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APPENDICES

Appendix A Determination of the Charge Carrier Species by Ultraviolet-visible Spectroscopy

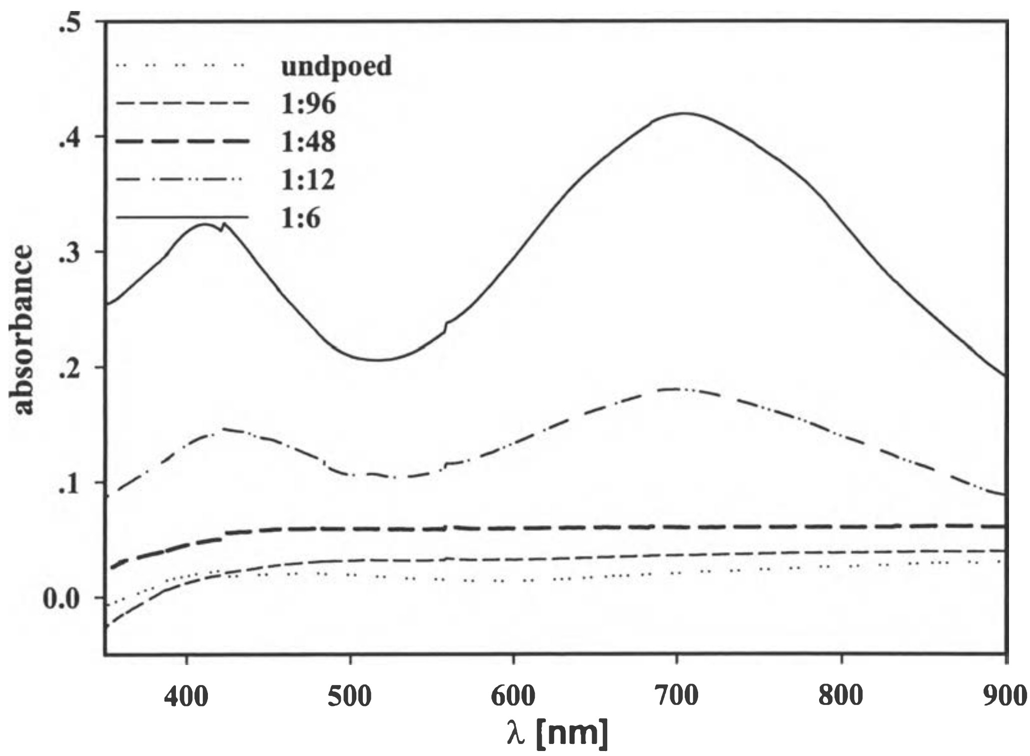


Figure A1 UV-Vis spectra of polypyrrole: (a) undoped; (b) 1:96; (c) 1:48; (d) 1:12; and; (e) 1:6.

Figure A1 shows the UV-VIS spectra of Ppy at different N_d/N_m ratios. There is no absoption peak for Ppy at 1:96 and 1:48 N_d/N_m ratio due to the limitation of solubility of the polymer. When N_d/N_m ratio increases to 1:12 and 1:6, the absorption peaks at 427.46 and 411.59 nm appear; they are assigned to the $\pi \rightarrow \pi^*$ transition. Peaks at 700.76and 706.05 nm are assigned to bipolaron. The absorption spectra are different from the previous work (Ruangchuay, 2003); the polaron absorption peaks at 398.02 and 648.67nm do not appear due to the overlapping of the bipolaron peaks. The blue shift of $\pi \rightarrow \pi^*$ transition refers to the decrease of conjugation in the polymer chains and the red shift of bipolaron due to the solvent stabilizing effect on the bipolaron (Shen,1997). The peaks and their interpretations of these spectra are summarized in Table A1.

Table A1. Absorption wavelengths of polypyrrole doped by β-naphthalenesulfonate sodium salt in NMP solution

N_d/N_m ratio	Peak position (nm)		Assignment
		Refference	
undoped	-	-	-
1:96	-	-	-
1:48	-	-	-
1:12	427.46	323.33[a]	π→ π* transition
	-	648.67	Polaron
	700.76	770.29	Bipolaron
1:6	411.59		π→ π* transition
	706.05		Bipolaron
1:3	-	411[b, c]	π→ π* transition
	-	652	Polaron
	-	970	Bipolaron
1:1.	-	415[b, c]	π→ π* transition
	-	655	Polaron
	-	965	Bipolaron

[a] Ruangchuay, 2003, [b] Shen, and Wan, 1997, [c] Used solvent is m-cresol.

Appendix B Determination of Functional Groups in Ppy by a Fourier Transform Infrared Spectroscopy

Table B1 Peak position in FT-IR spectra of undoped polypyrrole and polypyrrole at N_d/N_m = 1/96,1/48,1/12 and 1/6

	Ref.	Wave number [cm^{-1}]				
		undoped	Dopant /pyrrole mole ratio			
			1/96	1/48	1/12	1/6
$C\text{-}H_{asm/str}$	2923[h]	2924				
$C\text{-}H_{sym/str}$	2852[c]	2852				
$C{=}C_{sym}$ /$C\text{-}C_{asm}$ in pyrrole ring	1600-1300[g] 1560[f] 1531[f] 1575[a] 1542[h]	1548	1539	1541	1530	1537
$N\text{-}H_{bend}$	1445[e]	1465		1457	1443	1450
C-H&N-H def.	1298[h]	1287			1292	1299
$S{=}O_{str}$	1183[f] 1175[c] 1055[c]	1189	1162	1163	1161	1166
ν of Py ring	1165[h]		1162	1163	1161	1166
$C\text{-}N_{str}$	1200-1000[g] 1034[h]	1109 1044	 1025	 1032	 1031	1087 1032
ν In plane C-H/N-H	968[d]	965	959		959	961
ν out of plane C-H/N-H	922[d]	914				
N/A			850			851
Out of plane C-H	779[b]	795	778	777	777	778
N/A		679	669	669	669	669
N/A		617	600	601	610	619

str = stretching , asm = asymmetric vibration

bend = bending , sym = symmetric vibration

[a] Khulbe, and Mann, 1982

[b] Bogang, and Zerbi, 1989

[c] Silverstien *et al.*, 1991

[d] Shen, and Wan,1998

[e] Kang, and Geckeler, 2000

[f] Prisanaroon et al., 2000

[g] Yadong *et al.*, 2002

[h] Ruangchauy, 2003

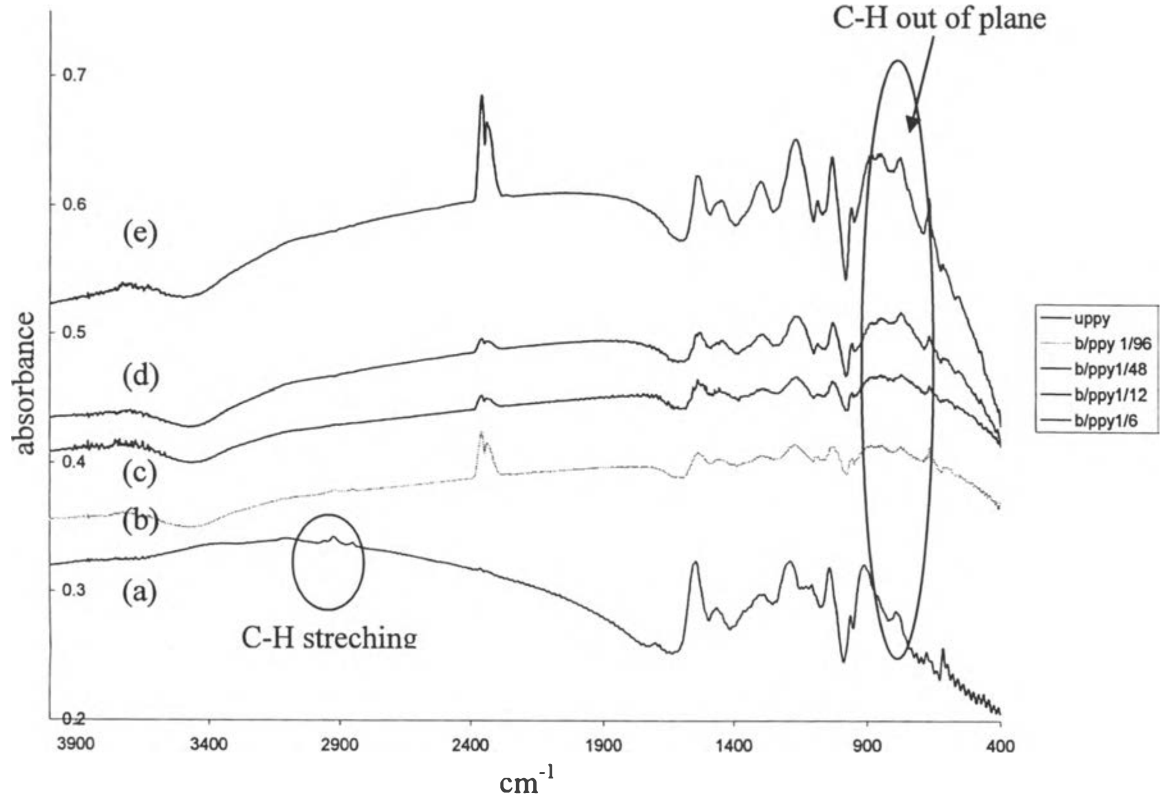


Figure B1 FTIR spectra of polypyrrolevarying N_d/N_m ratio: (a) undoped Ppy; (b)1/96 (c)1/48; (d) 1/12; (e) 1/6.

The absorption peaks due to C-H stretching ,2954 and 2852 cm^{-1} (Silverstien, 1991 and Ruangchuay, 2003), are visible in the spectrum of undoped poypyrrole. These peaks disappear from the spectra of doped polymers due to a masking of the polaron and bipolaron absorption at 8066 cm^{-1}(Street1985, Prissanaroon,2000). The success of doping can be verified from the absorption peaks around 777 -795 cm^{-1}, which are due to the C-H out of plane vibrations (Bogang, 1989) in the benzene ring from the β-naphthalenesulfonate anion.

Appendix C Elemental Analysis

TableC1 The amount of C,H,N, and S in polypyrrole.

	Composition (%)				
	C	H	N	S	S/N
Ppy_ud	5.18E+01	3.96E+00	1.53E+01	4.02E+00	2.63E-01
	5.19E+01	3.78E+00	1.51E+01	3.99E+00	2.65E-01
average	5.18E+01	3.87E+00	1.52E+01	4.00E+00	2.64E-01
SD	4.31E-02	1.29E-01	1.25E-01	1.48E-02	1.20E-03
Ppy_1:96	5.37E+01	3.21E+00	1.39E+01	4.63E+00	3.32E-01
	5.37E+01	3.45E+00	1.40E+01	4.53E+00	3.24E-01
average	5.37E+01	3.33E+00	1.39E+01	4.58E+00	3.28E-01
SD	5.66E-02	1.65E-01	3.96E-02	7.00E-02	5.95E-03
Ppy_1:48	5.64E+01	3.35E+00	1.33E+01	4.58E+00	3.45E-01
	5.66E+01	3.38E+00	1.33E+01	4.79E+00	3.60E-01
average	5.65E+01	3.36E+00	1.33E+01	4.69E+00	3.53E-01
SD	1.56E-01	2.33E-02	2.83E-03	1.48E-01	1.12E-02
Ppy_1:12	5.89E+01	3.55E+00	1.18E+01	5.84E+00	4.95E-01
	5.93E+01	3.64E+00	1.17E+01	6.05E+00	5.15E-01
average	5.91E+01	3.60E+00	1.18E+01	5.94E+00	5.05E-01
SD	2.88E-01	5.94E-02	3.39E-02	1.48E-01	1.41E-02
Ppy_1:6	6.05E+01	3.84E+00	1.14E+01	5.83E+00	5.10E-01
	6.06E+01	3.80E+00	1.14E+01	5.98E+00	5.23E-01
average	6.06E+01	3.82E+00	1.14E+01	5.90E+00	5.16E-01
SD	1.29E-01	2.69E-02	1.41E-03	1.07E-01	9.47E-03

Doping level is defined by S/N ratio.

Appendix D Determination of Degradation Temperature of Ppy by a Thermogravimatric Analysis

In thermogravimatric analysis, 4-10 mg of Ppy was used to determine the degradation temperature under N_2 atmosphere and 10°C/min of heating rate. The on-set degradation temperature (T_d) is defined as the temperature at which the rate of lost weight is 0.5 %wt./°C.

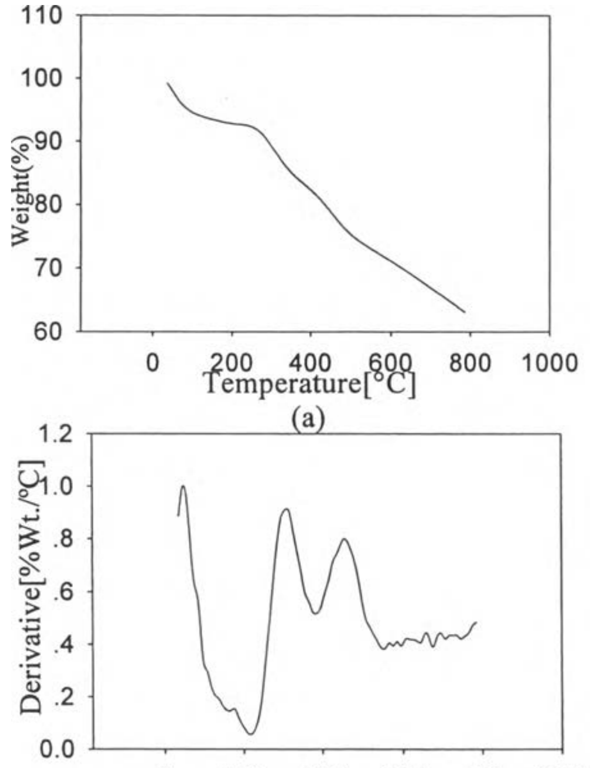


Figure D1 Thermogram of Ppy at N_d/N_m equal to1:96: (a) %Wt. lost; and (b) its derivative.

Figure D1 shows a thermogram of Ppy at various N_d/N_m ratios and their T_d are listed in Table D1. T_d increases when increasing N_d/N_m. This result is consistent with the results of Shen *et al.*(1998) showing that Ppy doped with naphthalene sulfonic acid possesses a good thermal stability.

Table D1 On-set of degradation temperature and moisture content of Ppy at various N_d/N_m ratios

N_d/N_m ratio	On-set T_d [°C]		Moisture Content (%)
		Ref.	
Undoped	220.7	223.3[a]	5.325
	241.7	-	9.272
1:96	243.8	-	6.545
	242.4	-	7.353
1:48	250.0	-	7.005
	254.8	-	6.669
1:12	292.5	260.2[a]	4.941
	275.5	-	5.652
1:6	292.1	-	5.504
	285.5		4.510
1:1	-	317[b]	-

[a] Ruangchuay, 2003 [b] Shen and Wan, 1998

Appendix E Determination of The Crystal Lattice Spacing and Order of Aggregation by an X-ray Diffractometer

From the Bragg's law (Cambell and White, 1991), a crystal lattice spacing, d, is calculated from the following relation:

$$1/d = (2\sin\theta)/\lambda \qquad (E.1)$$

where θ is the scattering angled, and λ is 1.542 Å for CuK_a radiation.

The order of aggregation, correlating with the breath of X-ray diffraction peak, is described by the Scherrer equation (Cambell and White, 1991):

$$t = (K\lambda)/(B\cos\theta) \qquad (E.2)$$

where t is the extentent of order of aggregation, B is the breath at half the peak height in radians, θ is the Bragg angle, and K is coefficient depending on the shape of the crystals it is normally close to 0.9.

The X-ray diffraction patterns of Ppy as various D/M ratios are shown in Figure E1 whereas the 2θ, d-spacing , t, and percentage of each deconvoluted peaks are tabulated in Table E2. The interpretations of d-spacings are shown in Table E1

Table E1 The crystal lattice spacing and their assignment

Material	d-spacing (Å)	Ref.	Assignment
Undoped	3.6	3.58[a]	The interplanar spacing between aromatic group
	4.5	4.51[a]	The distance between neighbouring pyrrole ring where the α-α' linkages are single bond
	5.9	5.4[b]	The distance between two hard segment separated by counterion (SO_4^{2-})
	9.6	N/A	-
Doped Ppy 1:96, 1:48, 1:12, 1:6	3.3-3.4	3.58[a]	The interplanar spacing between aromatic group
	4.1-4.2	3.9[b]	The distance between neighbouring pyrrole ring where the α-α' linkages are double bond
	6.9-7.2	6.9[a]	The distance between two hard segment separated by counterion(NSA)
	8.3		

[a] Gassner *et al.*(1997) [b] Ruangchuay *et al* (2003).

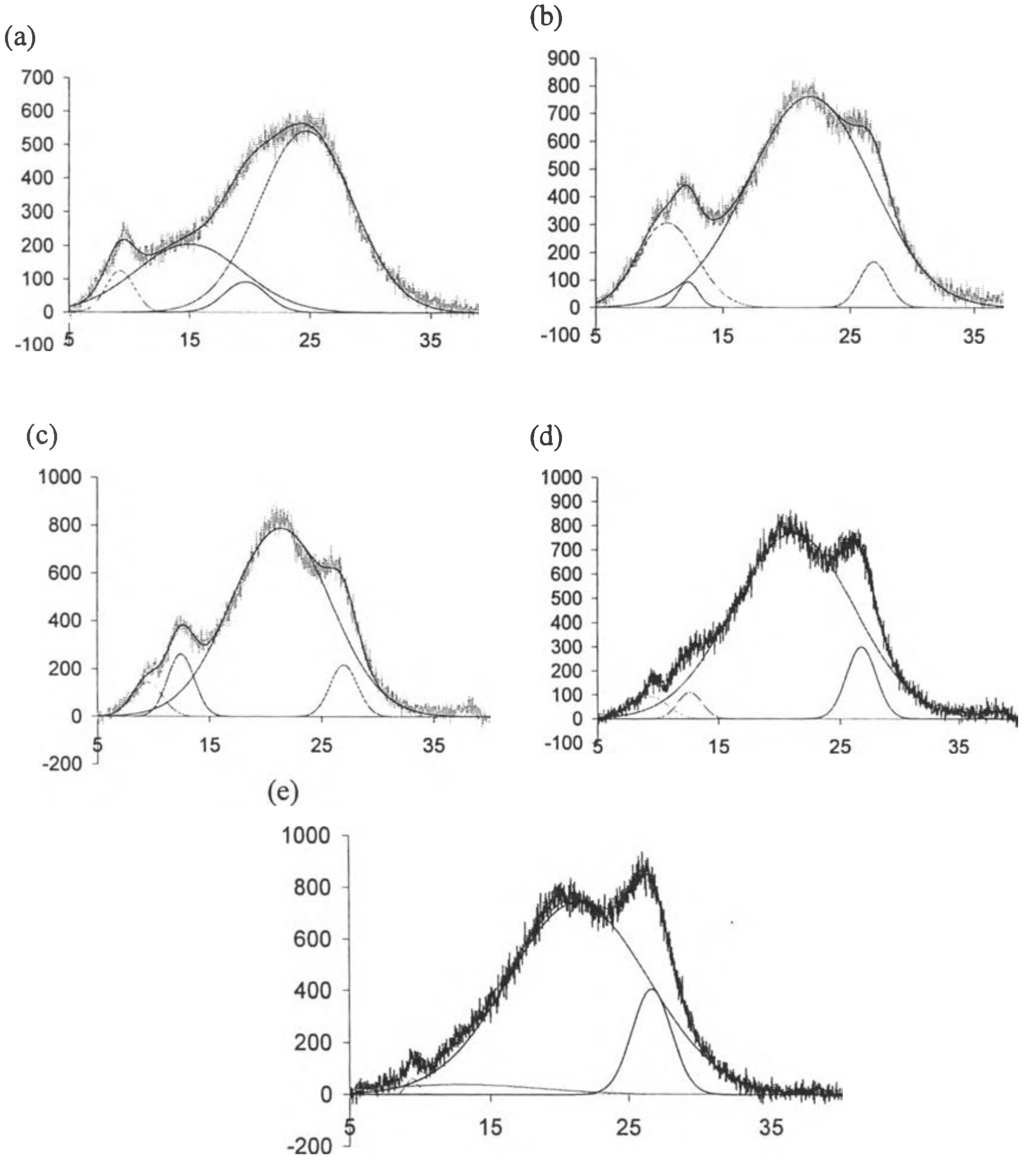


Figure E1 The X- ray diffraction patterns with deconvoluted result underneath of Ppy as various D/M ratios (a) undoped, (b) 1:96, (c) 1:48, (d) 1:12, and (e) 1:6.

