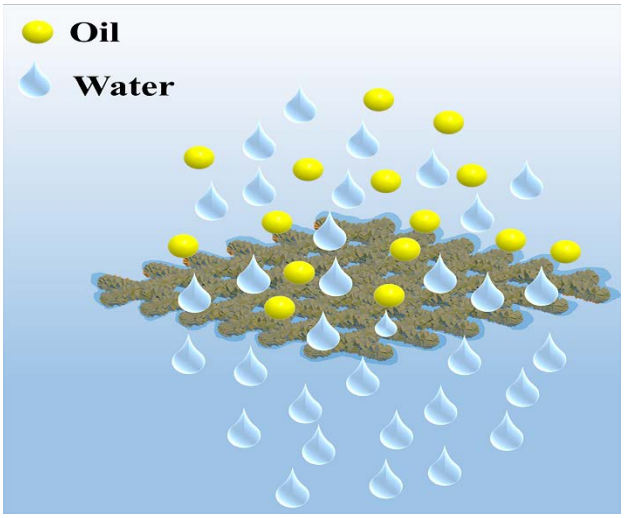

Fig. S3 schematic illustration of oil-wetting states and oil-water separation on Ag@MIL-100(Fe)/LENM.

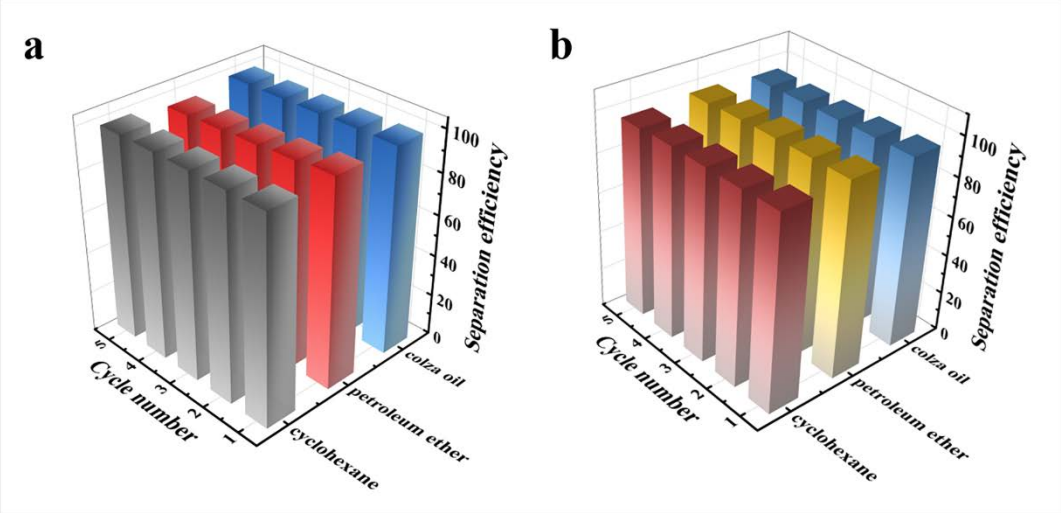

Fig. S4 Repeated separation efficiency of (a) SFEs and (b) SSEs oil/water emulsions permeated through the Ag@MIL-100(Fe)/LENM.

