Supplementary Information

Ion transport behavior through thermally reduced graphene oxide membrane for precise ion separation

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1. Materials

Graphite (≧98.0%) was purchased from Aladdin. Dopamine hydrochloride came from Dongguan walixi chemical co., LTD.(China). Potassium permanganate ($KMnO_4$) was purchased from saan chemical technology (Shanghai) co., LTD. Polyether sulfone membrane was obtained from Haining Taoyuan Medical Chemical Instrument Factory (China). The used water was distilled water.

All reagents were analytical grade and used as received without further purification.

2. Preparation of GO

The modified Hummers method was used to prepare GO suspension [19], which was divided into three stages. In the low temperature stage, 5 g of graphite and 2.5 g $NaNO_3$ was added to 110 mL concentrated sulfuric acid at a temperature about 273-278 K successively. Then 20 g $KMnO_4$ was slowly put in the mixture under stirring for 2 h. The second step, 200 mL of deionized water was added and the reaction time lasted about 30 min. In the third step, the temperature was raised to 371K and maintain about 1h. Then H_2O_2 (30%, no more than 10 mL) was slowly added after 200 mL of distilled water was added. The mixture was centrifuged and washed with distilled water until the pH became neutral. The concentration of GO was obtained by freezing a certain amount of GO solution.

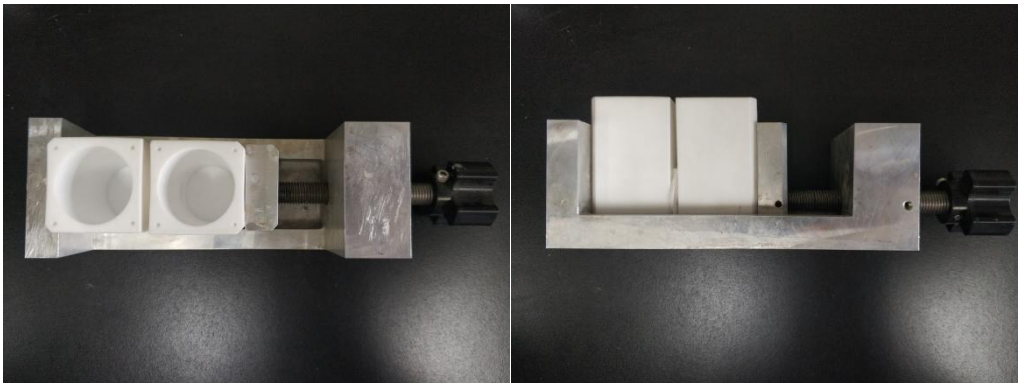

Figure S1. The photo of the home-made filtration device.

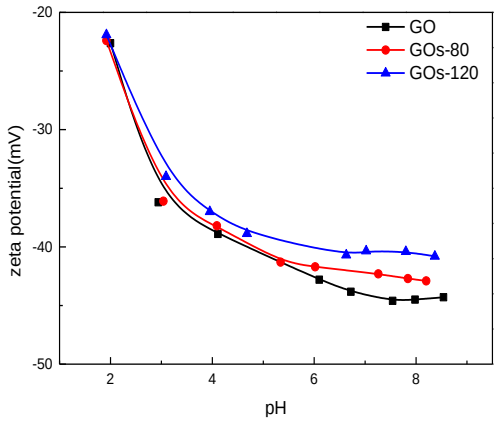

Figure S2. Zeta potential of GO, GOs-80, and GOs-120.

Table S1. Element composition of GO-25, GO-80, and GO-120.

	N%	C%	H%	O%
GO-25	0.83	47.35	1.94	49.88
GO-80	0.95	47.89	1.85	49.31
GO-120	1.13	50.47	1.73	46.67

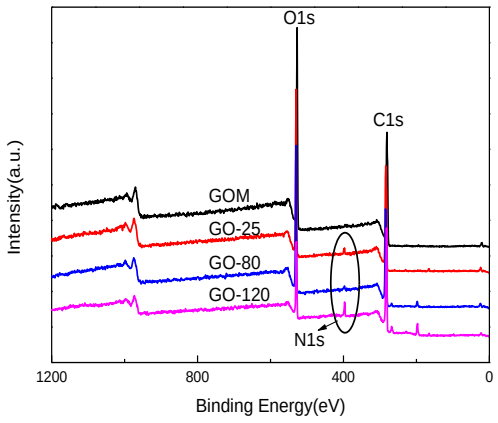

Figure S3. Full spectrum spectra of GOM, GO-25, GO-80, and GO-120.