Table E2 The deconvoluted result from X-ray diffraction of Ppy as various N_d/N_m ratios

D/M ratio	Line- broadening # 1				Line- broadening # 2				Line- broadening # 3				Line- broadening # 4			
	2θ (deg)	d (Å)	t (Å)	%	2θ (deg)	d (Å)	t (Å)	%	2θ (deg)	d (Å)	t (Å)	%	2θ (deg)	d (Å)	t (Å)	%
UPpy (1)	9.2	9.5	30.1	8.7	13.2	6.7	7.4	3.0	19.4	4.6	20.2	46.8	25.4	3.5	8.8	41.4
UPpy (2)	9.1	9.7	28.7	7.9	14.3	6.2	7.6	5.2	19.2	4.6	19.7	45.4	24.5	3.6	8.5	41.5
UPpy (3)	9.2	9.6	28.8	4.4	15.0	5.9	7.6	7.0	19.6	4.5	19.4	44.9	24.7	3.6	8.8	43.7
1:96	10.7	8.3	14.6	15.2	12.3	7.2	42.7	1.6	21.9	4.1	7.1	79.1	26.7	3.3	30.1	4.1
1:48	9.4	9.4	25.4	4.4	12.4	7.1	28.2	7.3	21.4	4.2	7.6	82.0	27.4	3.3	28.0	6.3
1:12	9.5	9.3	24.7	2.8	12.6	7.0	33.7	2.5	21.2	4.1	6.9	86.4	26.8	3.3	28.1	8.3
1:6 (1)	8.6	10.2	78.3	0.4	15.9	5.6	6.3	4.2	20.9	4.3	6.7	83.2	26.6	3.4	24.3	13.2
1:6 (2)	8.8	9.9	75.2	2.8	16.2	5.5	6.1	8.9	21.5	4.1	7.0	75.6	26.7	3.3	25.3	12.8
1:6 (3)	9.5	9.4	81.9	0.6	12.9	6.9	5.9	4.4	21.4	4.2	6.8	82.4	26.6	3.4	24.7	12.6

Appendix F Particle Size Analyzer

The particle size of samples was determined by a particle size analyzer (Malvern Instrument, Masterizer X). The result of this technique is volume based and expressed in terms of equivalent spheres (Instrument Manual, 1993). A mean diameter is defined by:

$$D[M,N] = \left[\frac{\int D^M n(D)dD}{\int D^N n(D)dD}\right]^{\frac{1}{M-N}} \quad \text{(F1)}$$

$$= \left[\frac{\sum V_i d_i^{M-3}}{\sum V_i d_i^{N-3}}\right]^{\frac{1}{M-N}} \quad \text{(F2)}$$

where V_i is the relative volume in size class i with mean class diameter d_i. In this work, the mean diameter over the volume distribution, D[4,3], is reported as shown in Table F1.

Table F1 The mean diameter, volume, and the specific surface area of molecular sieve 13X and polypyrrole

sample		D[4,3] (μm)	Volume (μm^3)	Specific surface area (m^2/m^3)
13X	1	8.68	342.55	1.9043
	2	8.93	373.02	1.8701
	3	8.01	269.20	1.9013
	average	8.54	328.26	1.8919
	SD	0.48	53.36	0.0189
Ppy_ud	1	38.67	2.421×10^5	0.2885
	2	37.05	2.129×10^5	0.3109
	3	28.31	9.499×10^4	0.4379
	average	34.68	1.833×10^5	0.3458
	SD	5.57	7.789×10^4	0.0805

(continued)

Table F1 (continued)

sample		D[4,3] (μm)	Volume (μm^3)	Specific surface area (m^2/m^3)
Ppy_1:6	1	40.52	2.785×10^5	0.2827
	2	38.52	2.393×10^5	0.2997
	3	37.84	2.268×10^5	0.3075
	average	38.96	2.482×10^5	0.2966
	SD	1.39	2.698×10^4	0.0127

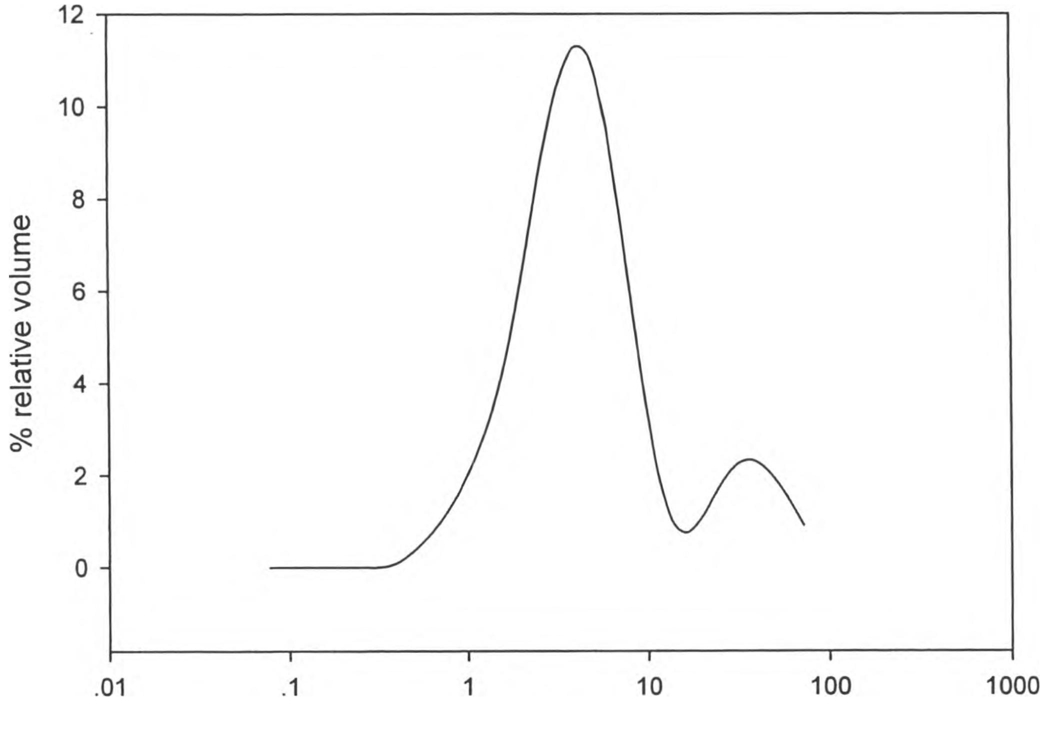


Figure F1 Particle size distribution of molecular sieve 13X.

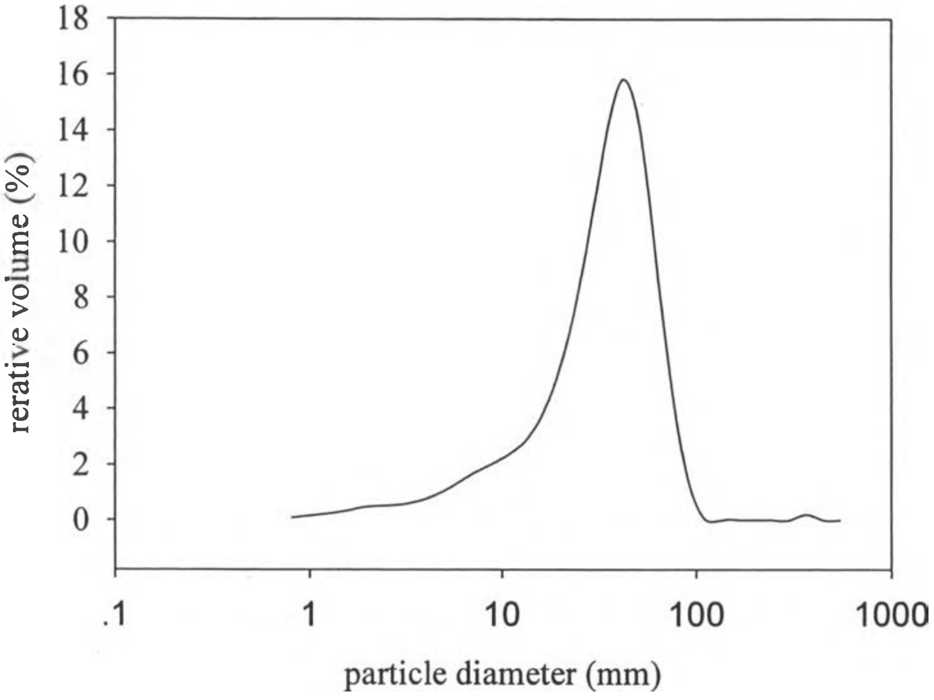


Figure F2 Particle size distribution of Ppy_ud.

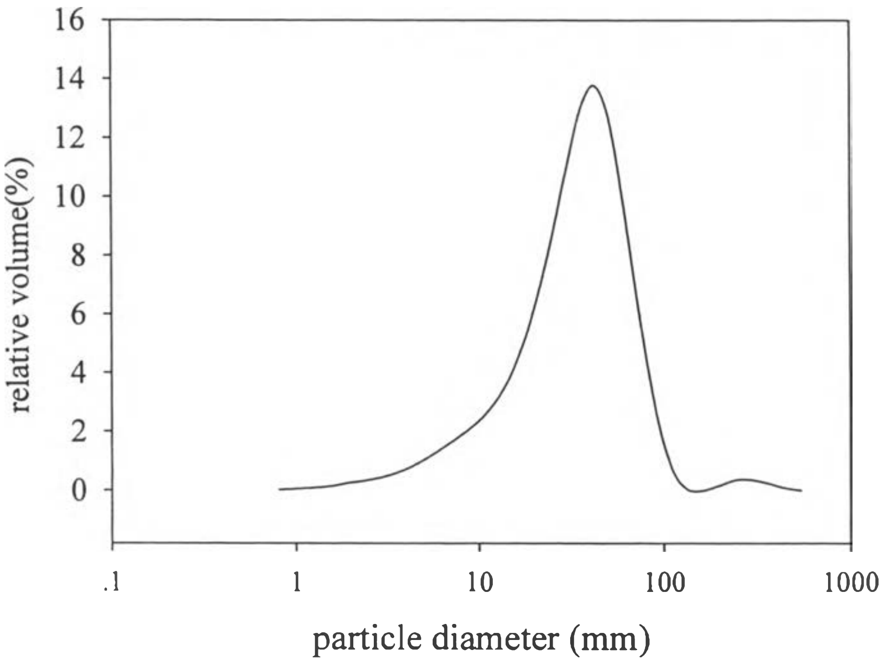


Figure F3 Particle size distribution of Ppy_1:6.

Appendix G Scanning Electron Microscope

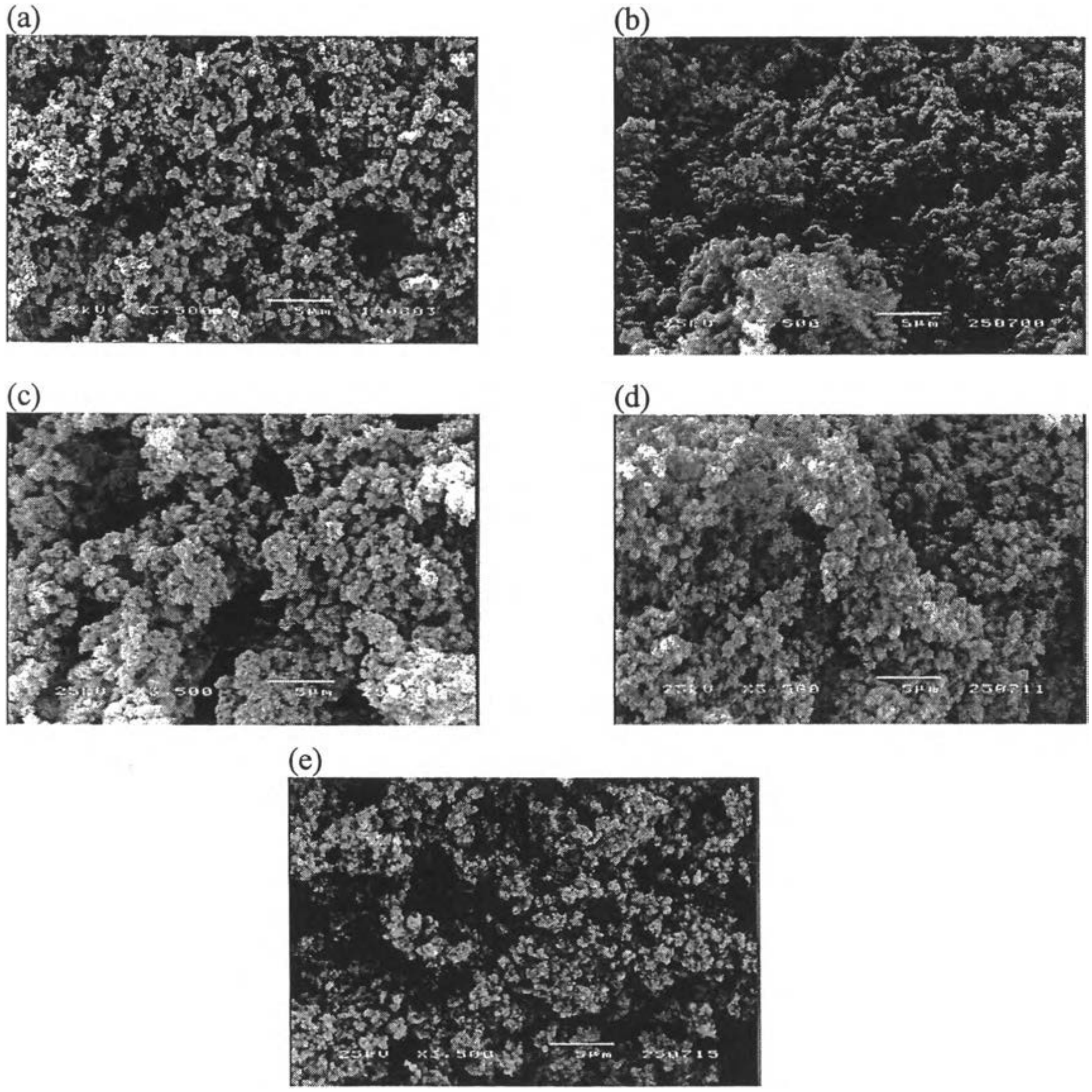
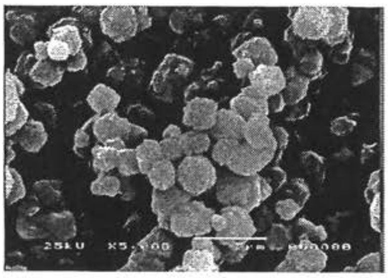
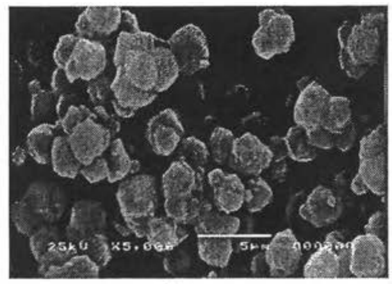


Figure G1 SEM micrographs of Ppy (a) undoped; (b) 1:96; (c) 1:48; (d) 1:12; (e) 1:6 N_d/N_m ratio.

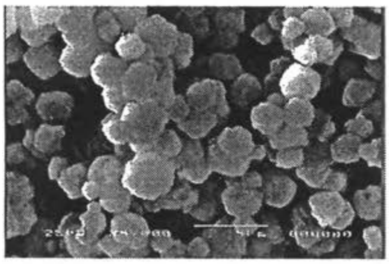
Figure G1 shows the SEM micrographs of Ppy at various N_d/N_m ratios at which the magnification and accelerating voltage are 3500 times and 25 kV, respectively. Similar to the earlier work (Ruangchauy, 2003), the morphology of those Ppy appears as globular structures, and is independent of N_d/N_m ratios.



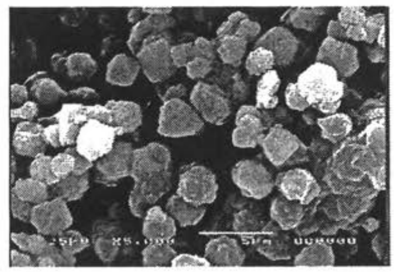
(a)



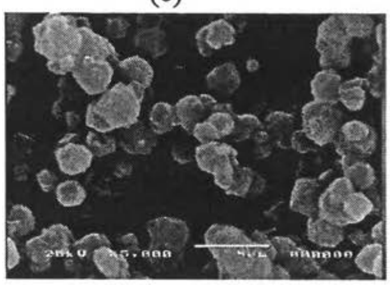
(b)



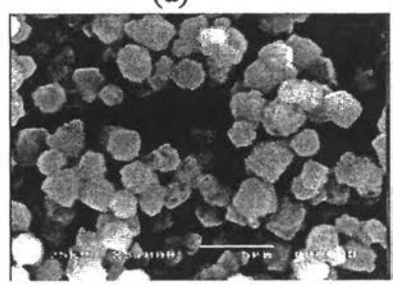
(c)



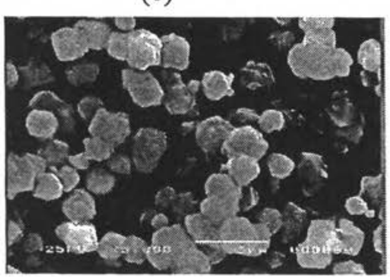
(d)



(e)



(f)



(g)

Figure G2 SEM micrograph of (a) unmodified 13X; (b) 32 mole% of Li; (c) 81 mole% of Li; (d) 48 mole % of K; (e) 94 mole% of K; (f) 35 mole% of Cs and (g) 59 mole% of Cs at 25 kV and 5000 magnification.

Appendix H Density Determination by Pycnometer

The density of molecular sieve 13X is determined at 20°C under ambient pressure by following equation:

$$d_z = \frac{d_w[W_3 - W_1]}{[W_2 - W_1]-[W_4 - W_3]} \quad \text{(H1)}$$

where d_z is the density of 13X, d_w is the density of water, 0.99860 at 20 °C and 1 atm (John,1999), W_1 is the weight of pycnometer flask, W_2 is the weight of water and pycnometer flask, W_3 is the weight of 13X and pycnometer flask, W_4 is the weight of 13X, water and pycnometer flask. Table H1 shows the density of zeolite from the experiment.

Table H1 The density of zeolite 13X

W_1(g)	W_2(g)	W_3(g)	W_4(g)	d_z(g/cm^3)
32.131	57.532	32.207	57.535	1.028
32.130	57.515	32.262	57.581	1.994
32.132	57.511	32.227	57.550	1.695
				1.572±0.494

The density of polypyrrole is determined at 25 °C under ambient pressure by following equation:

$$d_{Ppy} = \frac{[W_2 - W_1]}{25.499 - \left[\frac{W_3 - W_2}{d_h}\right]} \quad \text{(H2)}$$

where d_{Ppy} is the density of polypyrrole, d_h is the density of n- heptane, 0.6816 g/cm^3 at 25 °C and 1 atm (John,1999), W_1 is the weight of pycnometer flask, W_2 is the weight of polypyrrole and pycnometer flask, W_3 is the weight of polypyrrole, n-heptane and pycnometer flask. Table H2 shows the density of polypyrrole from the experiment.

Table H2 The density of polypyrrole

	W_1 (g)	W_2 (g)	W_3 (g)	d_{Ppy} (g/cm^3)
Ppy_ud	32.196	32.294	49.586	0.759
	32.196	32.291	49.597	0.875
	32.197	32.294	49.587	0.759
				0.798±0.067
Ppy_1:6	32.199	32.285	49.585	0.728
	32.197	32.373	49.592	0.743
	32.197	32.275	49.590	0.816
	32.197	32.274	49.588	0.791
				0.769±0.040

Appendix I Determination of Number of Unit Cell per Particle of Molecular Sieve 13X

The volume of a 13X particle is 328.26 μm^3

The density of 13X is 1.5727 g/cm^3

The weight of a 13X particle is $\dfrac{1.5727 g \times 328.26 \times 10^{-18} m^3}{10^{-6} m^3}$

$\underline{516.25 \times 10^{-12}}$ g

From the composition of 13X Si/Al ratio is 1.27*

The summation of Si and Al atom per a unit cell is 192[a] atom

Thus the unit cell formular of 13X is $Na_{80}[Si_{112}Al_{80}O_{384}]$

The weight of a unit cell is $\dfrac{13280\ g}{6.02 \times 10^{23}} = \underline{2.21 \times 10^{-20}}$ g

Thus one particle of 13x has approximately $\dfrac{516.25 \times 10^{12}}{2.21 \times 10^{20}}$ unit cells

$\underline{2.33 \times 10^{10}}$ unit cells

* www zigma-aldrich.com

Appendix J Surface Area of Molecular Sieve 13X

The surface area of 13X can be determined by the Brunauer-Emmett-Teller (BET) equation (Quantachrome, 1995).

$$\frac{1}{W((P_0/P)-1)} = \frac{1}{W_m C} + \frac{C-1}{W_m C}\left(\frac{P}{P_0}\right) \quad \text{(J1)}$$

where W is the weight (g) of gas adsorbed at a relative pressure(P/P_0), W_m is the weight (g) of adsorbate constituting a monolayer of surface coverage, C is a constant. W_m is obtained from slope and intercept of the plot $1/(W((P_0/P)-1))$ versus P/P_0

The specific surface area, S, is obtained by following equation (Quantachrome, 1995).

$$S = \frac{W_m N A_{cs}}{Mw} \quad \text{(J2)}$$

where N is Avorgadro's number (6.023 x 10^{23} molecule/mol), A_{cs} is cross sectional area of adsorbate (m^2), M is the molecular weight of the adsorbate, and w is the weight of 13X (g).