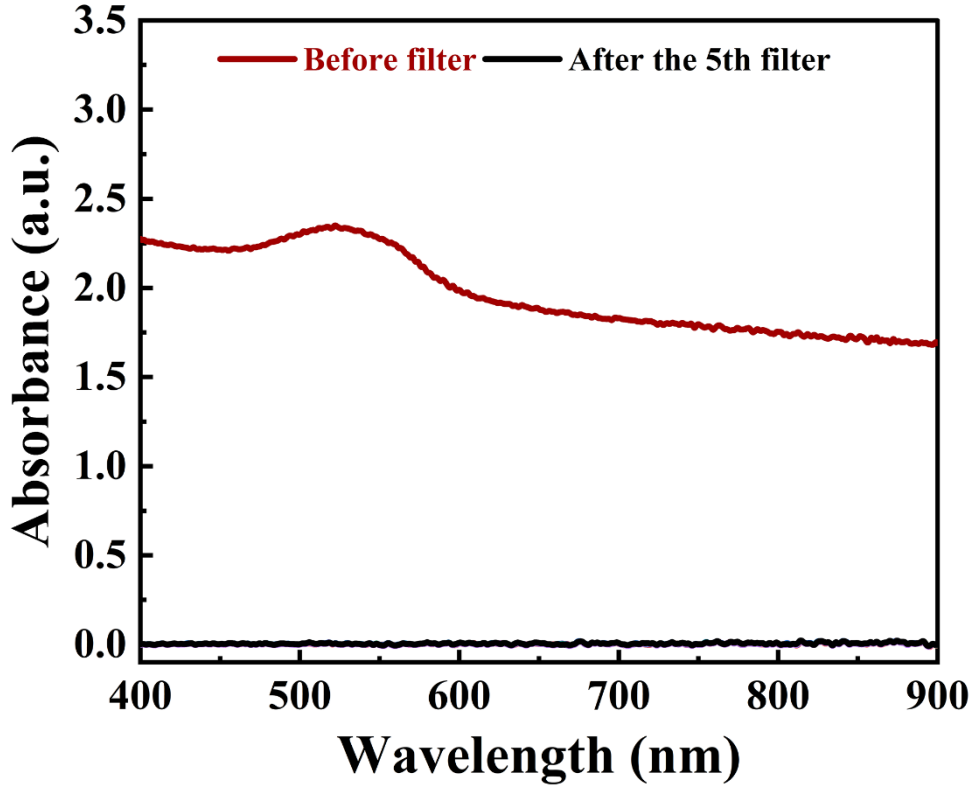

Fig. S5 UV-vis spectra of oil-water emulsion before and after repeated separation for 5 times (take cyclohexane as an example).

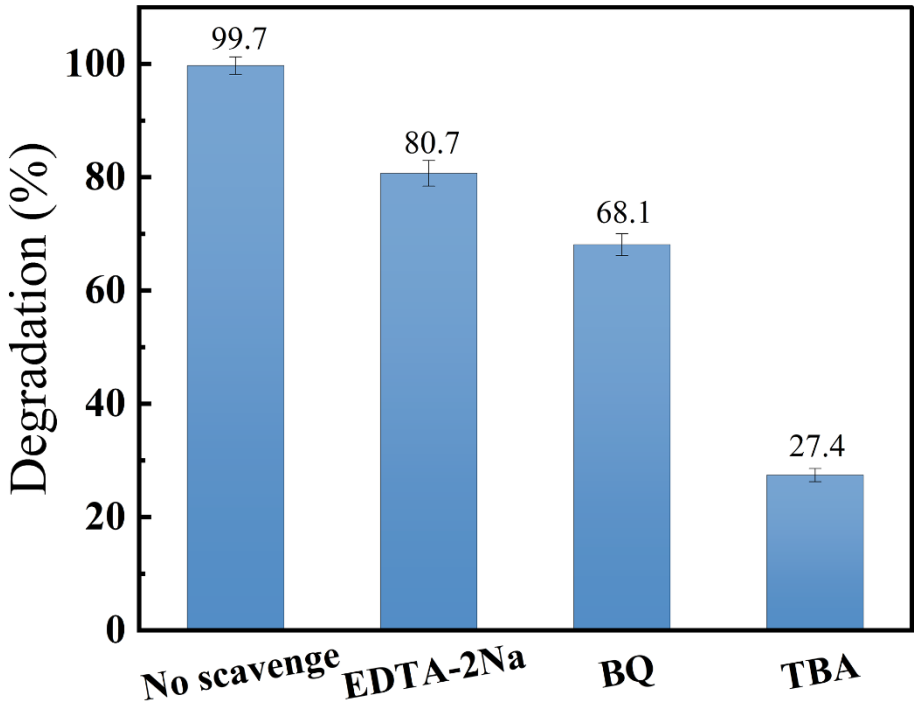

Fig. S6 The free radical capture experiment of Ag@MIL-100(Fe)/LENM.

Table S2 Comparison of dye degradation efficiency of similar catalysts reported in the literature (R_{dye} refers to dye removal efficiency).

Sample	Pollution	R_{dye}	Time (min)	Degradation system	Ref.
PAN/β-FeOOH	MB	> 98%	40	Photocatalysis	[1]
Ag/TCM-5	RhB	> 99%	90	Photothermal catalysis	[2]
$CuFe_2O_4$@MIL-100(Fe, Cu)	MB	> 99%	30	Photothermal-Fenton catalysis	[3]
MIL-101(Fe)/PMS	MB	> 92%	25	PMS catalysis	[4]
Ag@MIL-100(Fe)/LENM	MB	> 99%	30	photo-Fenton catalysis	this work

References

1. Zhang L, He Y, Ma L, Chen J, Fan Y, Zhang S, Shi H, Li Z, Luo P. Hierarchically stabilized PAN/β-FeOOH nanofibrous membrane for efficient water purification with excellent antifouling performance and robust solvent resistance. ACS Applied Materials & Interfaces. 2019, 11(37): 34487-34496

2. Zhang Q, Zhang Z, Zhao D, Wang L, Li H, Zhang F, Huo Y, Li H. Synergistic photocatalytic-photothermal contribution enhanced by recovered Ag^{+} ions on MXene membrane for organic pollutant removal. Applied Catalysis B: Environmental. 2023, 320: 122009

3. Shi S, Han X, Liu J, Lan X, Feng J, Li Y, Zhang W, Wang J. Photothermal-boosted effect of binary CuFe bimetallic magnetic MOF heterojunction for high-performance photo-Fenton degradation of organic pollutants. Science of the Total Environment. 2021, 795: 148883

4. Xiao Z, Li Y, Fan L, Wang Y, Li L. Degradation of organic dyes by peroxymonosulfate activated with water-stable iron-based metal organic frameworks. Journal of Colloid and Interface Science. 2021, 589: 298-307