Table S2. The surface character of GO-25, GO-80, and GO-120

	Surface area(m^2/g)	Pore size(nm)	Pore volume(cm^3/g)
GO-25	12.1633	50.38802	0.153221
GO-80	60.4379	1.90113	0.028725
GO-120	55.3727	2.15128	0.029781

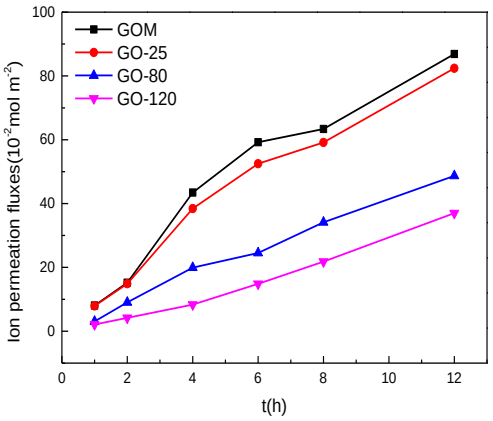

Figure S4. Effect of time to Na^+ permeation fluxes through GOM, GO-25, GO-80, and GO-120 membrane.
0.02 mol/L $NaNO_3$ solution in feed tank, 1.0 mol/L HNO_3 in permeate tank

Table S3. Separation factor of GOM, GO-25, GO-80, and GO-120 membrane to mixture ions ([M]=0.02mol/L)

	Na	K/ Na	Cs/ Na	Mg	Ca/ Mg	Sr /Mg	K/ Fe	Ca/ Fe	Fe
GO	1	1.29	1.32	1	1.18	1.26	2.98	1.57	1
GO-25	1	1.41	1.46	1	1.11	1.09	6.28	2.04	1
GO-80	1	1.33	1.39	1	1.67	1.73	49.84	11.50	1
GO-120	1	1.72	1.82	1	3.57	3.83	238.20	25.61	1

Table S4. Separation factor of GO-120 membrane to mixture ions ([M]=0.02mol/L).

HNO_3	Na	K/ Na	Cs/ Na		Mg	Ca/Mg	Sr/Mg		Na	K/ Na	Cs/ Na
0.5M	1	1.49	1.54	HNO_3	1	3.57	3.83	Cl^-	1	1.40	1.43
1M	1	1.72	1.82	$NaNO_3$	1	2.71	2.73	SO_4^{2-}	1	1.74	1.83
2M	1	1.65	1.81	KNO_3	1	3.13	3.11	NO_3^-	1	1.72	1.82

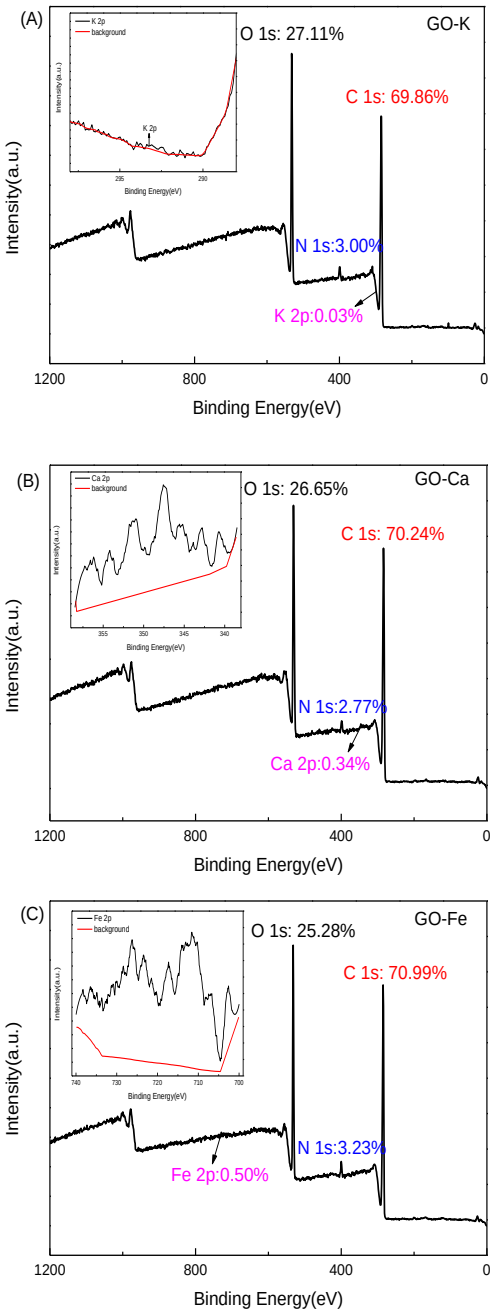

Figure S5. XPS survey spectra of (A) GO-K, (B) GO-Ca, (C) GO-Fe.