Table J1 The surface area, S, and specific pore volume, V, of 13X

	S (m^2/g)	V (cm^3/g)
13X	595	0.320
	690	0.366
	646	0.343
average	643 ±47	0.343±0.023

Appendix K Characterization of Molecular Sieve 13X by X-ray Diffraction

Table K1 The d-spacing of molecular sieve 13X and 13X_Li^+ XRD patterns

	d-spacing (Å)				
hkl	Ref.*	13x	Li 1st	Li 3rd	Li 7th
111	14.465	14.447	14.4297	14.3827	14.3827
220	8.845	8.8557	8.8029	8.768	8.8029
311	7.538	7.5574	7.5189	7.4809	7.4935
331	5.731	5.7415	5.7121	5.6902	5.6975
333, 511	4.811	4.8126	4.792	4.7716	4.7818
440	4.419	4.4227	4.401	4.3838	4.3881
531	4.226	4.2268	4.207	-	4.1992
620	3.946	3.9518	3.938	3.9208	3.9242
533	3.808	3.8145	3.7985	3.7794	3.7857
444	3.609	3.61	3.5928	3.5786	3.5814
711, 551	3.5	3.501	3.4875	3.4715	3.4768
642	3.338	3.3409	3.3262	3.3117	3.3165
731, 553	3.253	3.2547	3.2408	3.2269	3.2292
733	3.051	3.0538	3.0416	3.0294	3.0315
822, 660	2.944	2.9455	2.9341	2.921	2.9247
751, 555	2.885	2.886	2.8751	2.8626	2.8644
840	2.794	2.7945	2.7827	2.7726	2.7743
911	2.743	2.7428	2.7331	2.7217	2.7233

* Breck, D., W., 1973

Table K2 The d-spacing of 13X_K^+ and 13X_Cs^+ XRD patterns

	d-spacing (Å)						
hkl	Ref*	K 1st	K 3rd	K 7th	Cs 1st	Cs 3rd	Cs 7th
111	14.465	14.5245	14.477	14.447	14.5258	14.4783	14.4471
220	8.845	8.8557	8.8734	8.8734	8.8565	8.8741	8.8734
311	7.538	7.5574	7.5574	7.5703	7.558	7.5581	7.5703
331	5.731	5.7415	5.7564	5.7638	5.742	5.7569	5.7638
333, 511	4.811	4.8178	4.8282	4.8335	4.8182	4.8286	4.8335
440	4.419	4.4227	4.4315	4.4403	4.4231	4.4318	4.4403
531	4.226	4.2308	4.2348	4.2468	4.2311	4.2351	4.2468
620	3.946	3.9553	3.9657	3.9692	3.9556	3.9661	3.9692
533	3.808	3.8145	3.8243	3.8308	3.8148	3.8246	3.8308

* Breck, D., W., 1973

(continued)

Table K2 (continued)

	d-spacing (Å)						
hkl	ref	K 1st	K 3rd	K 7th	Cs 1st	Cs 3rd	Cs 7th
711, 551	3.5	3.5037	-	3.5173	3.504	-	3.5173
642	3.338	3.3434	3.3508	3.3558	3.3437	3.3511	3.3558
731, 553	3.253	3.2570	3.264	3.2687	3.2572	3.2642	3.2687
733	3.051	3.0558	3.062	3.0661	3.0561	3.0622	3.0661
822, 660	2.944	2.9493	2.955	2.9588	2.9495	2.9552	2.9588
751, 555	2.885	2.8878	2.8951	2.8988	2.8881	2.8953	2.8988
840	2.794	2.7962	2.8031	2.8065	2.7964	2.8033	2.8065
911	2.743	2.7461	2.751	2.756	2.7463	2.7512	2.7561

Table K3 The relative intensity (I/I_0) of 13X and 13X_Li^+ XRD patterns

	I/I_0				
hkl	Ref*	13X	Li 1st	Li 3rd	Li 7th
111	100	100	100	100	100
220	18	28	36	40	32
311	12	22	26	22	30
331	18	45	54	44	62
333, 511	5	15	18	18	26
440	9	26	32	26	40
531	1	4	4	-	2
620	4	12	16	14	20
533	21	70	78	66	84
444	1	2	4	4	6
711, 551	1	4	6	6	8
642	8	62	72	58	80
731, 553	1	4	6	6	8
733	4	14	18	16	22
822, 660	9	26	30	20	26
751, 555	19	66	74	54	78
840	8	28	30	18	22
911	2	6	10	8	8

* Breck, D., W., 1973

I = Intensity of XRD peaks

I_0 = the highest intensity of XRD peaks

Table K4 The relative intensity (I/I_0) of 13X_K^+ and 13X_Cs^+ XRD patterns

hkl	I/I0						
	Ref*	K 1st	K 3rd	K 7th	Cs 1st	Cs 3rd	Cs 7th
111	100	100	100	100	100	100	100
220	18	32	30	28	30	29	31
311	12	16	16	22	17	18	17
331	18	36	30	34	32	35	33
333, 511	5	18	18	18	17	18	18
440	9	18	16	12	18	14	15
531	1	4	4	6	3	5	3
620	4	16	22	24	18	20	21
533	21	72	74	66	70	75	73
711, 551	1	6	-	6	5	-	7
642	8	66	36	66	63	66	64
731, 553	1	10	8	16	10	10	8
733	4	20	12	24	20	14	15
822, 660	9	36	22	46	39	38	38
751, 555	19	68	48	84	70	75	77
840	8	50	40	82	50	54	68
911	2	10	8	12	10	10	12

* Breck, D., W., 1973

From the XRD patern, the changes of the cations from Na^+ to Li^+, K^+, and Cs^+ did not affect the framework structure of 13X, as shown in Figure K1, Figure K2 and Figure K3, respectively.

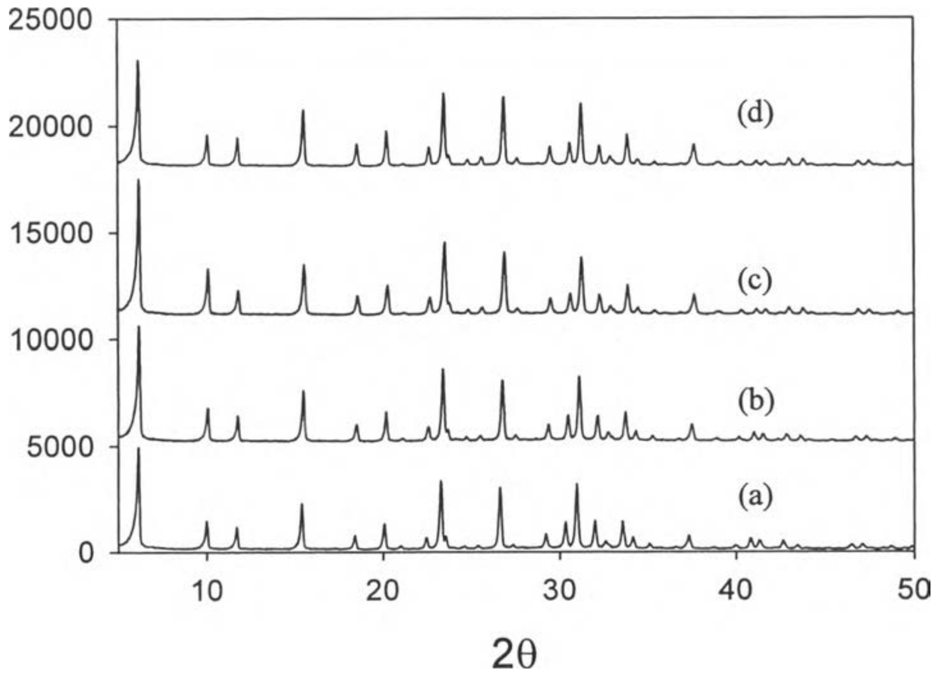


Figure K1 The XRD patterns of: (a) 13X ; (b) 13X_Li^{+} 1st; (c) 13X_Li^{+} 3rd; (d) 13X_Li^{+} 7th.

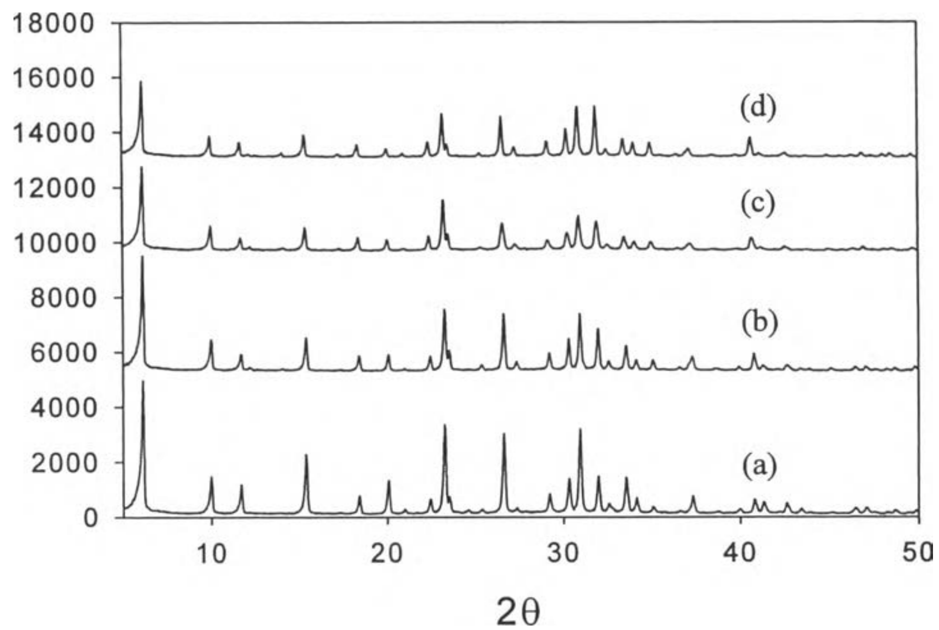


Figure K2 The XRD patterns of: (a) 13X ; (b) 13X_K^{+} 1st; (c) 13X_K^{+} 3rd; (d) 13X_K^{+} 7th.

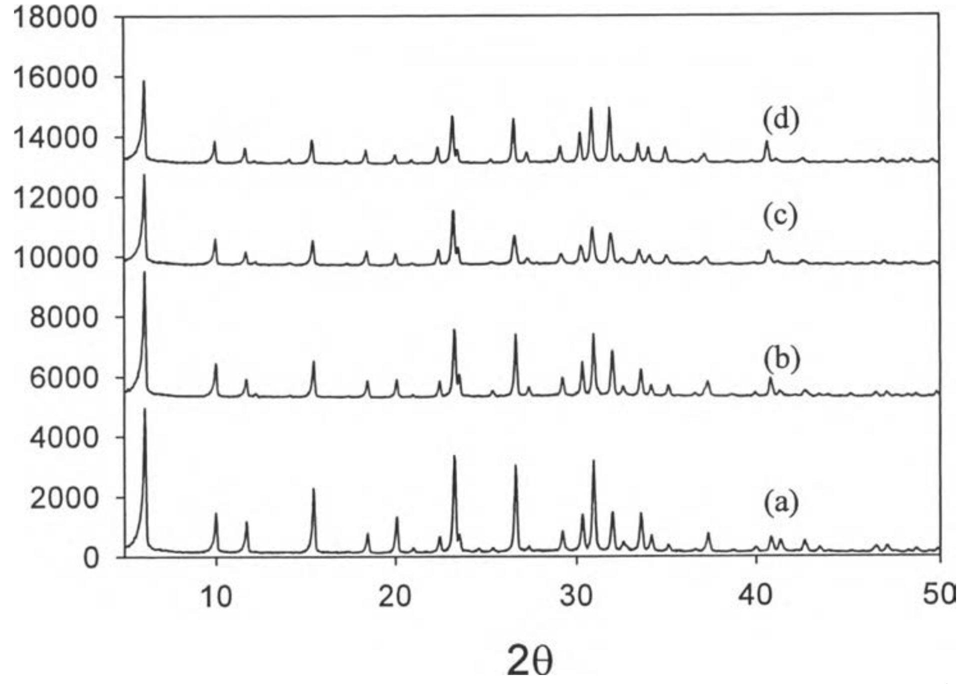


Figure K3 The XRD patterns of: (a) 13X ; (b) 13X_Cs^+ 1st; (c) 13X_Cs^+ 3rd; (d) 13X_Cs^+ 7th.

Appendix L Determination of Cation in Molecular Sieve 13X by Atomic Absorption Spectrophotometer (AAS)

Table L1 The AAS result of Li-Na ion exchange

Sample	Weight	Determination of Na			Determination of Li			Mole %
	(g)	Abs.*	Conc. (ppm)	Amount of Na (g/g sample)	Abs.	Conc. (ppm)	Amount of Li(g/g sample)	
13X/1	0.0525	0.499	0.70	0.13333				
13X/2	0.0504	0.476	0.67	0.13294				
13X/3	0.0520	0.509	0.72	0.13846				
Li 1st/1	0.0564	0.36	0.51	0.09043	0.557	1.81	0.0128	31.92
Li 1st/2	0.0536	0.342	0.49	0.09142	0.548	1.77	0.01322	32.39
Li 1st/3	0.0600	0.381	0.54	0.09000	0.594	1.94	0.01295	32.28
							Average	32.20
							SD	0.24
Li 2nd/1	0.0568	0.264	0.39	0.06866	0.804	2.72	0.01919	48.06
Li 2nd2	0.0550	0.250	0.37	0.06727	0.762	2.57	0.01868	47.90
Li 2nd/3	0.0519	0.241	0.36	0.06936	0.744	2.50	0.01928	47.92
							Average	47.96
							SD	0.08
Li/3rd/1	0.0528	0.200	0.30	0.05682	0.879	3.00	0.02275	57.01
Li/3rd/2	0.0556	0.205	0.31	0.05576	0.904	3.10	0.02228	56.95
Li/3rd/3	0.0515	0.195	0.30	0.05825	0.861	2.94	0.02281	56.46
							Average	56.81
							SD	0.30

* Abs = absorbance = $-\log(T/T_0)$ (continued)

T = % Transmittance

$$\text{Mole\%} = \frac{W_{cat}/MW_{cat} \times 100}{\left(W_{cat}/MW_{cat}\right)+\left(W_{Na}/MW_{Na}\right)}$$

where W_{cat} is weight of cation per gram of 13X, W_{Na} is weight of Na per gram of 13X, MW_{cat} is atomic weight of cation and MW_{Na} is atomic weight of cation.

Table L1 (continued)

sample	Weight (g)	Determination of Na			Determination of Li			Mole %
		Abs.	Conc. (ppm)	Amount of Na (g/g sample	Abs.	Conc. (ppm)	Amount of Li (g/g sample	
Li 5^{th}/1	0.0561	0.280	0.39	0.03476	0.327	1.67	0.029768	73.93
Li 5^{th}/2	0.0506	0.250	0.34	0.03360	0.290	1.45	0.028656	73.85
Li 5^{th}/3	0.0508	0.251	0.34	0.03346	0.290	1.46	0.02874	73.98
							Average	73.92
							SD	0.06
Li 6^{th}/1	0.0510	0.200	0.27	0.02647	0.307	1.55	0.030392	79.17
Li/6^{th}/2	0.0552	0.209	0.28	0.02536	0.324	1.65	0.029891	79.60
Li/6^{th}/3	0.0514	0.200	0.27	0.02626	0.311	1.57	0.030545	79.38
							Average	79.39
							SD	0.21
Li 7^{th}/1	0.0548	0.201	0.27	0.02463	0.349	1.78	0.032482	81.36
Li 7^{th}/2	0.0518	0.186	0.25	0.02413	0.321	1.63	0.031467	81.19
Li 7^{th}/3	0.0520	0.192	0.26	0.02500	0.333	1.69	0.0325	81.15
							Average	81.24
							SD	0.11

Table L2 The AAS result Cs-Na ion exchange

sample	weight	Determination of Na			Determination of Cs			Mole%
	(g)	Abs	Conc. (ppm)	amount of Na (g/g sample)	Abs	conc. (ppm)	Amount of Cs (g/g sample)	
Cs1st/1	0.0528	0.327	0.34	0.06458	0.070	2.00	0.1892	33.62
Cs1st/2	0.0628	0.348	0.37	0.05859	0.083	2.39	0.1902	35.95
Cs 1st/3	0.0488	0.278	0.27	0.05614	0.064	1.82	0.1863	36.46
							average	35.34
							SD	1.51
Cs3rd/1	0.0592	0.249	0.24	0.04020	0.107	3.05	0.2572	52.52
Cs3rd/2	0.0558	0.231	0.22	0.03871	0.098	2.80	0.2512	52.88
Cs3rd/3	0.0502	0.217	0.20	0.03984	0.091	2.62	0.2610	53.12
							average	52.84
							SD	0.30
Cs7th/1	0.0423	0.179	0.17	0.03900	0.084	2.42	0.2861	55.92
Cs7th/2	0.0490	0.195	0.18	0.03653	0.095	2.71	0.2767	56.71
Cs7th/3	0.0605	0.236	0.22	0.03669	0.118	3.35	0.2772	56.64
							averge	56.42
							SD	0.43
Cs15th/1	0.0441	0.174	0.16	0.03650	0.091	2.60	0.2950	58.28
Cs15th/2	0.0560	0.206	0.19	0.03392	0.112	3.18	0.2846	59.19
Cs15th/3	0.0580	0.212	0.19	0.03362	0.118	3.34	0.2885	59.74
							average	59.07
							SD	0.73

Table L3 The AAS result of K-Na ion exchange

sample	weight	Determination of Na			Determination of K			mole%
	(g)	Abs	Conc. (ppm)	Amount of Na (g/g sample)	Abs	Conc. (ppm)	Amount of K (g/g sample)	
K1st/1	0.0569	0.266	0.35	0.06151	0.297	0.52	0.09139	46.52
K1st/2	0.0502	0.238	0.31	0.06175	0.266	0.46	0.09163	46.49
K1st/3	0.053	0.247	0.32	0.06038	0.277	0.48	0.09057	46.76
							average	46.59
							SD	0.147
K3rd/1	0.0704	0.132	0.17	0.02415	0.576	1.03	0.14631	78.01
K3rd/2	0.0593	0.112	0.14	0.02361	0.492	0.87	0.14671	78.44
K3rd/3	0.0516	0.098	0.12	0.02326	0.435	0.77	0.14922	78.98
							average	78.48
							SD	0.48
K5th/1	0.0545	0.105	0.13	0.01193	0.26	0.45	0.16514	89.02
K5th/2	0.0519	0.099	0.13	0.01252	0.245	0.42	0.16185	88.32
K5th/3	0.0492	0.095	0.12	0.0122	0.253	0.44	0.17886	89.57
							average	88.97
							SD	0.62
K7th/1	0.0533	0.06	0.08	0.0075	0.27	0.47	0.17636	93.22
K7th/2	0.0517	0.058	0.07	0.00677	0.262	0.45	0.17408	93.77
K7th/3	0.0499	0.056	0.07	0.00701	0.25	0.43	0.17234	93.50
							average	93.50
							SD	0.27

Appendix M Determination of 13X Composition by X-ray Fluorescence.

