Nanofiltration membrane from reactive positively charged nanofiber interlayer

for recycling lithium from waste batteries

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Characterization

Surface and cross-sectional morphologies of membrane samples were taken in JEOL JSM-6510L scanning electron microscope after coated by platinum. The chemical structure of primary and modified NFM was characterized by FTIR-ATR spectrometer (Tensor27, Bruker) and X-ray photoelectron instrument (XPS, Thermo Electron Co.). The static water contact angle of membranes was measured by using contact angle goniometry (KRUSS DSA30S, KRUSS Co., Germany). The concentration of single salt was measured by conductivity meter, and the concentration of mixed salt was measured by inductively coupled plasma mass spectrometry (ICP). A total organic carbon analyzer (TOC-5050A, Shimadzu, Japan) was utilized to measure the concentration of PEG solution with different molecular weights.
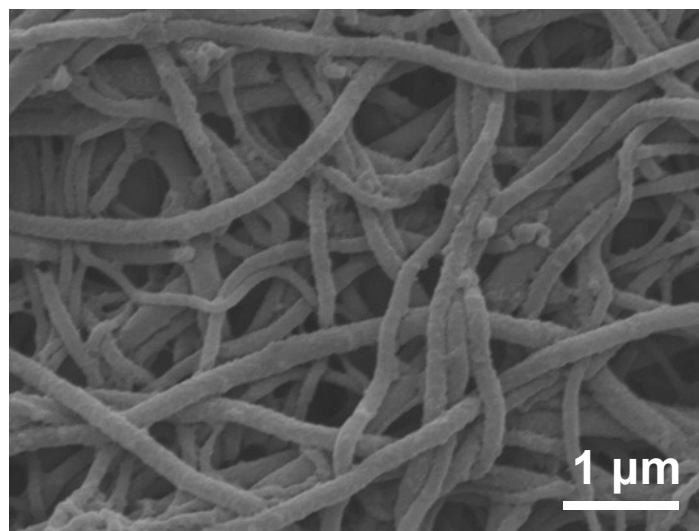
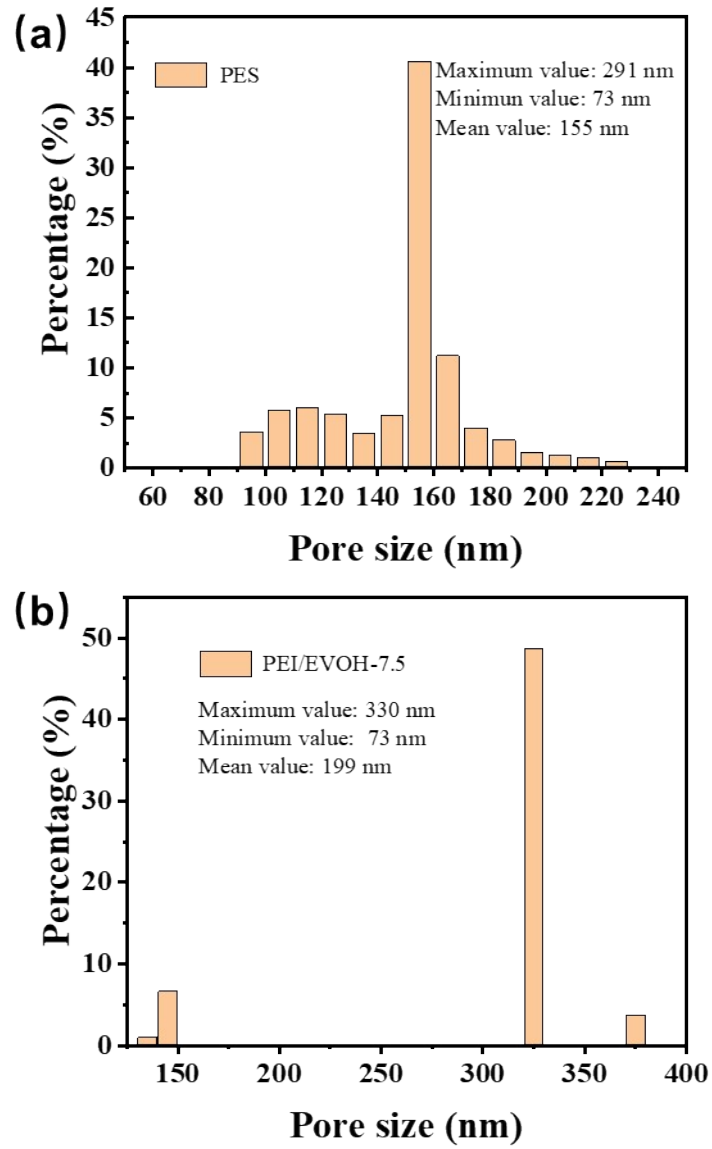**Figure S1** The SEM image of EVOH nanofiber membrane crosslinked via GA

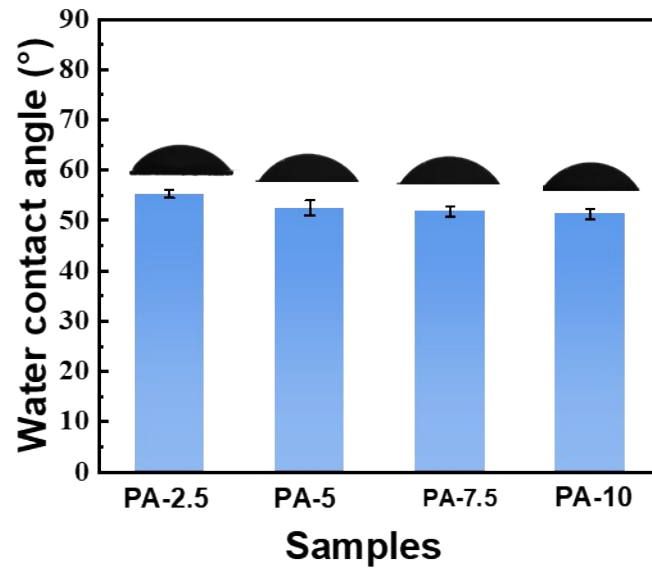**Figure S2** The pore size and distribution of (a) PES membrane and (b) PEI/EVOH-7.5.

