Facile fabrication of polyelectrolyte complex / carbon nanotube nanocomposites with improved mechanical properties and ultra-high separation performance

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1. Effect of [HCl] on ionic complexation between CMCNa and PDDA.
2. FT-IR and ζ potential of MWCNT-COOH.
3. Dispersion of MWCNTs in the PEC/MWCNTs blending membrane and its mechanical property.
4. Comparison of pervaporation performance of PEC/MWCNTs nanocomposite membranes with other membranes.

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1. Effect of [HCl] on ionic complexation between CMCNa and PDDA.

Fig. 1 shows the light transmittance of CMCNa solutions (200 mL) with increasing PDDA dosage at different [HCl]. It is found that the light transmittance decreases with increasing PDDA dosage at each [HCl], especially for lower [HCl]. No turbidity happened in CMCNa when [HCl] is 0.015 M and PEC do not well precipitate out when [HCl] is 0.01 M. Moreover, when [HCl] is lower than 0.0025 M, the obtained PECs precipitate can hardly be dissolved in NaOH because less COOH groups are protonated. Thus, 0.004 M HCl was chosen to prepare CMCNa-PDDA PEC/MWCNT nanocomposites.

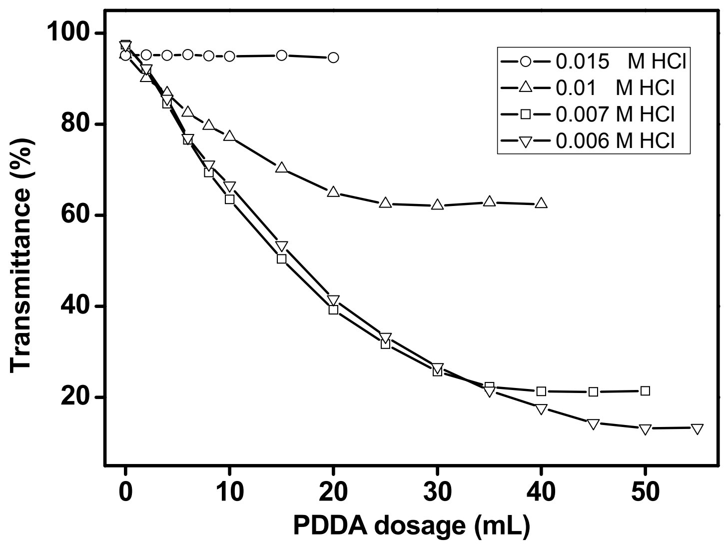
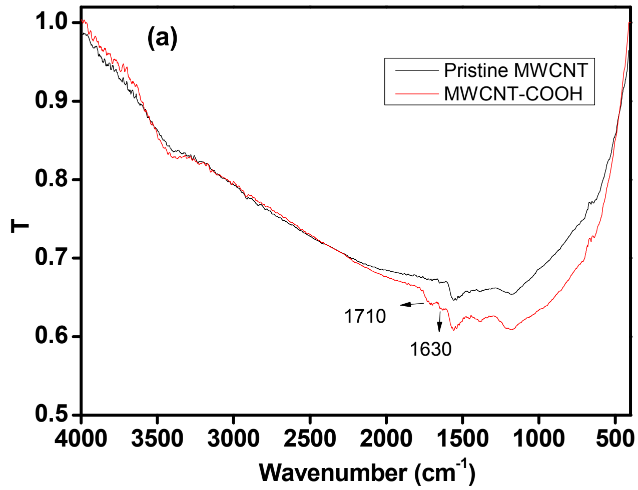


Fig. 1 Light transmittance of CMCNa solution (200 mL) added with different amount of PDDA solution at different [HCl]. The monomer mole concentration of both parent solutions of CMCNa and PDDA are 0.005 M

2. FT-IR and ζ potential of MWCNT-COOH.

FT-IR spectra of MWCNT-COOH and pristine MWCNT are given in Fig. 2(a). Compared with the pristine MWCNT, two new absorption bands at 1710 cm^{-1} (-COOH group) and 1630 cm^{-1} (-COONa group) rise for MWCNT-COOH sample. The presence of COONa is because partial ionization of COOH groups during the washing of MWCNT-COOH by de-ionized water. ζ potential of MWCNT-COOH aqueous dispersion is -5.1 mv (Fig. 2(b))and this value is in accordance with FT-IR structure of MWCNT-COOH.