Table M1 The composition of 13X and ion-exchanged 13X

	Amount of compound (%/w)							
	Na_2O	Al_2O_3	SiO_2	K_2O	Cs_2O	CaO	Fe_2O_3	Cl
13X	7.526	28.498	63.279	0.123	-	0.071	0.043	0.461
Li 1^{st}	7.829	29.598	62.445	0.089	-	-	0.039	-
Li 3^{rd}	2.026	30.172	67.167	0.054	-	0.101	0.050	0.430
Li 7^{th}	1.391	31.16	66.77	0.056	-	0.09	0.044	0.452
K 1^{st}	2.937	23.537	47.038	26.255	-	0.066	0.038	0.310
K 3^{rd}	1.119	21.264	41.151	36.144	-	0.058	-	0.264
K 7^{th}	0.261	19.768	37.939	41.672	-	0.079	0.041	0.241
Cs 1^{st}	3.120	17.760	33.545	-	45.236	0.051	0.086	0.202
Cs 3^{rd}	1.551	11.079	20.506	0.020	66.704	0.025	-	0.115
Cs 7^{th}	1.526	11.031	20.275	-	67.297	0.027	-	0.115
Cs 15^{th}	1.109	11.785	21.829	0.019	65.099	0.035	-	0.125

The relative mole of element in 13X, as shown in Table M2, was calculated by following procedure.

The metal oxide, M_aO_b:

$$\text{Mole of } M_aO_b = \%/MW \quad \text{(M1)}$$

$$\text{Mole of M} = (a\ \%)/MW \quad \text{(M2)}$$

$$\text{The relative mole} = \text{Mole of M/Mole of Al} \quad \text{(M3)}$$

Table M2 The relative mole of elements in 13X and ion-exchanged 13X

	Relative mole					
sample	Na	Al	Si	O	K	Cs
13X	0.4344	1	1.8874	5.4980	0.0046	-
Li 1st	0.4351	1	1.7933	5.3070	0.0016	-
Li 3rd	0.1104	1	1.8922	5.3452	0.0019	-
Li 7th	0.0734	1	1.8213	5.1863	0.0019	-
K 1st	0.2068	1	1.7117	5.6410	1.2197	-
K 3rd	0.0865	1	1.6449	5.7579	1.8444	-
K 7th	0.0217	1	1.6313	5.9228	2.2874	-
Cs 1st	0.2890	1	1.6054	5.3106	-	0.4479
Cs 3rd	0.2303	1	1.5732	5.8235	0.0019	2.1176
Cs 7th	0.1873	1	1.5623	5.7933	-	2.1457
Cs15th	0.1548	1	1.5744	5.7012	0.0017	1.9428

Appendix N Determination of the Geometric Correction Factor (K)

The geometric correction factor, used to correct the geometric effect in linear-array four point probe, can be determined by using a known specific resistivity silicon wafer and the following equation (Ruangchuay, 2003):

$$K = \frac{I\rho}{Vt} \quad \text{(N1)}$$

where K is geometric correction factor, ρ is resistivity of stand materials which were calibrated by using a four point probe(Kokusai Electric, VR-10-Resistivity Test) at King Mongkut's Institute Technology of Lad Krabang (Ω.cm), t is a film thickness (cm),I is a current (A), V is a voltage drop (V).

Table N1 The geometric correction factors of probe A and probe B were measured by 0.03 Ω.cm Si wafer, 0.0724 cm sample thickness, at 28 °C and 50 % RH

	I (mA)	V (mV)	K
Probe A	120	3.6	13.81
	133	4.4	12.53
	184	6.6	11.56
	227	8.5	11.07
	283	11.0	10.66
	385	16.7	9.55
	394	17.2	9.49
		Average	11.23
		SD	1.56
Probe B	38.1	1.4	11.28
	88	3.4	10.72
	169	6.9	10.15
	142	5.6	10.51
		Average	10.66
		SD	0.47

Appendix O Determination of Specific Conductivity of PPy as Various N_d/N_m Ratios by Four Point Probe Meter

By using four point probe meter, the specific conductivity of the samples is calculated by following equation (Ruangchuay,2003):

$$\sigma = \frac{I}{KV_a t} \tag{O1}$$

where σ is a specific conductivity(S/cm), I is an applied current(A), K is a geometric correction factor, V_a is an average voltage drop(V_a), and t is a film thickness(cm).

That the specific conductivities are acceptable is confirmed by two criteria. The first one is the relation between voltage drop and applied current following the Ohmic's law:

$$V = IR \tag{O2}$$

It means that a correlation coefficient (r^2) of the voltage drop and the applied current is nearly unity (Kreyszig, 1970). The correlation coefficient is computed by following equation:

$$r = \frac{\Sigma x_i y_i - \frac{1}{n}\Sigma x_i \Sigma y_i}{\sqrt{[\Sigma x_i^2 - \frac{1}{n}(\Sigma x_i)^2][\Sigma y_i^2 - \frac{1}{n}(\Sigma y_i)^2]}} \tag{O3}$$

where x_i is the applied current, y_i is the voltage drop, and n is the number of data. The second one is a value of a signal to noise ratio of the voltage drop (S/N) which should be less than 5%. The S/N is calculated by following equation:

$$S/N = (SD/V_a)x100 \tag{O4}$$

where SD is the standard deviation of V_a .

Figure O1 depicts the linear regime and the r^2 of Ppy at 1:48 D/M ratio in which the Ohmic's law applies. When N_d/N_m ratio increases the specific conductivity also increases, as shown in Figure O2. This tendency is similar to the work of Ruangchuay (2003) in which the dopant effect is explained in terms of the stability of charge carrier due to the dopant anion .

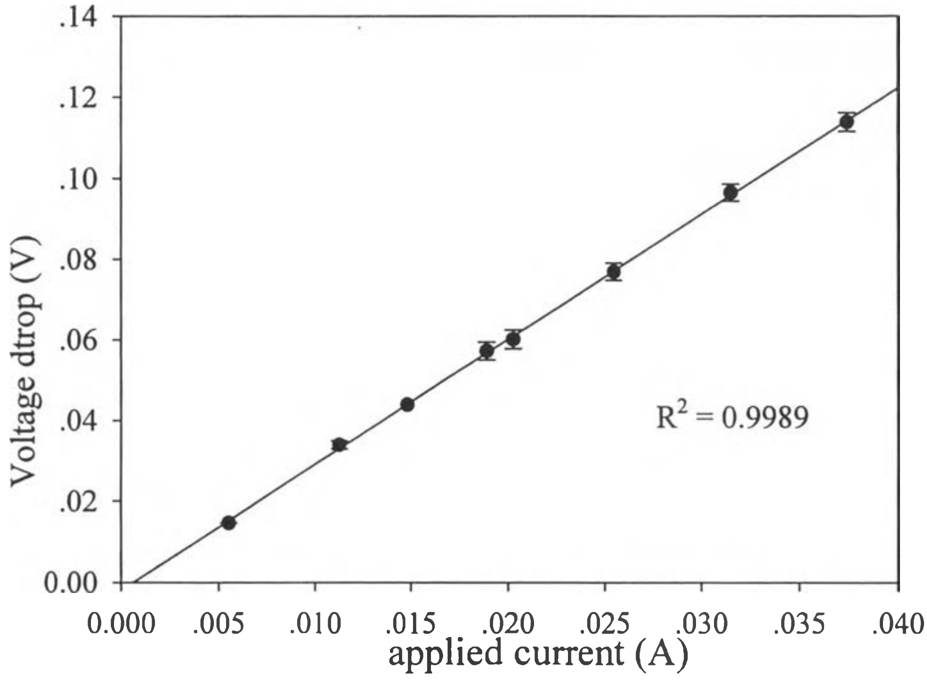


Figure O1 Linear regime and the r^2 of Ppy at 1:48 N_d/N_m ratio determined at 27 °C 1 atm, and 71% relative humidity.

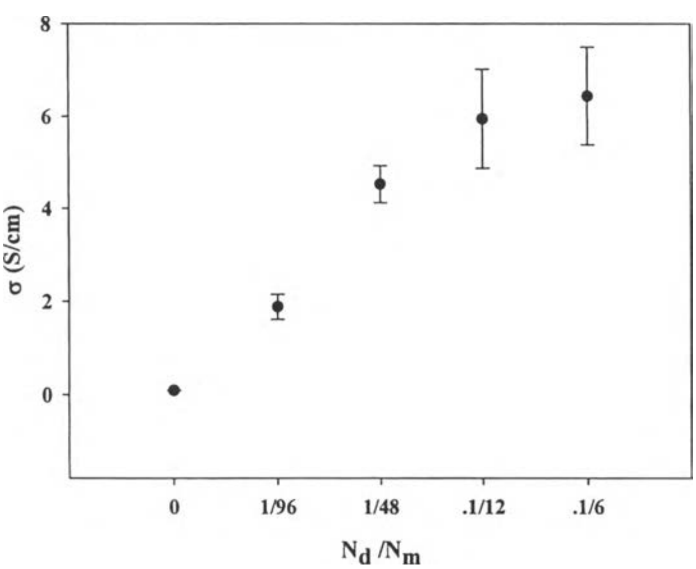


Figure O2 Specific conductivity of Ppy as various N_d/N_m ratios determined at 27 °C, 1atm, and 71% relative humidity.

Table O1 Specific conductivity of Ppy at various N_d/N_m ratio, determined at 1atm

		V_a [mV]	SD[mV]	S/N[%]	I[mA]	σ(S/cm)
sample	Ppy_ud(1)	49.7	1.9	3.8	0.644	9.36E-02
t[a] =	0.013 cm	109.1	2.3	2.1	1.399	9.27E-02
K =	10.66	122.8	4.6	3.7	1.559	9.17E-02
Temp.[b] =	27 °C	208.3	2.8	1.4	2.616	9.17E-02
RH[c] =	71 %	283.7	4.6	1.6	3.601	9.17E-02
r^2 =	1	451.1	19.8	4.39	5.714	9.15E-02
					average	9.21E-02
sample	Ppy_ud(2)	137	1.8	1.3	2.014	9.66E-02
t =	0.0143 cm	296	2.7	0.9	4.327	9.60E-02
K =	10.66	445.3	2.5	0.6	6.538	9.64E-02
Temp. =	27 °C	913.7	1.8	0.2	13.582	9.76E-02
RH =	71%				average	9.67E-02
r^2 =	0.999					
sample	Ppy_ud(3)	124.3	3	2.4	1.333	9.15E-02
t =	0.011 cm	318	3.2	1	3.389	9.10E-02
K =	10.66	610.4	3.3	0.55	6.517	9.12E-02
Temp. =	27 °C	821.9	3.8	0.46	8.792	9.13E-02
RH =	71 %	1115.4	3	0.27	11.981	9.17E-02
r^2 =	0.9994	1355.3	3.3	0.24	14.633	9.22E-02
		1587.2	3.6	2.3	17.511	9.42E-02
		1811.6	2.1	1.2	19.901	9.38E-02
					average	9.21E-02

[a]t is thickness, [b]Temp. is temperature, [c]RH is room humidity

(continued)

Table O1 (continued)

		V_a [mV]	SD[mV]	S/N[%]	I[mA]	σ(S/cm)
sample	Ppy_1:96(1)	51.6	2.5	4.8	13.116	2.23E+00
t =	0.0107 cm	65.9	2.5	3.8	16.384	2.18E+00
K =	10.66	73.2	0	0	18.377	2.20E+00
Temp. =	27 °C	92.6	1.2	1.3	22.874	2.17E+00
RH =	72 %	134.8	2.4	1.8	33.031	2.15E+00
r^2 =	0.9988				average	2.19E+00
sample	Ppy_1:96(2)	33.6	1.5	4.5	7.962	1.75E+00
t =	0.0127 cm	79.1	2	2.5	18.929	1.77E+00
K =	10.66	95	2.5	2.6	23.479	1.83E+00
Temp.	28 °C	106.1	2.2	2.1	24.946	1.74E+00
RH	72 %	135.5	2.1	1.6	32.888	1.80E+00
r^2	0.9974	151.4	6.3	0.41	37.162	1.81E+00
					average	1.79E+00
sample	Ppy_1:96(3)	51.2	2.5	4.8	10.863	1.72E+00
t =	0.0116 cm	100.9	2.3	2.3	20.837	1.67E+00
K =	10.66	143.7	2.5	1.7	29.698	1.67E+00
Temp. =	28°C	182.3	2.4	1.3	37.553	1.67E+00
RH =	72 %	186	1.5	0.78	38.365	1.67E+00
r^2 =	0.9995	197.4	2.4	1.2	37.553	1.64E+00
					average	1.68E+00
sample	Ppy_1:48(1)	40.1	2	5.1	18.443	5.20E+00
t =	0.0083cm	52.2	2.3	4.4	22.858	4.96E+00
K =	10.66	59.2	1.7	2.8	25.758	4.92E+00
Temp. =	28 °C	72.9	1.2	1.6	30.569	4.74E+00
RH =	75%	85.2	2.4	2.9	35.994	4.78E+00
r^2 =	0.9963	93.7	1.9	2	39.833	4.83E+00
					average	4.99E+00

(continued)

Table O1 (continued)

		V_a [mV]	SD[mV]	S/N[%]	I[mA]	σ(S/cm)
sample	Ppy_1:48(2)	39.6	1.5	3.9	17.097	4.56E+00
t =	0.0089 cm	48.2	1.7	3.5	19.748	4.33E+00
K =	10.66	73.8	1.6	2.1	30.77	4.40E+00
Temp. =	28 °C)	83.4	1.3	1.6	34.498	4.37E+00
RH =	75%	93.4	1.7	1.8	38.369	4.33E+00
r^2 =	0.9981	116.7	1.5	1.3	39.98	3.62E+00
					average	4.27E+00
sample	Ppy_1:48(3)	34	1	3	11.262	4.33E+00
t =	0.0072 cm	57.2	2.3	3.8	18.901	4.31E+00
K =	10.66	60.1	2.2	3.9	20.247	4.39E+00
Temp. =	28 °C	76.9	2.1	2.8	25.445	4.32E+00
RH =	75%	96.5	2.1	2.2	31.504	4.26E+00
r^2 =	0.9989	113.9	2.3	2	37.411	4.29E+00
					average	4.32E+00
sample	Ppy_1:12(1)	24.1	1.2	5.1	20.888	5.35E+00
t =	0.0152 cm	34.2	0	0	29.527	5.34E+00
K	10.66	41.9	2.4	5.7	35.889	5.29E+00
Temp. =	27 °C	45.2	2.2	4.8	38.961	5.33E+00
RH =	73%				average	5.37E+00
r^2 =	0.9986					
sample	Ppy_1:12(2)	24.5	0.68	2.8	17.522	7.46E+00
t =	0.009 cm	33.8	1.3	3.9	23.183	7.16E+00
K =	10.66	43.5	1.6	3.7	29.848	7.15E+00
Temp. =	27 °C	49.9	2	4	34.085	7.14E+00
RH	73%	58.8	1.4	2.3	39.725	7.05E+00
r^2 =	0.9974				average	7.19E+00

(continued)

Table O1 (continued)

		V_a [mV]	SD[mV]	S/N[%]	I[mA]	σ(S/cm)
sample	Ppy_1:12(3)	33.7	1.8	5.4	24.628	5.28E+00
t =	0.013 cm	38.1	2	5.1	28.097	5.33E+00
K =	10.66	44	0.94	2.1	32.039	5.26E+00
Temp. =	27 °C	48.3	1.1	2.2	35.647	5.28E+00
RH =	73%	52.3	2.3	4.3	38.178	5.27E+00
r^2 =	0.9994				average	5.28E+00
sample	Ppy_1:6(1)	22.3	2.4	10.9	26.215	5.38E+00
t =	0.0205 cm	24.9	1.5	5.9	29.623	5.45E+00
K =	10.66	30.4	2.1	6.9	34.641	5.22E+00
Temp. =	27 °C	33.8	1.3	3.8		5.10E+00
RH =	73				average	5.29E+00
r^2 =	0.9857					
sample	Ppy_1:6(2)	24.3	0.68	2.8	26.949	6.72E+00
t =	0.0155 cm	28.6	1.9	6.6	30.848	6.53E+00
K =	10.66	34.1	0	0	37.185	6.59E+00
Temp. =	27 °C	34.9	1.7	5	38.646	6.71E+00
RH =	73%				average	6.66E+00
r^2 =	0.9971					
sample	Ppy_1:6(3)	29.7	1.6	5.4	30.703	7.47E+00
t =	0.013 cm	34.1	0.76	2.2	34.397	7.30E+00
K =	10.66	36.2	2.4	6.7	36.795	7.35E+00
Temp. =	27 °C	39.3	1.1	2.7	39.98	7.35E+00
RH =	73%				average	7.37E+00
r^2 =	0.9941					

Appendix P The Specific Conductivity of Ppy When Exposed to Methane

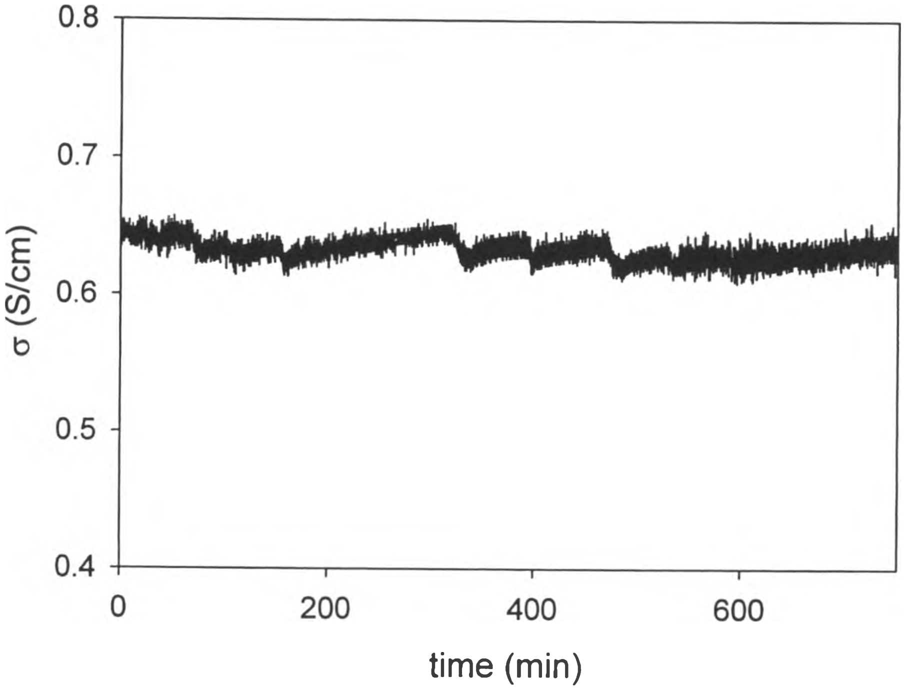


Figure P1 Specific conductivity of Ppy_ud(1) when exposed to methane.

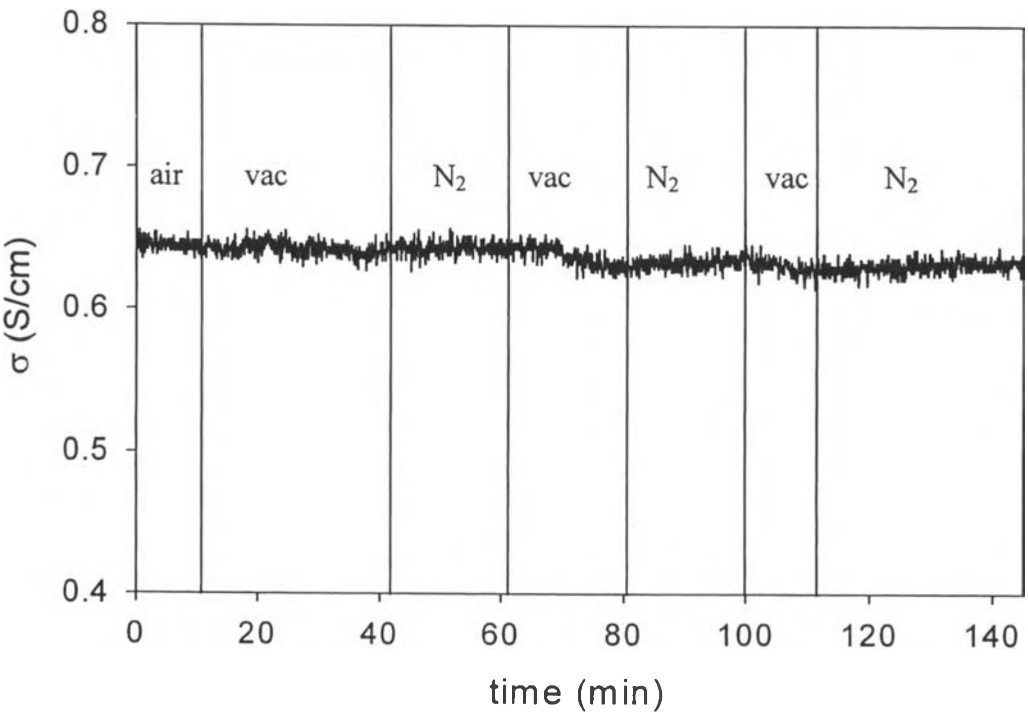


Figure P2 Specific conductivity of Ppy_ud(1) when exposed to methane.