Figure S3 Water contact angles of nanofiltration membranes at various PEI content
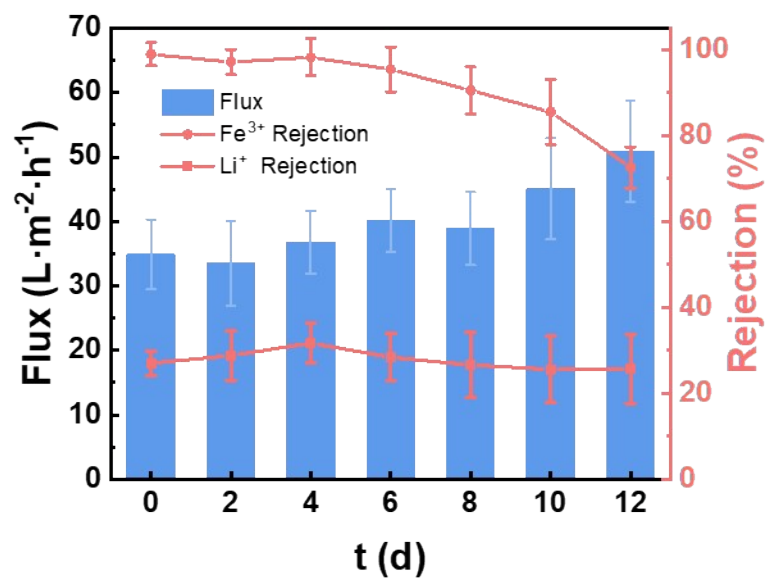
Figure S4 Separation performance with continuous filtration time (Feed: 2000 ppm LiCl&FeCl₃ mixture solution, Fe/Li ratio of 10, pH adjusted to 1.5)
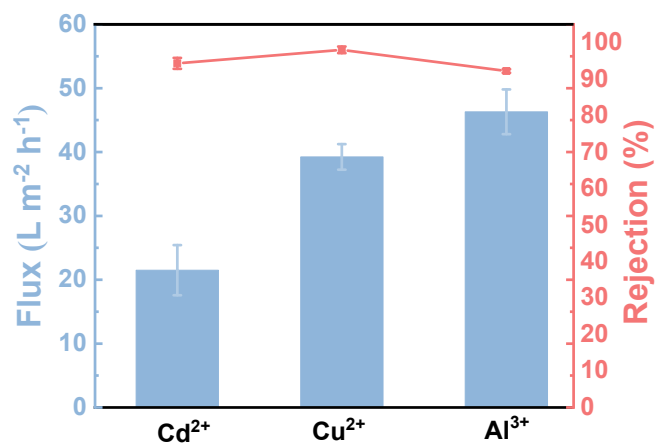
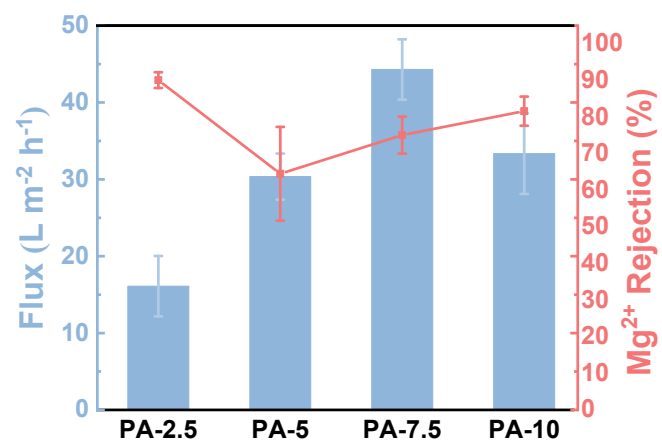**Figure S5** Heavy metal ion aqueous solution flux and rejection of PA-7.5 at the pressure of 0.6 Mpa

Figure S6 MgCl$_2$ aqueous solution flux and Mg^{2+} rejection of nanofiltration membranes at the pressure of 0.6 Mpa

Table S1 Comparison of the performance of the reported PEI-based NF membranes in literatures

Membranes	Selective layer thickness (nm)	PWP (L m^{-2} h^{-1} bar^{-1})	Mg^{2+} rejection (%)	Ref.
PEI-TMC composite NF membrane	~65	5.02 (at 8 bar)	95	[13]
PSF/DTES/PEI-TMC	132	6.2 (at 8 bar)	92	[22]
Polyetherimide /TMC/BPEI /EDTA	135	0.6 (at 10 bar)	92	[36]
PSF/PEI-TMC/QBPD	116	16.1(at 6 bar)	92	[37]
PES/CNC-COOH/PEI-TMC	60	3.4 (at 8 bar)	96	[24]
APVC-PEI-TMC(DPCL-2)	299	3.546 (at 6 bar)	95	[38]
PA-7.5	**222**	**6.7 (at 6 bar)**	**75**	**This work**