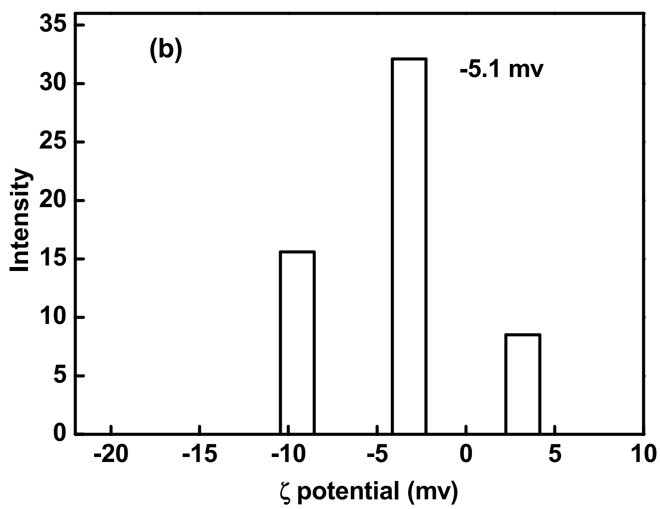


Fig. 2 (a) FT-IR of MWCNT-COOH and pristine MWCNT, (b) ζ potential of MWCNT-COOH aqueous dispersion (0.016 wt%). MWCNT-COOH aqueous dispersion was filtered with a 5 µm microfiltration membrane before ζ potential measurements.

3. Dispersion of MWCNTs in the PEC/MWCNTs blending membrane and its mechanical property.

Fig. 3 shows the dispersion of MWCNTs in the PEC/MWCNTs blend film. It can be seen from Fig. 3 that MWCNTs agglomerated in the PEC matrix. Moreover, cross-sectional examination (Fig. 3b) shows that MWCNTs are dispersed between PEC aggregates but not encapsulated in them.

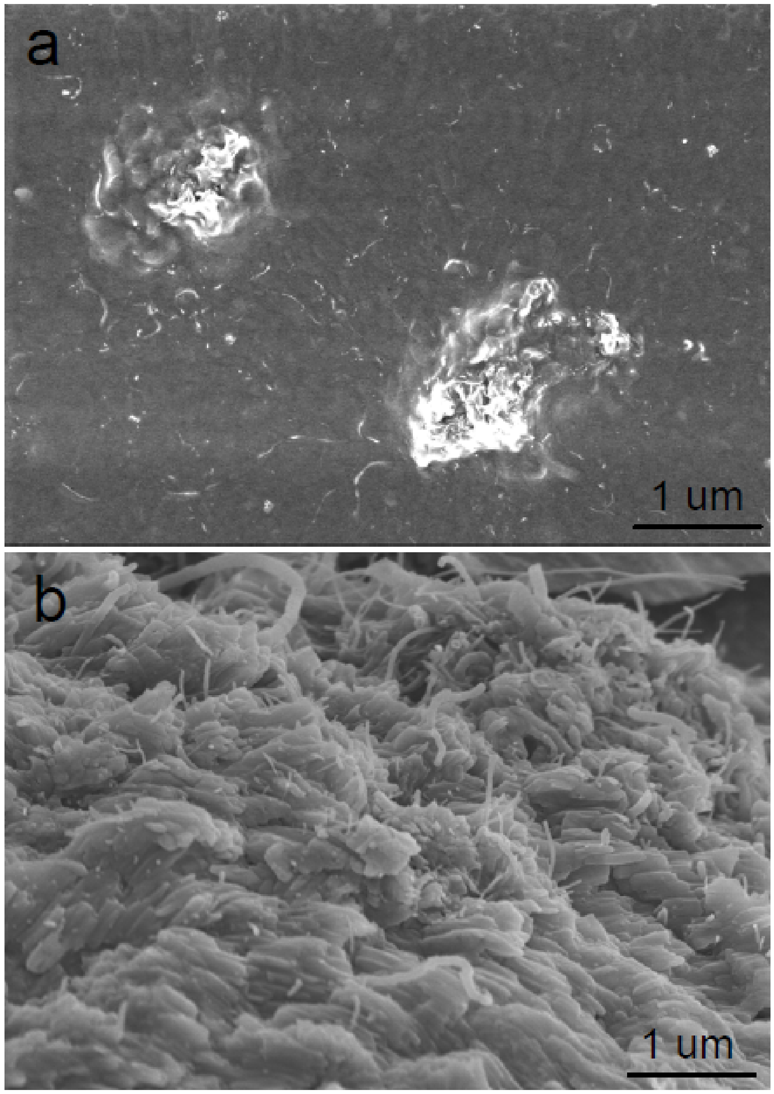


Fig. 3 Dispersion of MWCNTs in the MWCNT/PEC blend film containing 5 wt% MWCNTs (a) surface, (b) cross-section.