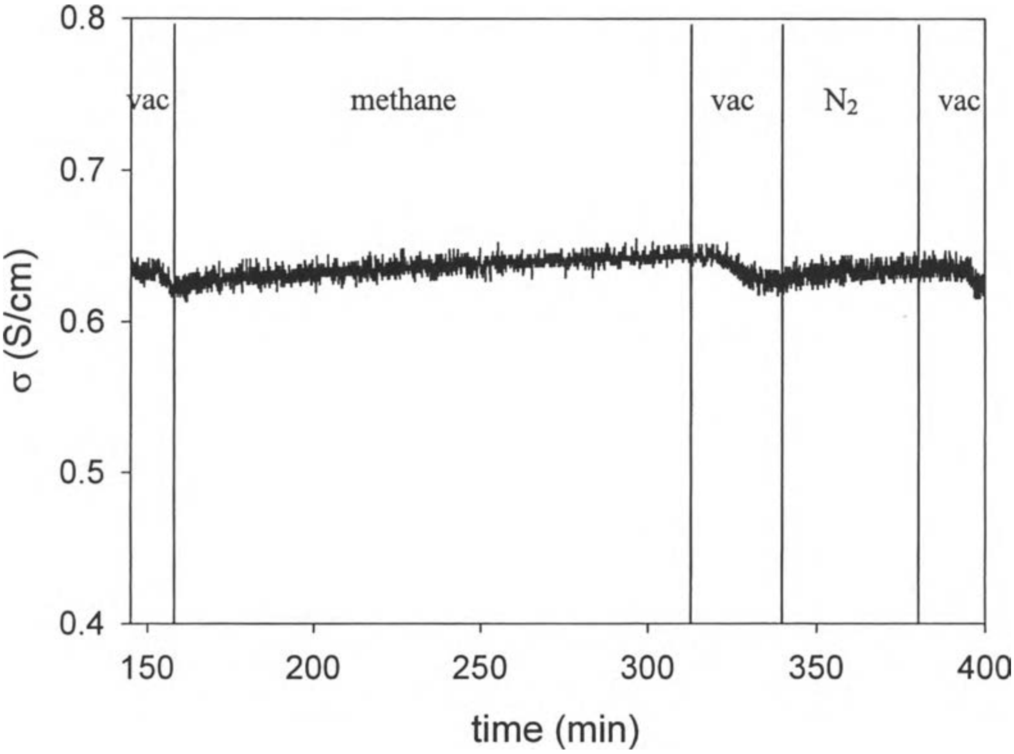


Figure P3 Specific conductivity of Ppy_ud(1) when exposed to methane.

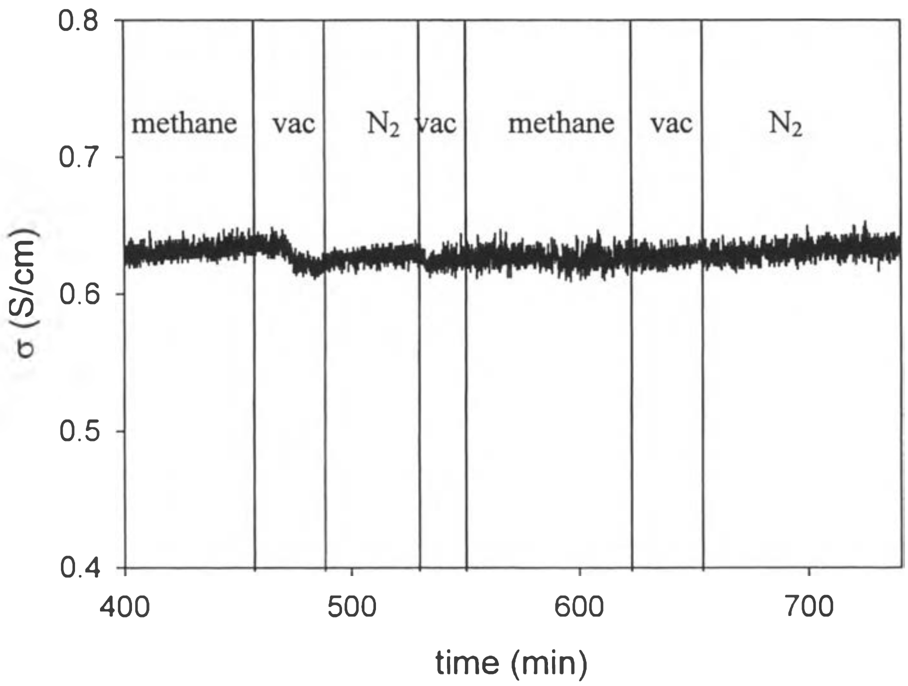


Figure P4 Specific conductivity of Ppy_ud(1) when exposed to methane.

Table P1 Specific conductivity and sensitivity of Ppy_ud(1) when exposed to 10% methane/N_2

Ppy_ud(1)		thickness	0.172 mm
K	11.23	T_r^a	28 °C
RH (%)	55	T_c^b	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r^c (min)	$\Delta\sigma^d/\sigma_{N2}$
air	6.44E-01	1.26E-02	16	-	1.99E-02
vacuum	6.43E-01	1.15E-02	25	-	1.83E-02
N_2	6.42E-01	1.06E-02	21	-	1.69E-02
vacuum	6.33E-01	1.40E-03	21	-	2.21E-03
N_2	6.33E-01	1.33E-03	20	-	2.11E-03
vacuum	6.29E-01	-2.94E-03	8	-	-4.65E-03
N_2	6.32E-01	0.00E+00	41	13	0.00E+00
vacuum	6.23E-01	-8.56E-03	9	4	-1.35E-02
methane	6.41E-01	9.45E-03	161	80	1.50E-02
vacuum	6.27E-01	-4.29E-03	24	5	-6.80E-03
N_2	6.34E-01	2.78E-03	40	-	4.41E-03
vacuum	6.36E-01	3.95E-03	13	-	6.25E-03
methane	6.33E-01	1.10E-03	60	-	1.75E-03
vacuum	6.22E-01	-9.57E-03	35	4	-1.52E-02
N_2	6.27E-01	-4.15E-03	34	-	-6.57E-03
vacuum	6.29E-01	-2.95E-03	4	-	-4.68E-03
methane	6.26E-01	-5.38E-03	42	-	-8.52E-03
vacuum	6.28E-01	-3.98E-03	20	-	-6.30E-03
N_2	6.34E-01	-5.36E-03	35	-	-8.49E-03

[a] T_r = room temperature, [b] T_c = chamber temperature

[c] t_r = the time that σ reaches equilibrium, [d] $\Delta\sigma = \sigma - \sigma_{N2(7)}$

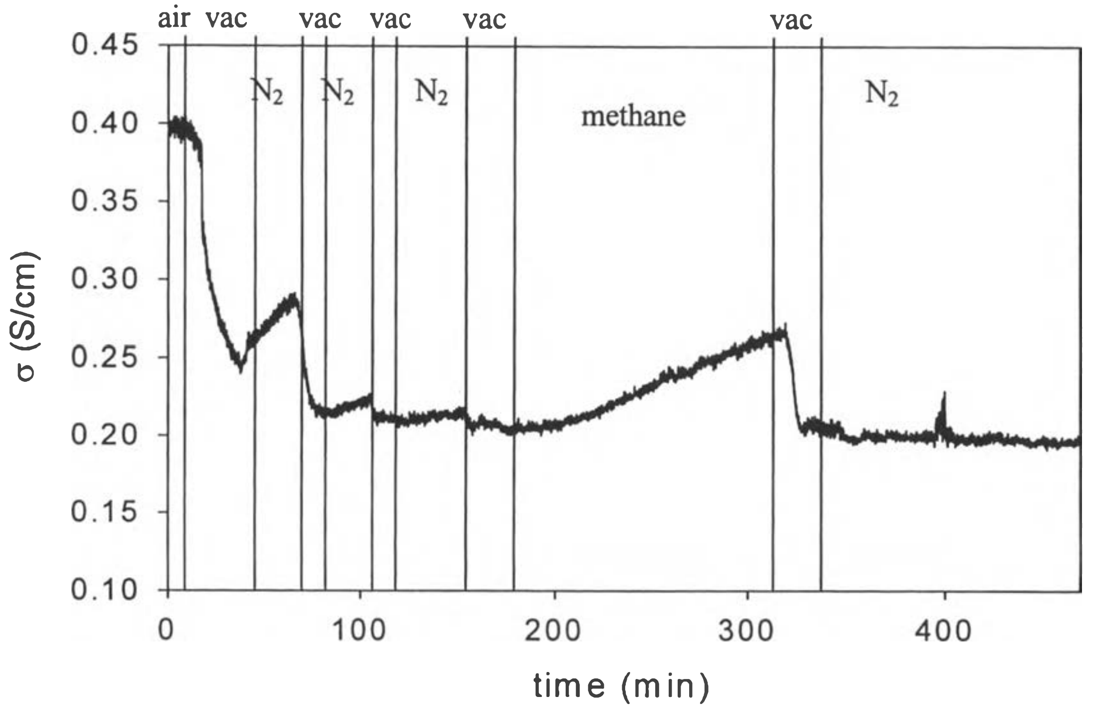


Figure P5 Specific conductivity of Ppy_ud(2) when exposed to methane.

Table P2 Specific conductivity and sensitivity of Ppy_ud(2) when exposed to 10% methane/N_2

*Ppy_ud(2)		thickness	0.163 mm
K	10.66	T_r	28 °C
RH	55 %	T_c	28 °C

gas	σ (S/cm)	Δσ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	3.97E-01	1.86E-01	16	-	8.81E-01
vacuum	2.49E-01	3.81E-02	25	13	1.80E-01
N_2	2.80E-01	6.96E-02	21	20	3.30E-01
vacuum	2.15E-01	4.62E-03	21	10	2.19E-02
N_2	2.19E-01	7.79E-03	20	10	3.69E-02
vacuum	2.11E-01	6.89E-04	8	5	3.26E-03
N_2	2.11E-01	0.00E+00	41	-	0.00E+00
vacuum	2.06E-01	-4.27E-03	9	3	-2.02E-02
methane	2.60E-01	4.94E-02	161	147	2.34E-01
vacuum	2.05E-01	-5.74E-03	24	7	-2.72E-02
N_2	2.42E-01	3.10E-02	40	-	1.47E-01
vacuum	1.99E-01	-1.18E-02	13	-	-5.59E-02
methane	1.97E-01	-1.35E-02	60	-	-6.40E-02

* The sample was broken during the experiment.

Table P3 Specific conductivity and sensitivity of Ppy_ud(3) when exposed to 10% methane/N_2

Ppy_ud(3)		thickness	0.173 mm
K	10.66	T_r	26 °C
RH	60 %	T_c	28 ° C

gas	σ (S/cm)	Δσ (S/cm)	Time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.93E-01	1.39E-01	26	-	9.01E-01
vacuum	2.11E-01	5.71E-02	25	11	3.71E-01
N_2	2.39E-01	8.49E-02	42	39	5.51E-01
vacuum	1.49E-01	-5.08E-03	27	16	-3.30E-02
N_2	1.98E-01	4.35E-02	106	97	2.82E-01
vacuum	1.41E-01	-1.31E-02	17	11	-8.49E-02
N_2	1.60E-01	5.46E-03	33	30	3.54E-02
vacuum	1.34E-01	-2.02E-02	12	11	-1.31E-01
N_2	1.54E-01	0.00E+00	52	-	0.00E+00
vacuum	1.51E-01	-2.96E-03	18	13	-1.92E-02
methane	1.57E-01	2.55E-03	49	-	1.65E-02
vacuum	1.45E-01	-9.43E-03	16	-	-6.12E-02
N_2	1.61E-01	6.97E-03	27	10	4.52E-02
vacuum	1.51E-01	-2.24E-03	12	-	-1.45E-02
methane	1.53E-01	-5.39E-04	36	11	-3.50E-03
vacuum	1.49E-01	-4.41E-03	11	-	-2.86E-02
N_2	1.64E-01	9.95E-03	24	8	6.45E-02
vacuum	1.61E-01	7.31E-03	17	-	4.74E-02
methane	1.68E-01	1.41E-02	61	-	9.13E-02
vacuum	1.58E-01	4.12E-03	16	-	2.67E-02
N_2	1.49E-01	-4.66E-03	56	12	-3.02E-02

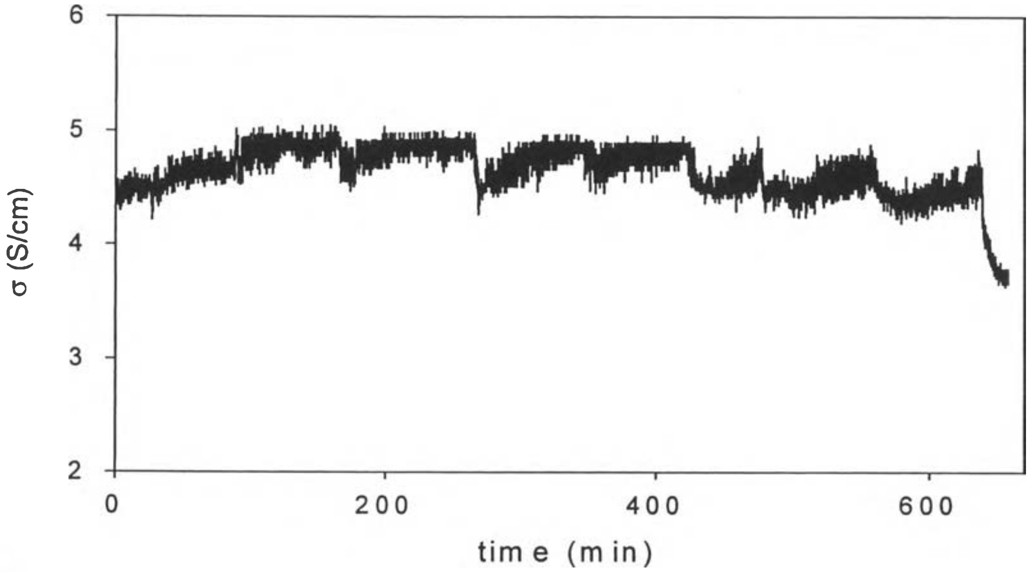


Figure P6 Specific conductivity of Ppy_1:6(1) when exposed to methane.

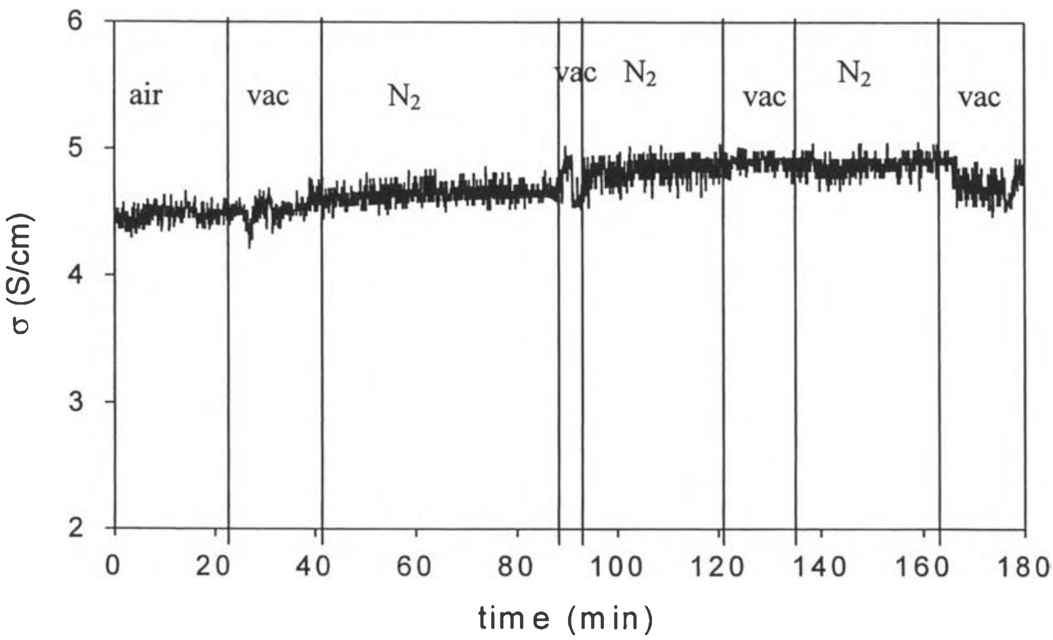


Figure P7 Specific conductivity of Ppy_1:6(1) when exposed to methane.

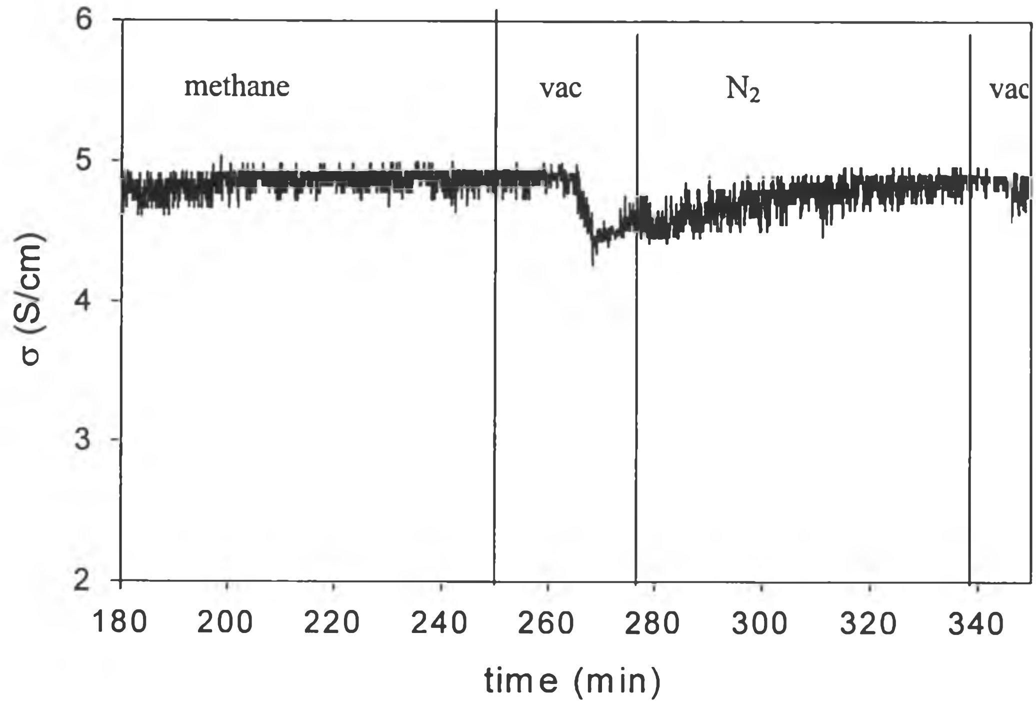


Figure P8 Specific conductivity of Ppy_1:6(1) when exposed to methane.

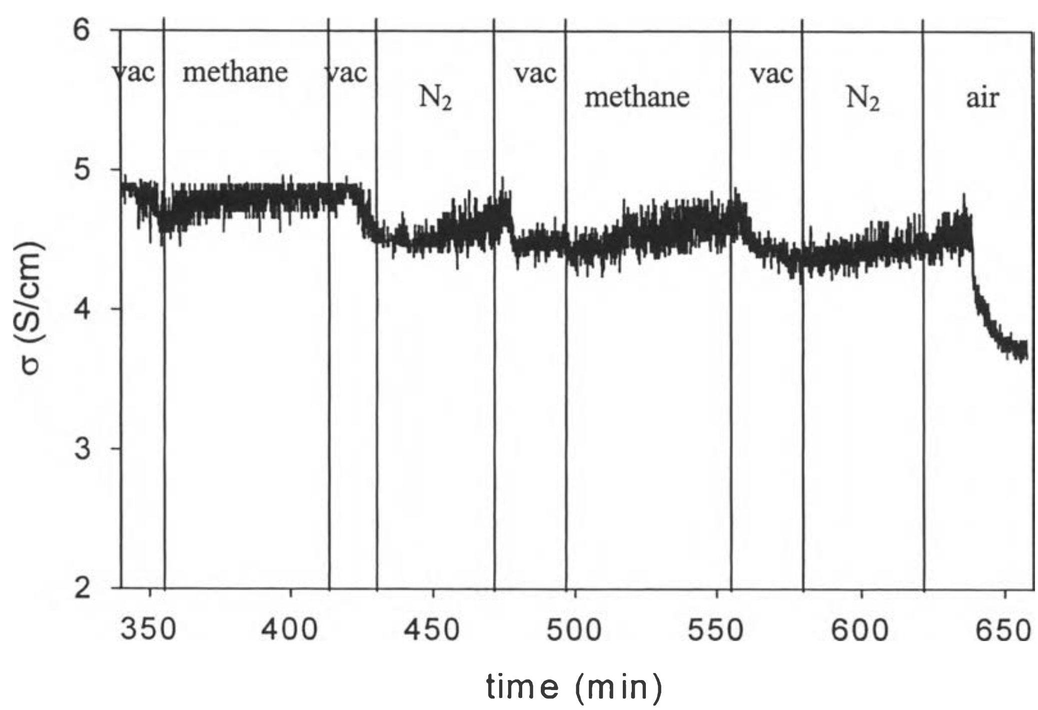


Figure P9 Specific conductivity of Ppy_1:6(1) when exposed to methane.

Table P4 Specific conductivity and sensitivity of Ppy_1:6(1) when exposed to 10% methane/N_2

Ppy_1:6(1)		thickness	0.129 mm
K	10.66	T_r	27 °C
RH	60 %	T_c	28 °C

gas	σ (S/cm)	Δσ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
Air	4.47E+00	-3.86E-01	22	-	-3.86E-01
vacuum	4.53E+00	-3.29E-01	6	-	-3.29E-01
N_2	4.65E+00	-2.05E-01	48	-	-2.05E-01
vacuum	4.65E+00	-2.13E-01	7	-	-2.13E-01
N_2	4.84E+00	-1.84E-02	27	-	-1.84E-02
vacuum	4.90E+00	3.77E-02	16	-	3.77E-02
N_2	4.86E+00	0.00E+00	38	-	0.00E+00
vacuum	4.68E+00	-1.83E-01	4	-	-1.83E-01
methane	4.86E+00	4.88E-03	80	-	4.88E-03
vacuum	4.50E+00	-3.63E-01	16	3	-3.63E-01
N_2	4.80E+00	-5.73E-02	61	44	-5.73E-02
vacuum	4.83E+00	-2.72E-02	14	-	-2.72E-02
methane	4.79E+00	-7.40E-02	69	25	-7.40E-02
vacuum	4.81E+00	-4.42E-02	15	-	-4.42E-02
N_2	4.53E+00	-3.33E-01	34	-	-3.33E-01
vacuum	4.47E+00	-3.89E-01	24	3	-3.89E-01
methane	4.57E+00	-2.92E-01	57	23	-2.92E-01
vacuum	4.44E+00	-4.19E-01	18	5	-4.19E-01
N_2	4.38E+00	-4.78E-01	30	-	-4.78E-01

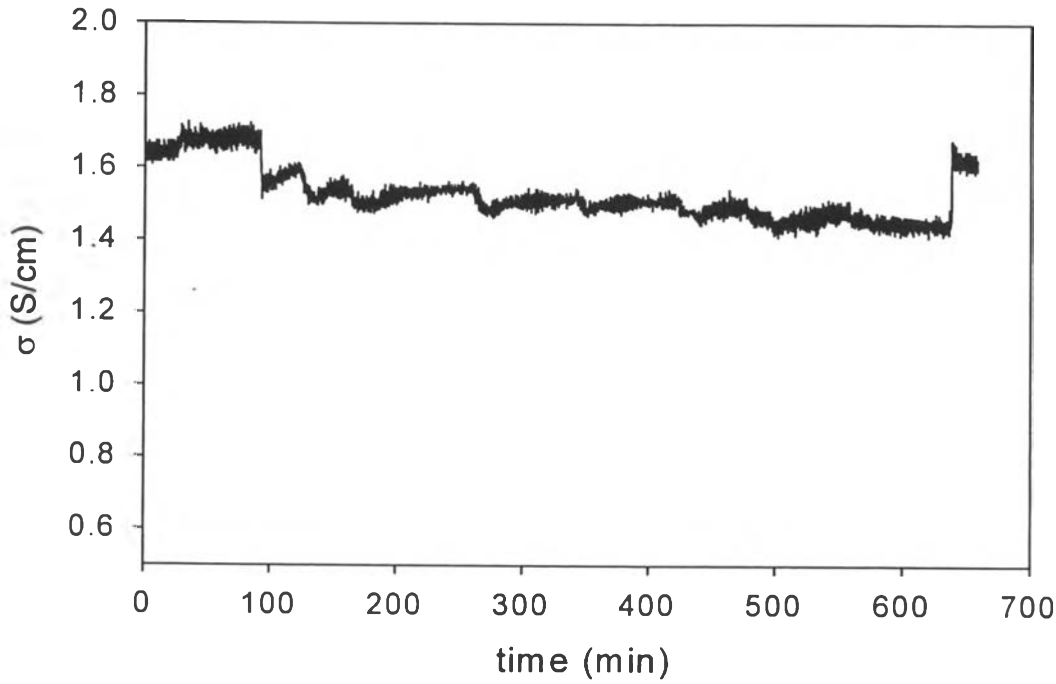


Figure P10 Specific conductivity of Ppy_1:6(2) when exposed to methane.

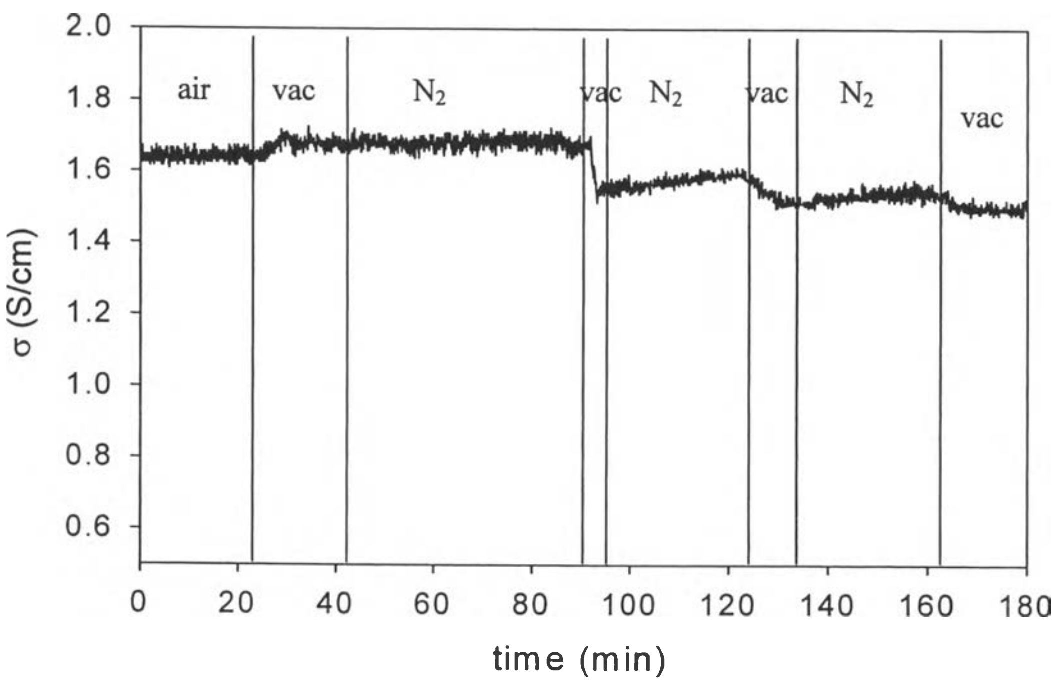


Figure P11 Specific conductivity of Ppy_1:6(2) when exposed to methane.

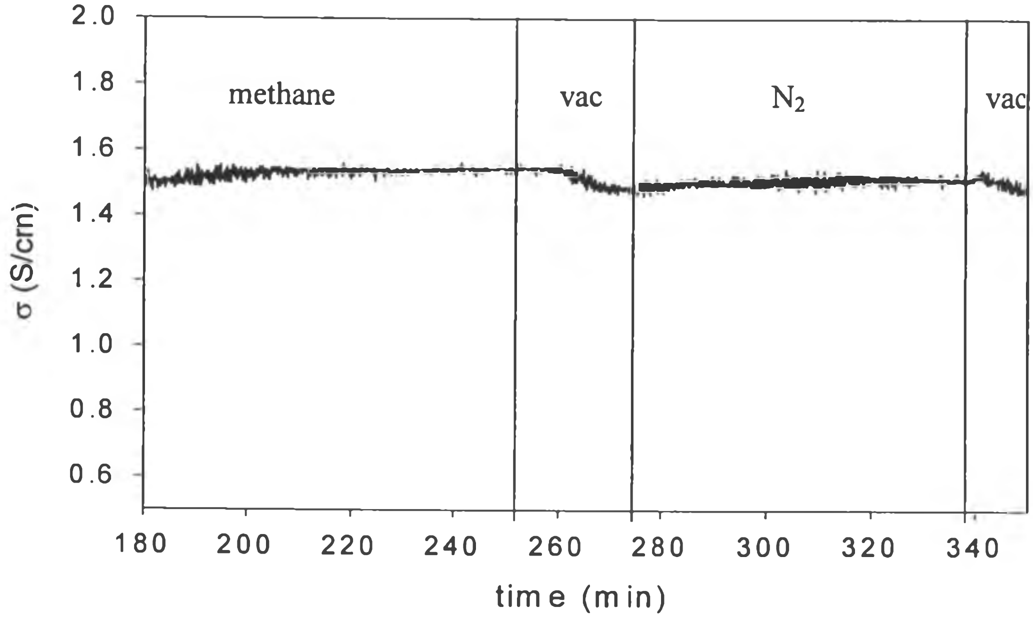


Figure P12 Specific conductivity of Ppy_1:6(2) when exposed to methane.

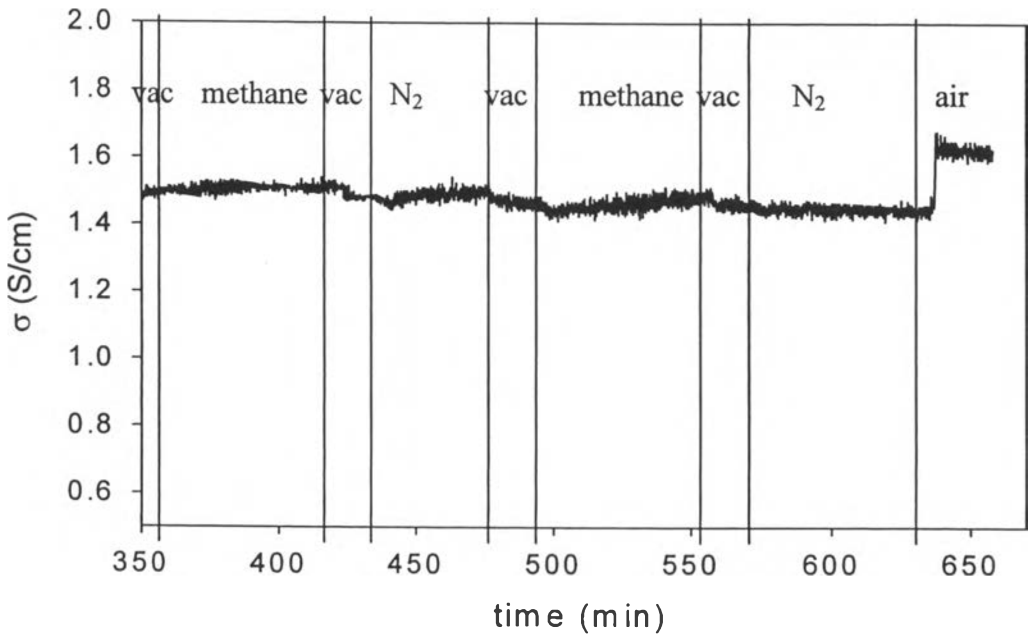


Figure P13 Specific conductivity of Ppy_1:6(2) when exposed to methane.

Table P5 Specific conductivity and sensitivity of Ppy_1:6(2) when exposed to 10% methane/N_2

Ppy_1:6(2)		thickness	0.165 mm
K	11.23	T_r	27 °C
RH	60%	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
Air	1.64E+00	1.01E-01	22		6.58E-02
vacuum	1.67E+00	1.35E-01	6	-	8.78E-02
N_2	1.68E+00	1.41E-01	48	-	9.16E-02
vacuum	1.54E+00	3.27E-03	7	2	2.12E-03
N_2	1.58E+00	4.80E-02	27	20	3.12E-02
vacuum	1.51E+00	-2.51E-02	16	5	-1.63E-02
N_2	1.53E+00	0.00E+00	38	-	0.00E+00
vacuum	1.49E+00	-4.38E-02	4	2	-2.85E-02
methane	1.54E+00	1.73E-03	80	20	1.12E-03
vacuum	1.48E+00	-5.40E-02	16	5	-3.50E-02
N_2	1.51E+00	-2.54E-02	61	10	-1.65E-02
vacuum	1.49E+00	-4.46E-02	14	-	-2.89E-02
methane	1.50E+00	-3.03E-02	69	-	-1.97E-02
vacuum	1.50E+00	-3.03E-02	15	-	-1.97E-02
N_2	1.48E+00	-5.24E-02	34	-	-3.40E-02
vacuum	1.46E+00	-7.26E-02	24	2	-4.71E-02
methane	1.47E+00	-6.58E-02	57	10	-4.27E-02
vacuum	1.46E+00	-7.91E-02	18	-	-5.14E-02
N_2	1.44E+00	-9.08E-02	30	-	-5.89E-02

Table P6 Specific conductivity and sensitivity of Ppy_ud/13X_5(1) when exposed to 10% methane/N_2

Ppy_ud/13X_5(1)		thickness	0.160 mm
K	10.66	T_r	27 °C
RH	50 %	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	Time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$*
air	7.72E-02	6.72E-03	20	-	9.54E-02
vacuum	6.57E-02	-4.72E-03	34	-	-6.70E-02
N_2	7.53E-02	4.89E-03	79	-	6.94E-02
vacuum	6.41E-02	-6.35E-03	13	-	-9.01E-02
N_2	7.97E-02	9.25E-03	64	36	1.31E-01
vacuum	7.16E-02	1.17E-03	11	-	1.66E-02
N_2	6.49E-02	-5.57E-03	55	35	-7.91E-02
vacuum	7.44E-02	3.98E-03	10	7	5.64E-02
N_2	7.04E-02	0.00E+00	36	33	0.00E+00
vacuum	8.13E-02	1.08E-02	14	8	1.54E-01
methane	7.57E-02	5.23E-03	43	26	7.42E-02
vacuum	7.57E-02	5.22E-03	22	17	7.42E-02
N_2	8.32E-02	1.28E-02	33	15	1.82E-01
vacuum	7.55E-02	5.06E-03	14	-	7.18E-02
methane	8.75E-02	1.71E-02	53	16	2.43E-01
vacuum	9.69E-02	2.65E-02	14	6	3.76E-01
N_2	9.97E-02	2.92E-02	26	10	4.15E-01
vacuum	9.76E-02	2.72E-02	9	6	3.86E-01
methane	8.13E-02	1.08E-02	65	50	1.54E-01
vacuum	8.20E-02	1.15E-02	39	26	1.64E-01
N_2	9.67E-02	2.63E-02	27	-	3.73E-01

*$\Delta\sigma = \sigma - \sigma_{N2(9)}$

Table P7 Specific conductivity and sensitivity of Ppy_ud/13X_5(2) when exposed to 10% methane/N_2

Ppy_ud/13X_5(2)		thickness	0.168 mm
K	11.23	T_r	27 °C
RH	50 %	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.47E-01	3.28E-03	26	-	2.28E-02
vacuum	1.47E-01	2.76E-03	42	-	1.92E-02
N_2	1.46E-01	2.38E-03	51	-	1.65E-02
vacuum	1.45E-01	1.73E-03	16	-	1.20E-02
N_2	1.46E-01	2.01E-03	70	-	1.40E-02
vacuum	1.43E-01	-4.82E-04	57	3	-3.35E-03
N_2	1.44E-01	3.71E-04	68	24	2.58E-03
vacuum	1.43E-01	-7.31E-04	21	16	-5.09E-03
N_2	1.44E-01	0.00E+00	33	14	0.00E+00
vacuum	1.43E-01	-8.79E-04	18	-	-6.12E-03
methane	1.43E-01	-1.12E-03	48	-	-7.79E-03
vacuum	1.42E-01	-1.53E-03	11	-	-1.07E-02
N_2	1.41E-01	-3.12E-03	103	-	-2.17E-02
vacuum	1.39E-01	-5.06E-03	20	6	-3.52E-02
methane	1.39E-01	-4.60E-03	46	30	-3.20E-02
vacuum	1.37E-01	-6.81E-03	11	-	-4.73E-02
N_2	1.39E-01	-4.87E-03	49	15	-3.39E-02
vacuum	1.39E-01	-4.61E-03	20	-	-3.20E-02
methane	1.39E-01	-4.51E-03	46	27	-3.14E-02
vacuum	1.37E-01	-6.97E-03	11	10	-4.85E-02
N_2	1.38E-01	-5.29E-03	49	-	-3.68E-02

Table P8 Specific conductivity and sensitivity of Ppy_ud/13X_20(1) when exposed to 10% methane/N_2

Ppy_ud/13X_20(1)		thickness	0.175 mm
K	10.66	T_r	29 °C
RH	55 %	T_c	28 °C

gas	σ (S/cm	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	8.63E-02	4.58E-02	26	-	1.13E+00
vacuum	5.09E-02	1.04E-02	13	6	2.56E-01
N_2	5.80E-02	1.75E-02	45	26	4.33E-01
vacuum	4.11E-02	5.80E-04	12	10	1.43E-02
N_2	4.79E-02	7.44E-03	52	50	1.84E-01
vacuum	3.68E-02	-3.66E-03	13	10	-9.04E-02
N_2	4.11E-02	6.51E-04	74	47	1.61E-02
vacuum	4.14E-02	8.96E-04	11	-	2.21E-02
N_2	4.05E-02	0.00E+00	68	-	0.00E+00
vacuum	3.99E-02	-6.37E-04	11	-	-1.57E-02
methane	4.05E-02	-1.47E-05	67	27	-3.63E-04
vacuum	3.89E-02	-1.64E-03	15	-	-4.06E-02
N_2	3.87E-02	-1.79E-03	52	24	-4.41E-02
vacuum	0.03562	-4.88E-03	13	5	-1.20E-01
methane	3.93E-02	-1.23E-03	56	10	-3.03E-02
vacuum	3.94E-02	-1.12E-03	13	-	-2.76E-02
N_2	4.44E-02	3.88E-03	37	25	9.57E-02
vacuum	4.07E-02	2.01E-04	12	-	4.97E-03
methane	3.98E-02	-7.43E-04	48	15	-1.84E-02
vacuum	3.94E-02	-1.11E-03	16	-	-2.73E-02
N_2	3.89E-02	-1.62E-03	36	-	-4.01E-02

Table P9 Specific conductivity and sensitivity of Ppy_ud/13X_20(2) when exposed to 10% methane/N_2

Ppy_ud/13X_20(2)		thickness	0.17 mm
K	11.23	T_r	29 °C
RH	55 %	T_c	28 °C

gas	σ (S/cm)	Δσ (S/cm)	time (min)	t_r (min)	Δ σ/σ_{N2}
air	8.62E-02	2.91E-03	26	-	3.49E-02
vacuum	0.079523	-3.75E-03	13	6	-4.51E-02
N_2	8.49E-02	1.63E-03	45	31	1.95E-02
vacuum	7.63E-02	-6.93E-03	12	8	-8.33E-02
N_2	8.45E-02	1.25E-03	52	45	1.51E-02
vacuum	7.55E-02	-7.78E-03	13	6	-9.34E-02
N_2	8.33E-02	0.00E+00	74	55	0.00E+00
vacuum	7.61E-02	-7.14E-03	11	7	-8.57E-02
methane	0.082879	-3.96E-04	68	65	-4.75E-03
vacuum	7.47E-02	-8.60E-03	11	10	-1.03E-01
N_2	0.081475	-1.80E-03	67	60	-2.16E-02
vacuum	7.28E-02	-1.04E-02	15	12	-1.25E-01
methane	8.25E-02	-8.15E-04	52	100	-9.78E-03
vacuum	8.49E-02	1.62E-03	13	-	1.94E-02
N_2	8.88E-02	5.50E-03	37	13	6.61E-02
vacuum	7.85E-02	-4.75E-03	12	8	-5.71E-02
methane	7.78E-02	-5.43E-03	48	39	-6.52E-02
vacuum	0.066238	-1.70E-02	16	13	-2.05E-01
N_2	6.72E-02	-1.61E-02	36	-	-1.93E-01

Table P10 Specific conductivity and sensitivity of Ppy_ud/13X_40(1) when exposed to 10% methane/N_2