Fig. 4 shows that the mechanical strength of the MWCNTs/PEC blend film is very poor and not improved as compared with pristine PEC film. This is due to the agglomeration of MWCNTs in the blend film.

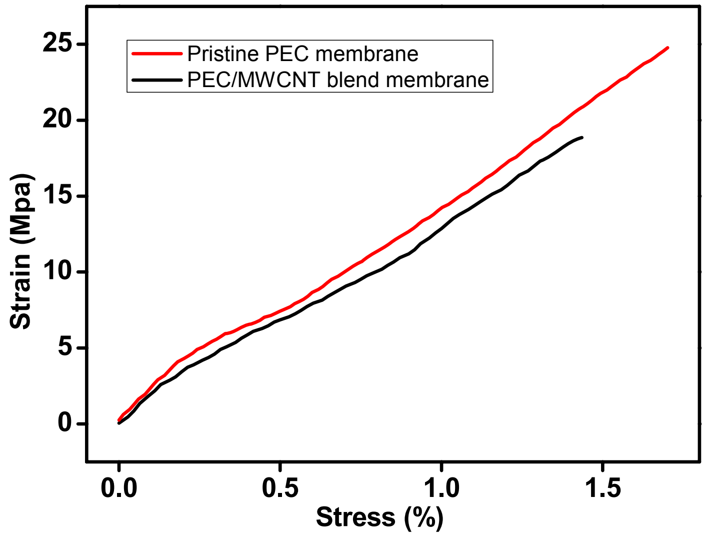


Fig. 4 Stress~strain curve of PEC/MWCNT blend film (5 wt% MWCNTs) and pristine PEC film.

4. Comparison of pervaporation performance of PEC/MWCNTs nanocomposite membranes with other membranes.

Table 1 shows that the pervaporation performance of PEC/MWCNTs in dehydrating 10 wt% water-isopropanol. As compared with other recent reported membranes, it is seen that the pervaporation performance of PEC/MWCNT9505 nanocomposite membrane is superior, especially in flux.

Table 1. A comparison of pervaporation performance of PEC/MWCNT9505 nanocomposite membrane with other membranes in dehydrating water-isopropanol. J is permeation flux and α is separation factor.

Membranes	Temp	Feed water	J (kg/m^2h)	α	ref
PEC/MWCNT9505	70 °C	10 wt%	2.35	2562	This work
PERVAP 2510[a]	70 °C	10 wt%	0.75	810	1
PEC/MWCNT9505	30 °C	10 wt%	0.63	1991	This work
5 wt% APTEOS[b]/PVA[c]	30 °C	10 wt%	0.026	1580	2
5 wt% Na^+ MMAT[d]-10/PVA	30 °C	10 wt%	0.051	1116	3
10 wt% silicalite-1 / PVA	30 °C	10 wt%	0.069	2241	4
5 wt% NaY zeolite/SA[e]	30 °C	10 wt%	0.14	171	5
10 wt% NaY zeolite/CS[f]	30 °C	10 wt%	0.062	254	6

[a] PERVAP 2510: Commercial membrane from Sulzer Chemtech, Germany.
[b] APEOS: *γ*-aminopropyl-triethoxysilane.
[c] Poly(vinyl alcohol)
[d] Sodium montmorillonite.
[e] Sodium alginate
[f] Chitosan

Ref for Table 1:

1. X. Y. Qiao, T. Chung, W. F. Guo, T. M. Matsuura, M. Teoh, *J. Membr. Sci.,* 2005**, 252,** 37.
2. Q. G. Zhang, Q. L. Liu, Y. Chen, *Ind. Eng. Chem. Res.,* 2007**, 46***,* 913.
3. S. G. Adoor, M. Sairam and T. M. Aminabhavi, *J. Membr. Sci.,* 2006, **285,**182.
4. S. G. Adoor, B. Prathab, L. S. Manjeshwar and T. M. Aminabhavi, *Polymer,* 2007, **48,** 5417.
5. M.. Kariduraganavar, A.A. Kittur and S.S. Kulkarni, *J. Membr. Sci.,* 2004, **238,** 165
6. A.A. Kittur, S.S. Kulkarni and M.I. Aralaguppi, *J. Membr. Sci.,* 2005, **247,** 75.