Ppy_ud/13X_40(1)		thickness	0.167 mm
K	10.66	T_r	28 °C
RH (%)	55	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.33E-02	9.46E-03	18	-	2.50E+00
vacuum	4.60E-03	8.07E-04	31	15	2.13E-01
N_2	6.59E-03	2.80E-03	53	40	7.39E-01
vacuum	4.21E-03	4.20E-04	18	9	1.11E-01
N_2	5.45E-03	1.66E-03	62	40	4.39E-01
vacuum	3.64E-03	-1.51E-04	18	12	-3.97E-02
N_2	3.89E-03	9.83E-05	48	-	2.60E-02
vacuum	3.79E-03	3.16E-06	17	-	8.34E-04
N2	3.79E-03	0.00E+00	39	-	0.00E+00
vacuum	3.73E-03	-5.54E-05	10	-	-1.46E-02
methane	3.73E-03	-5.70E-05	56	-	-1.50E-02
vacuum	3.78E-03	-1.16E-05	16	-	-3.05E-03
N_2	3.59E-03	-2.03E-04	37	-	-5.35E-02
vacuum	3.60E-03	-1.87E-04	17	-	-4.94E-02
methane	3.51E-03	-2.83E-04	33	-	-7.46E-02
vacuum	3.48E-03	-3.05E-04	9	-	-8.05E-02
N_2	3.41E-03	-3.74E-04	30	25	-9.87E-02
vacuum	3.38E-03	-4.06E-04	13	-	-1.07E-01
methane	3.43E-03	-3.54E-04	45	-	-9.34E-02
vacuum	3.40E-03	-3.83E-04	15	-	-1.01E-01
N_2	3.40E-03	-3.91E-04	45	13	-1.03E-01

Table P11 Specific conductivity and sensitivity of Ppy_ud/13X_40(2) when exposed to 10% methane/N_2

Ppy_ud/13X_40(2)		thickness	0.163 mm
K	11.23	T_r	28 °C
RH (%)	55	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	8.47E-03	6.62E-03	18	-	3.57E+00
vacuum	1.97E-03	1.16E-04	31	23	6.23E-02
N_2	3.47E-03	1.62E-03	53	50	8.73E-01
vacuum	1.65E-03	-2.05E-04	18	17	-1.11E-01
N_2	2.63E-03	7.73E-04	62	62	4.17E-01
vacuum	6.92E-04	-1.16E-03	18	17	-6.27E-01
N_2	1.94E-03	8.85E-05	48	45	4.77E-02
vacuum	1.41E-03	-4.49E-04	17	8	-2.42E-01
N2	1.85E-03	0.00E+00	39	31	0.00E+00
vacuum	1.48E-03	-3.69E-04	10	7	-1.99E-01
methane	1.82E-03	-3.53E-05	56	42	-1.91E-02
vacuum	1.40E-03	-4.49E-04	16	13	-2.42E-01
N_2	1.48E-03	-3.76E-04	37	30	-2.03E-01
vacuum	1.37E-03	-4.81E-04	17	12	-2.60E-01
methane	1.44E-03	-4.14E-04	33	27	-2.24E-01
vacuum	1.26E-03	-5.94E-04	9	5	-3.20E-01
N_2	1.27E-03	-5.88E-04	30	-	-3.17E-01
vacuum	1.25E-03	-6.08E-04	13	10	-3.28E-01
methane	1.34E-03	-5.09E-04	45	30	-2.74E-01
vacuum	1.25E-03	-6.06E-04	15	14	-3.27E-01
N_2	1.25E-03	-6.01E-04	45	-	-3.24E-01

Table P12 Specific conductivity and sensitivity of Ppy_1:6/13X_10(1) when exposed to 10% methane/N_2

Ppy_1:6/13X_10(1)		thickness	0.177 mm
K	10.66	T_r	26 °C
RH	55 %	T_c	28 °C

gas	σ (S/cm)	Δσ (S/cm)	time (min)	t_r (min)	$\Delta\ \sigma/\sigma_{N2}$
air	1.24E+00	-3.41E-01	26	-	-0.21612
vacuum	1.44E+00	-1.43E-01	42	-	-0.09026
N_2	1.60E+00	2.21E-02	50	-	0.013964
vacuum	1.63E+00	5.27E-02	16	-	0.03337
N_2	1.62E+00	3.82E-02	70	-	0.024198
vacuum	1.56E+00	-1.54E-02	56	2	-0.00978
N_2	1.57E+00	-9.56E-03	68	23	-0.00605
vacuum	1.56E+00	-2.02E-02	21	15	-0.01279
N_2	1.58E+00	0.00E+00	33	15	0
vacuum	1.57E+00	-9.97E-03	17	-	-0.00632
methane	1.55E+00	-2.60E-02	48	-	-0.01648
vacuum	1.55E+00	-2.51E-02	11	-	-0.0159
N_2	1.53E+00	-5.07E-02	103	-	-0.03212
vacuum	1.51E+00	-6.46E-02	20	5	-0.04093
methane	1.54E+00	-4.17E-02	46	28	-0.02642
vacuum	1.51E+00	-6.66E-02	11	-	-0.04217
N_2	1.51E+00	-6.94E-02	49	16	-0.04392
vacuum	1.52E+00	-6.10E-02	19	-	-0.0386
methane	1.54E+00	-4.10E-02	45	27	-0.02593
vacuum	1.51E+00	-7.18E-02	11	10	-0.04547
N_2	1.51E+00	-7.39E-02	48	-	-0.04681

Table P13 Specific conductivity and sensitivity of Ppy_1:6/13X_10(2) when exposed to 10% methane/N_2

Ppy_1:6/13X_10(2)		thickness	0.173 mm
K	11.23	T_r	26 °C
RH	55 %	T_c	28 °C

gas	σ (S/cm)	Δσ (S/cm)	time (min)	t_r (min)	$\Delta\ \sigma/\sigma_{N2}$
air	1.56E+00	3.14E-01	26	-	2.52E-01
vacuum	1.32E+00	7.55E-02	42	30	6.07E-02
N_2	1.42E+00	1.81E-01	50	23	1.45E-01
vacuum	1.28E+00	3.19E-02	15	9	2.57E-02
N_2	1.34E+00	1.01E-01	69	26	8.10E-02
vacuum	1.17E+00	-7.47E-02	56	-	-6.01E-02
N_2	1.23E+00	-1.59E-02	68	48	-1.28E-02
vacuum	1.21E+00	-3.05E-02	21	-	-2.45E-02
N_2	1.24E+00	0.00E+00	33	9	0.00E+00
vacuum	1.14E+00	-1.05E-01	17	-	-8.44E-02
methane	1.24E+00	-5.64E-03	48	15	-4.54E-03
vacuum	1.15E+00	-9.14E-02	11	-	-7.35E-02
N_2	1.15E+00	-9.53E-02	103	65	-7.66E-02
vacuum	1.11E+00	-1.37E-01	20	15	-1.11E-01
methane	1.15E+00	-9.73E-02	46	-	-7.83E-02
vacuum	1.13E+00	-1.16E-01	11	-	-9.31E-02
N_2	1.11E+00	-1.35E-01	49	-	-1.09E-01
vacuum	1.11E+00	-1.31E-01	19	-	-1.06E-01
methane	1.14E+00	-1.02E-01	45	-	-8.17E-02
vacuum	1.12E+00	-1.22E-01	11	-	-9.80E-02
N_2	1.11E+00	-1.34E-01	48	-	-1.08E-01

Table P14 Specific conductivity and sensitivity of Ppy_1:6/13X_20(1) when exposed to 10% methane/N_2

Ppy_1:6/13X_20(1)		thickness	0.169 mm
K	10.66	T_r	27 °C
RH	55 %	T_c	28 °C

gas	σ (S/cm)	Δσ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	8.63E-02	4.58E-02	32	-	1.13E+00
vacuum	5.09E-02	1.04E-02	40	18	2.56E-01
N_2	5.80E-02	1.75E-02	48	22	4.33E-01
vacuum	4.11E-02	5.80E-04	30.	-	1.43E-02
N_2	4.79E-02	7.44E-03	39	16	1.84E-01
vacuum	3.68E-02	-3.66E-03	14	6	-9.04E-02
N_2	4.11E-02	6.51E-04	29	-	1.61E-02
vacuum	4.14E-02	8.96E-04	11	-	2.21E-02
N_2	4.05E-02	0.00E+00	38	-	0.00E+00
vacuum	3.99E-02	-6.37E-04	19	-	-1.57E-02
methane	4.05E-02	-1.47E-05	31	-	-3.63E-04
vacuum	3.89E-02	-1.64E-03	8	6	-4.06E-02
N_2	3.87E-02	-1.79E-03	32	26	-4.41E-02
vacuum	0.03562	-4.88E-03	14	7	-1.20E-01
methane	3.93E-02	-1.23E-03	24	-	-3.03E-02
vacuum	3.94E-02	-1.12E-03	13	-	-2.76E-02
N2	4.44E-02	3.88E-03	27	-	9.57E-02
vacuum	4.07E-02	2.01E-04	15	-	4.97E-03
methane	3.98E-02	-7.43E-04	30	-	-1.84E-02

Table P15 Specific conductivity and sensitivity of Ppy_1:6/13X_20(2) when exposed to 10% methane/N_2

Ppy_1:6/13X_20(2)		thickness	0.166 mm
K	11.23	T_r	27 °C
RH	55 %	T_c	28 °C

gas	σ (S/cm)	Δσ (S/cm)	time (min)	t_r (min)	$\Delta\,\sigma/\sigma_{N2}$
air	8.62E-02	2.91E-03	32	-	3.49E-02
vacuum	7.95E-02	-3.75E-03	40	-	-4.51E-02
N_2	8.49E-02	1.63E-03	48	-	1.95E-02
vacuum	7.63E-02	-6.93E-03	30	-	-8.33E-02
N_2	8.45E-02	1.25E-03	39	-	1.51E-02
vacuum	7.55E-02	-7.78E-03	14	-	-9.34E-02
N_2	8.33E-02	0.00E+00	29	12	0.00E+00
vacuum	7.61E-02	-7.14E-03	11	-	-8.57E-02
methane	8.29E-02	-3.96E-04	38	28	-4.75E-03
vacuum	7.47E-02	-8.60E-03	19	12	-1.03E-01
N2	8.15E-02	-1.80E-03	31	14	-2.16E-02
vacuum	7.28E-02	-1.04E-02	8	-	-1.25E-01
methane	8.25E-02	-8.15E-04	32	21	-9.78E-03
vacuum	8.49E-02	1.62E-03	14	12	1.94E-02
N_2	8.88E-02	5.50E-03	24	-	6.61E-02
vacuum	7.85E-02	-4.75E-03	13	-	-5.71E-02
methane	7.78E-02	-5.43E-03	27	10	-6.52E-02
vacuum	6.62E-02	-1.70E-02	15	-	-2.05E-01
N_2	6.72E-02	-1.61E-02	30	-	-1.93E-01

Table P16 Specific conductivity and sensitivity of Ppy_1:6/13X_40(1) when exposed to 10% methane/N_2

Ppy_1:6/13X_40(1)		thickness	0.180 mm
K	10.66	T_r	28 °C
RH	54 %	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	4.94E-01	2.50E-01	22	-	1.03E+00
vacuum	3.49E-01	1.06E-01	20	20	4.33E-01
N_2	3.59E-01	1.15E-01	28	20	4.71E-01
vacuum	3.15E-01	7.16E-02	21	21	2.94E-01
N_2	2.87E-01	4.37E-02	36	11	1.79E-01
vacuum	2.48E-01	4.66E-03	35	25	1.91E-02
N_2	2.47E-01	3.73E-03	55	20	1.53E-02
vacuum	2.37E-01	-7.11E-03	17	11	-2.92E-02
N_2	2.44E-01	0.00E+00	35	18	0.00E+00
vacuum	2.34E-01	-1.02E-02	18	7	-4.20E-02
methane	2.40E-01	-3.55E-03	41	30	-1.46E-02
vacuum	2.29E-01	-1.52E-02	22	19	-6.25E-02
N_2	2.27E-01	-1.69E-02	30	-	-6.93E-02
vacuum	2.23E-01	-2.06E-02	10	-	-8.45E-02
methane	2.24E-01	-1.93E-02	52	-	-7.92E-02
vacuum	2.19E-01	-2.48E-02	15	-	-1.02E-01
N_2	2.19E-01	-2.51E-02	42	-	-1.03E-01
vacuum	2.23E-01	-2.11E-02	10	5	-8.66E-02
methane	2.24E-01	-1.99E-02	40	-	-8.17E-02
vacuum	2.23E-01	-2.03E-02	15	-	-8.33E-02
N2	2.19E-01	-2.45E-02	42	-	-1.01E-01

Table P17 Specific conductivity and sensitivity of Ppy_1:6/13X_40(2) when exposed to 10% methane/N_2

Ppy_1:6/13X_40(2)		thickness	0.175 mm
K	11.23	T_r	28 °C
RH	54 %	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta \sigma/\sigma_{N2}$
air	4.65E-01	1.93E-01	22	-	7.09E-01
vacuum	3.77E-01	1.04E-01	20	23	3.83E-01
N_2	3.86E-01	1.14E-01	28	20	4.17E-01
vacuum	3.44E-01	7.17E-02	21	22	2.63E-01
N_2	3.16E-01	4.39E-02	36	15	1.61E-01
vacuum	2.76E-01	4.00E-03	35	30	1.47E-02
N_2	2.76E-01	3.42E-03	55	24	1.26E-02
vacuum	2.65E-01	-7.72E-03	17	12	-2.83E-02
N_2	2.72E-01	0.00E+00	35	17	0.00E+00
vacuum	2.62E-01	-1.06E-02	18	5	-3.90E-02
methane	2.69E-01	-3.64E-03	41	28	-1.34E-02
vacuum	2.56E-01	-1.61E-02	22	15	-5.92E-02
N_2	2.55E-01	-1.74E-02	30	-	-6.37E-02
vacuum	2.51E-01	-2.16E-02	10	-	-7.94E-02
methane	2.53E-01	-1.99E-02	52	-	-7.29E-02
vacuum	2.47E-01	-2.57E-02	15	-	-9.45E-02
N_2	2.47E-01	-2.53E-02	42	-	-9.29E-02
vacuum	2.53E-01	-1.98E-02	10	6	-7.25E-02
methane	2.51E-01	-2.10E-02	40	-	-7.72E-02
vacuum	2.53E-01	-1.91E-02	15	-	-7.03E-02
N_2	2.47E-01	-2.52E-02	42	-	-9.27E-02

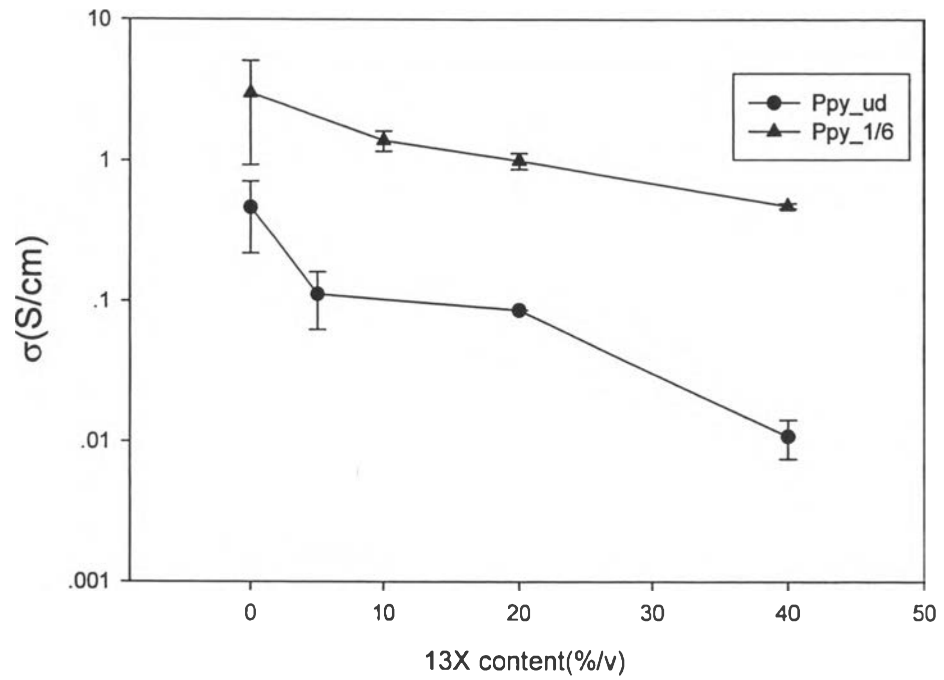


Figure P14 Specific conductivity of Ppy_ud and Ppy_1:6 at various 13X contents.

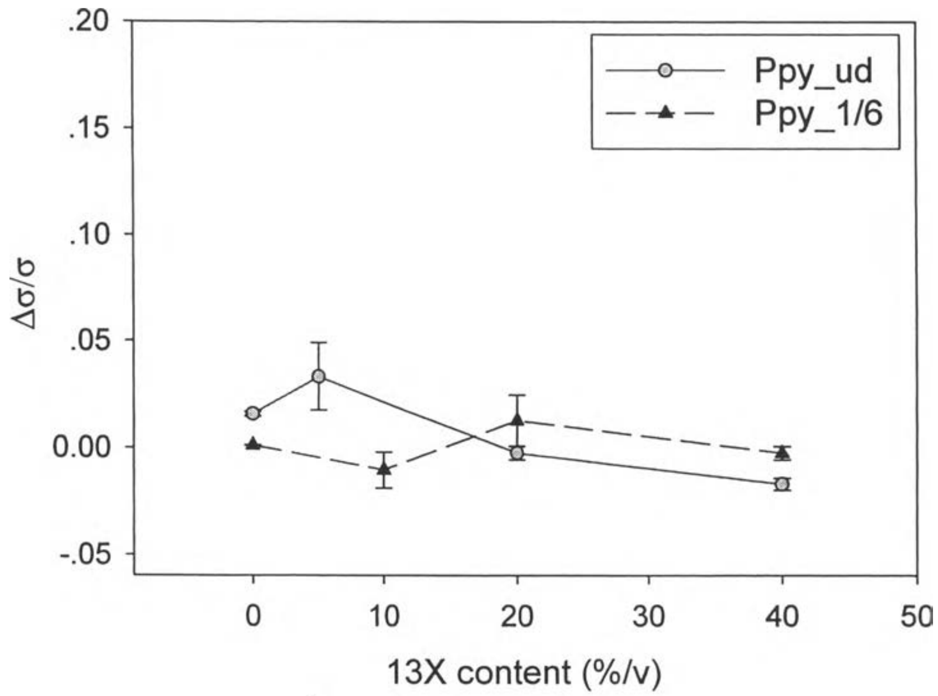


Figure P15 The electrical response of Ppy_ud and Ppy_1:6 to methane at various 13X contents.

The electrical response of polypyrrole to the target gases, the sensitivity, is calculated by following equation (Densakulprasert, 2003):

$$\text{Sensitivity} = (\sigma_g - \sigma_{N2})/\Delta\sigma_{N2} \qquad (P1)$$

where σ_g is specific conductivity of Ppy exposed to target gases, and σ_{N2} is specific conductivity of Ppy exposed to N_2 at the previous target-gas exposure step.

We will assume that the polymer will respond to a target gas if the sensitivity is either greater than 0.05 or less than -0.05.

From Table P18, it shows that Ppy and its composite do not response to 10% methane due to the methane molecule characteristics. Methane is a tetrahedral molecule (Atkins, 1995) causing no interaction with polypyrrole.

Table P18 The Ppy/zeolite13X samples and their % apparent doping levels (DL), % degrees of crystallinity (DC), the induction times (t_i), the recovery time (t_{re}), electrical conductivity values in air, electrical conductivity values in N_2, electrical conductivity values in methane and the electrical response ($\Delta\sigma/\sigma_{N2}$) upon exposed to 10 %methane /NO_2 mixture at 28 °C, at atmospheric pressure

sample	DL	DC	t_i^e (min)	t_{re}^f (min)	σ (S/cm) air	σ (S/cm) N_2	σ (S/cm) Methane	Δσ (S/cm)	$\Delta\sigma/\Delta\sigma_{N2}$
Ppy_ud	0.26	54.3	80	5	(4.68±2.48) x 10^{-1}	(3.96 ±3.36) x 10^{-1}	(3.97±3.44) x 10^{-1}	(6.00±4.78) x10^{-3}	(1.57±0.11) x 10^{-2}
Ppy_ud/13X_5	0.26	54.3	26	17	(1.12 ±0.49) x 10^{-1}	(1.07± 0.52) x 10^{-1}	(1.09 ±0.47) x 10^{-1}	(2.06±4.49) x 10^{-3}	(3.32±5.80) x 10^{-2}
Ppy_ud/13X_20	0.26	54.3	46±26	10	(8.62±.01) x 10^{-2}	(6.19 ±3.02) x 10^{-2}	(6.17 ±0.03.00) x 10^{-2}	(-2.05±2.70) x 10^{-4}	(-2.56±3.11) x 10^{-3}
Ppy_ud/13X_40	0.26	54.3	42	13	(1.09 ±0.34) x 10^{-2}	(2.82±1.37) x 10^{-3}	(2.78±1.35) x 10^{-3}	(4.62±1.56) x 10^{-5}	(-1.71±0.29) x 10^{-2}
Ppy_1:6	0.51	80.4	23±3	5	3.01±2.08	3.17±2.31	3.17±2.30	(3.31±2.22) x 10^{-3}	(1.06±0.01) x 10^{-3}
Ppy_1:6/13X_10	0.51	80.4	15	-	1.40±0.23	1.41±0.24	1.40±0.22	(-1.58±1.44) x 10^{-2}	(-1.05±0.00.84) x10^{-2}
Ppy_1:6/13X_20	0.51	80.4	28	12	1.00 ±0.13	(9.72±1.59) x 10^{-1}	(9.80 ±1.50) x 10^{-1}	(-2.05±2.70) x 10^{-4}	(1.26±1.20) x 10^{-2}
Ppy_1:6/13X_40	0.51	80.4	29±1	17±3	(4.79 ±0.20) x 10^{-1}	(2.58±0.20) x 10^{-1}	(2.54±0.20) x 10^{-1}	(-3.60±0.06) x 10^{-3}	(-2.56±3.11) x 10^{-3}

[e] t_i is the t_r at the target gas exposure step, [f] t_{re} is the t_r at the evacuation step.

Appendix Q The Specific Conductivity of Ppy When Exposed to CO_2

Table Q1 Specific conductivity and sensitivity of Ppy_ud(1) when exposed to 10% CO_2/N_2

Ppy_ud (1)		thickness	0.163 mm
K	11.23	T_r^a	25 °C
RH (%)	55	T_c^b	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma^*/\sigma_{N2}$
air	5.33E-02	2.87E-02	24	-	1.17E+00
vacuum	2.39E-02	-7.60E-04	17	12	-3.09E-02
N_2	3.17E-02	7.05E-03	20	8	2.86E-01
vacuum	2.50E-02	4.01E-04	15	11	1.63E-02
N_2	2.58E-02	1.16E-03	41	14	4.70E-02
vacuum	2.51E-02	5.08E-04	8	-	2.06E-02
N_2	2.59E-02	1.29E-03	83	60	5.24E-02
vacuum	2.22E-02	-2.43E-03	4	-	-9.86E-02
N_2	2.46E-02	0.00E+00	39	-	0.00E+00
vacuum	2.53E-02	6.99E-04	3	-	2.84E-02
CO_2	2.43E-02	-2.84E-04	41	25	-1.16E-02
vacuum	2.42E-02	-3.81E-04	13	-	-1.55E-02
N_2	2.49E-02	2.83E-04	45	-	1.15E-02
vacuum	2.15E-02	-3.07E-03	20	-	-1.25E-01
CO_2	2.47E-02	1.05E-04	59	31	4.28E-03
vacuum	2.56E-02	1.04E-03	15	11	4.21E-02
N_2	2.57E-02	1.05E-03	31	-	4.25E-02
vacuum	2.44E-02	-2.18E-04	6	-	-8.87E-03
CO_2	2.45E-02	-7.16E-05	27	-	-2.91E-03
vacuum	2.42E-02	-4.10E-04	12	-	-1.67E-02
N_2	2.21E-02	-2.56E-03	25	21	-1.04E-01

* $\Delta\sigma = \sigma_{CO2} - \sigma_{N2(4)}$

Table Q2 Specific conductivity and sensitivity of Ppy_ud(2) when exposed to 10% CO_2/N_2

Ppy_ud (2)		thickness	0.176 mm
K	11.23	T_r^a	25 °C
RH (%)	56	T_c^b	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.68E-02	1.18E-02	23	-	7.84E-01
vacuum	1.48E-02	-1.61E-04	20	20	-1.07E-02
N_2	1.96E-02	4.63E-03	67	62	3.08E-01
vacuum	1.33E-02	-1.72E-03	11	9	-1.15E-01
N_2	1.85E-02	3.47E-03	144	119	2.31E-01
vacuum	1.52E-02	2.20E-04	9	10	1.47E-02
N_2	1.60E-02	1.03E-03	24	-	6.83E-02
vacuum	1.35E-02	-1.54E-03	8	6	-1.03E-01
N_2	1.50E-02	0.00E+00	35	30	0.00E+00
vacuum	1.43E-02	-6.90E-04	18	-	-4.60E-02
CO_2	1.46E-02	-4.03E-04	39	-	-2.69E-02
vacuum	1.45E-02	-4.80E-04	13	10	-3.20E-02
N_2	1.50E-02	7.64E-07	33	15	5.09E-05
vacuum	1.39E-02	-1.09E-03	23	14	-7.28E-02
CO_2	1.48E-02	-1.74E-04	38	-	-1.16E-02
vacuum	1.43E-02	-6.72E-04	9	-	-4.47E-02
N_2	1.48E-02	-2.23E-04	30	23	-1.49E-02
vacuum	1.49E-02	-1.49E-04	11	-	-9.89E-03
CO_2	1.52E-02	2.18E-04	34	13	1.45E-02
vacuum	1.47E-02	-3.21E-04	12	-	-2.14E-02
N_2	1.45E-02	-5.48E-04	42	-	-3.65E-02

Table Q3 Specific conductivity and sensitivity of Ppy_1:6(1) when exposed to 10% CO_2/N_2

Ppy_1:6 (1)		thickness	0.155 mm
K	10.66	T_r[a]	27 °C
RH (%)	60	T_c[b]	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	7.44E-01	4.03E-01	32	-	1.18E+00
vacuum	4.68E-01	1.27E-01	17	14	3.71E-01
N_2	4.96E-01	1.54E-01	40	28	4.52E-01
vacuum	4.05E-01	6.33E-02	16	10	1.85E-01
N_2	4.44E-01	1.02E-01	49	29	2.99E-01
vacuum	3.35E-01	-6.04E-03	53	48	-1.77E-02
N_2	3.43E-01	1.91E-03	30	24	5.60E-03
vacuum	3.31E-01	-1.04E-02	16	10	-3.06E-02
N_2	3.41E-01	0.00E+00	51	24	0.00E+00
vacuum	3.32E-01	-9.63E-03	21	14	-2.82E-02
CO_2	3.38E-01	-3.92E-03	42	13	-1.15E-02
vacuum	3.14E-01	-2.77E-02	15	15	-8.11E-02
N_2	3.21E-01	-2.05E-02	12	-	-5.99E-02
vacuum	3.20E-01	-2.11E-02	8	-	-6.18E-02
CO_2	3.28E-01	-1.36E-02	88	32	-3.99E-02
vacuum	3.19E-01	-2.23E-02	13	10	-6.53E-02
N_2	3.17E-01	-2.49E-02	32	-	-7.30E-02
vacuum	3.09E-01	-3.26E-02	15	8	-9.56E-02
CO_2	3.12E-01	-2.98E-02	31	12	-8.72E-02
vacuum	3.17E-01	-2.49E-02	13	-	-7.29E-02
N_2	3.16E-01	-2.56E-02	48	6	-7.49E-02

Table Q4 Specific conductivity and sensitivity of Ppy_1:6(2) when exposed to 10% CO_2/N_2

Ppy_1:6 (2)		thickness	0.163 mm
K	11.23	T_r[a]	27 °C
RH (%)	60	T_c[b]	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	9.09E-01	7.43E-02	32	-	8.90E-02
vacuum	8.48E-01	1.28E-02	17	-	1.53E-02
N_2	8.62E-01	2.71E-02	40	-	3.25E-02
vacuum	8.21E-01	-1.38E-02	16	5	-1.66E-02
N_2	8.46E-01	1.08E-02	49	21	1.29E-02
vacuum	8.12E-01	-2.33E-02	53	6	-2.79E-02
N_2	8.23E-01	-1.14E-02	30	-	-1.37E-02
vacuum	8.46E-01	1.07E-02	16	-	1.28E-02
N_2	8.35E-01	0.00E+00	51	24	0.00E+00
vacuum	8.40E-01	4.94E-03	21	-	5.92E-03
CO_2	8.34E-01	-8.05E-04	36	-	-9.64E-04
vacuum	8.07E-01	-2.79E-02	15	6	-3.34E-02
N_2	8.08E-01	-2.65E-02	12	9	-3.17E-02
vacuum	8.24E-01	-1.06E-02	8	-	-1.27E-02
CO_2	8.17E-01	-1.78E-02	88	6	-2.13E-02
vacuum	8.20E-01	-1.49E-02	13	-	-1.78E-02
N_2	8.18E-01	-1.69E-02	32	-	-2.03E-02
vacuum	8.14E-01	-2.13E-02	15	-	-2.55E-02
CO_2	8.02E-01	-3.28E-02	31	-	-3.92E-02
vacuum	8.11E-01	-2.43E-02	13	-	-2.91E-02
N_2	8.20E-01	-1.51E-02	48	-	-1.81E-02

Table Q5 Specific conductivity of Ppy when exposed to air, N_2, and methane and the electrical response of Ppy to 10% CO_2

	σ (S/cm)			$\Delta\sigma/\Delta\sigma_{N2}$
	air	N_2	CO_2	
Ppy_ud	5.33E-02	2.46E-02	2.43E-02	-1.16E-02
	2.68E-02	1.50E-02	1.46E-02	-2.69E-02
average	4.01E-02	1.98E-02	1.95E-02	-1.93E-02
SD	1.87E-02	6.79E-03	6.86E-03	1.08E-02
Ppy_1:6	7.44E-01	3.41E-01	3.38E-01	-1.15E-02
	9.09E-01	8.35E-01	8.34E-01	-9.64E-04
average	8.27E-01	5.88E-01	5.86E-01	-6.23E-03
SD	1.17E-01	3.49E-01	3.51E-01	7.45E-03

There is no electrical response of Ppy to 10% CO_2 as shown in Table Q5 because CO_2 is a linearly symmetric molecule and its dipole moment is 0 Cm (Atkins, 1995); hence interaction with polypyrrole is not expected.

Appendix R The Specific Conductivity of Ppy When Exposed to CO

Table R1 Specific conductivity and sensitivity of Ppy_ud(1) when exposed to 1000 ppm CO

Ppy_ud (1)		thickness	0.173 mm
K	10.66	T_r	30 °C
RH (%)	60	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	Δσ/σ
air	1.96E-01	2.87E-02	13	-	1.72E-01
vacuum	1.50E-01	-1.72E-02	20	16	-1.03E-01
N_2	1.78E-01	1.02E-02	67	45	6.11E-02
vacuum	1.38E-01	-2.97E-02	26	11	-1.78E-01
N_2	1.50E-01	-1.78E-02	62	10	-1.06E-01
vacuum	1.24E-01	-4.36E-02	21	17	-2.60E-01
N_2	1.41E-01	-2.65E-02	40	7	-1.58E-01
vacuum	1.49E-01	-1.88E-02	15	12	-1.12E-01
N2	1.67E-01	0.00E+00	49	9	0.00E+00
vacuum	1.46E-01	-2.18E-02	9	8	-1.30E-01
CO	1.60E-01	-6.95E-03	58	10	-4.15E-02
vacuum	1.30E-01	-3.70E-02	10	8	-2.21E-01
N_2	1.38E-01	-2.95E-02	31	17	-1.76E-01
vacuum	1.03E-01	-6.42E-02	14	11	-3.84E-01
CO	1.21E-01	-4.66E-02	26	19	-2.78E-01
vacuum	1.04E-01	-6.29E-02	11	8	-3.76E-01
N_2	1.02E-01	-6.53E-02	45	-	-3.90E-01
vacuum	8.39E-02	-8.35E-02	12	7	-4.99E-01
CO	9.59E-02	-7.14E-02	29	9	-4.27E-01
vacuum	8.06E-02	-8.68E-02	6	-	-5.18E-01
N_2	9.38E-02	-7.36E-02	71	47	-4.40E-01

Table R2 Specific conductivity and sensitivity of Ppy_ud(2) when exposed to 1000 ppm CO

Ppy_ud (2)		thickness	0.175 mm
K	11.23	T_r	30 °C
RH (%)	60	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	Δσ/σ
air	2.66E-01	8.42E-02	13	-	4.63E-01
vacuum	1.72E-01	-1.01E-02	20	13	-5.56E-02
N_2	1.89E-01	6.78E-03	67	50	3.73E-02
vacuum	1.69E-01	-1.29E-02	26	8	-7.09E-02
N_2	1.86E-01	3.95E-03	62	58	2.17E-02
vacuum	1.68E-01	-1.36E-02	21	8	-7.47E-02
N_2	1.85E-01	2.80E-03	40	36	1.54E-02
vacuum	1.67E-01	-1.44E-02	15	6	-7.92E-02
N2	1.82E-01	0.00E+00	49	46	0.00E+00
vacuum	1.67E-01	-1.48E-02	9	10	-8.14E-02
CO	1.81E-01	-8.29E-04	58	50	-4.56E-03
vacuum	1.68E-01	-1.42E-02	10	6	-7.81E-02
N_2	1.73E-01	-8.57E-03	31	24	-4.71E-02
vacuum	1.66E-01	-1.60E-02	14	8	-8.82E-02
CO	1.74E-01	-8.04E-03	26	20	-4.42E-02
vacuum	1.67E-01	-1.50E-02	11	8	-8.25E-02
N_2	1.74E-01	-7.37E-03	45	42	-4.05E-02
vacuum	1.66E-01	-1.58E-02	12	8	-8.69E-02
CO	1.72E-01	-9.87E-03	29	28	-5.42E-02
vacuum	1.65E-01	-1.71E-02	6	6	-9.41E-02
N_2	1.76E-01	-6.07E-03	71	58	-3.34E-02

Table R3 Specific conductivity and sensitivity of Ppy_1:6(1) when exposed to 1000 ppm CO

Ppy_1:6 (1)		thickness	0.182 mm
K	10.66	T_r	31 °C
RH (%)	65	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma^c/\sigma$
air	1.07E+00	1.54E-01	16	-	1.69E-01
vacuum	8.14E-01	-9.79E-02	17	-	-1.07E-01
N_2	8.64E-01	-4.80E-02	16	8	-5.26E-02
vacuum	7.40E-01	-1.71E-01	12	7	-1.88E-01
N_2	8.89E-01	-2.26E-02	57	28	-2.48E-02
vacuum	7.18E-01	-1.94E-01	15	9	-2.13E-01
N_2	9.27E-01	1.55E-02	84	60	1.70E-02
vacuum	7.63E-01	-1.49E-01	9	6	-1.63E-01
N2	9.12E-01	0.00E+00	60	40	0.00E+00
vacuum	5.91E-01	-3.21E-01	24	6	-3.52E-01
CO	8.54E-01	-5.78E-02	40	25	-6.34E-02
vacuum	5.99E-01	-3.13E-01	12	5	-3.43E-01
N_2	8.82E-01	-2.98E-02	39	17	-3.27E-02
vacuum	6.57E-01	-2.55E-01	20	13	-2.79E-01
CO	7.76E-01	-1.35E-01	52	34	-1.49E-01
vacuum	6.04E-01	-3.08E-01	12	10	-3.37E-01
N_2	7.01E-01	-2.11E-01	41	32	-2.31E-01
vacuum	6.70E-01	-2.42E-01	23	10	-2.66E-01
CO	7.01E-01	-2.11E-01	34	-	-2.31E-01
vacuum	6.98E-01	-2.14E-01	17	-	-2.35E-01
N_2	6.94E-01	-2.18E-01	23	-	-2.39E-01

Table R4 Specific conductivity and sensitivity of Ppy_1:6(2) when exposed to 1000 ppm CO

Ppy_1:6 (2)		thickness	0.165 mm
K	11.23	T_r	31 °C
RH (%)	65	T_c	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma^c/\sigma$
air	2.16E+00	5.44E-01	16	-	3.36E-01
vacuum	1.67E+00	5.52E-02	17	10	3.41E-02
N_2	1.68E+00	5.81E-02	16	-	3.59E-02
vacuum	1.62E+00	-2.20E-03	12	9	-1.36E-03
N_2	1.66E+00	4.13E-02	57	47	2.55E-02
vacuum	1.59E+00	-3.23E-02	15	10	-2.00E-02
N_2	1.65E+00	2.69E-02	84	-	1.66E-02
vacuum	1.56E+00	-5.54E-02	9	9	-3.42E-02
N2	1.62E+00	0.00E+00	60	14	0.00E+00
vacuum	1.51E+00	-1.07E-01	24	13	-6.61E-02
CO	1.54E+00	-7.49E-02	40	20	-4.62E-02
vacuum	1.49E+00	-1.28E-01	12	-	-7.93E-02
N_2	1.51E+00	-1.10E-01	39	-	-6.79E-02
vacuum	1.47E+00	-1.47E-01	20	-	-9.05E-02
CO	1.50E+00	-1.17E-01	52	13	-7.21E-02
vacuum	1.47E+00	-1.52E-01	12	-	-9.37E-02
N_2	1.49E+00	-1.29E-01	41	6	-7.96E-02
vacuum	1.43E+00	-1.87E-01	23	6	-1.16E-01
CO	1.47E+00	-1.46E-01	34	-	-9.01E-02
vacuum	1.39E+00	-2.30E-01	17	8	-1.42E-01
N_2	1.43E+00	-1.92E-01	23	6	-1.18E-01

Table R5 Specific conductivity of Ppy when exposed to air, N_2, and methane and the electrical response of Ppy to 1000 ppm CO

	σ (S/cm)			$\Delta\sigma/\Delta\sigma_{N2}$
	air	N_2	CO	
Ppy_ud	1.96E-01	1.67E-01	1.60E-01	-4.15E-02
	2.66E-01	1.82E-01	1.81E-01	-4.56E-03
average	2.31E-01	1.75E-01	1.71E-01	-2.30E-02
SD	4.95E-02	1.06E-02	1.48E-02	2.61E-02
Ppy_1:6	1.07E+00	9.12E-01	8.54E-01	-6.34E-02
	2.16E+00	1.62E+00	1.54E+00	-4.62E-02
average	1.62E+00	1.27E+00	1.20E+00	-5.48E-02
SD	7.71E-01	5.01E-01	4.85E-01	1.22E-02

Appendix S The Specific Conductivity of Ppy When Expose to SO_2

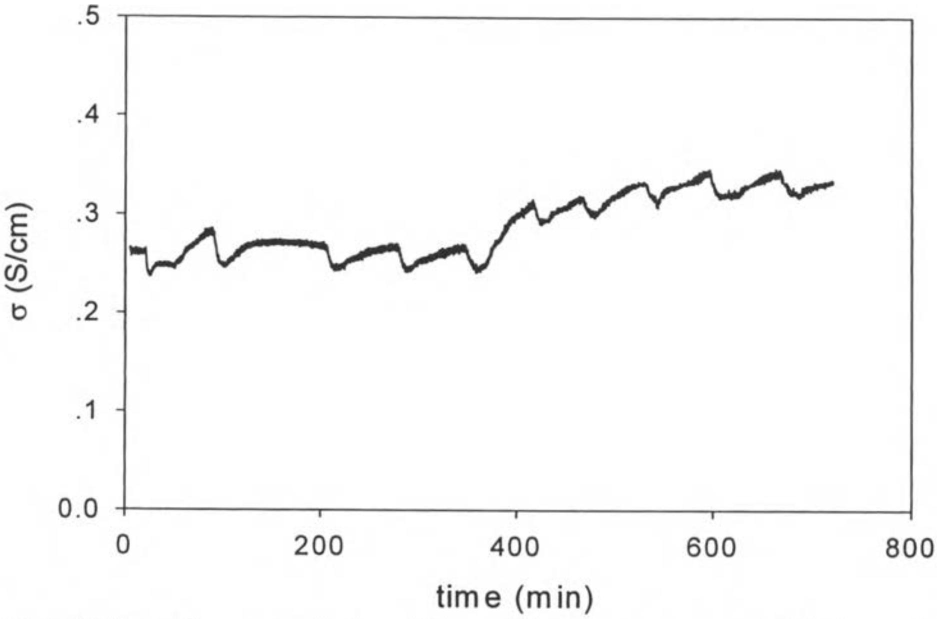


Figure S1 Specific conductivity of Ppy_ud(1) when exposed to 1000 ppm SO_2.

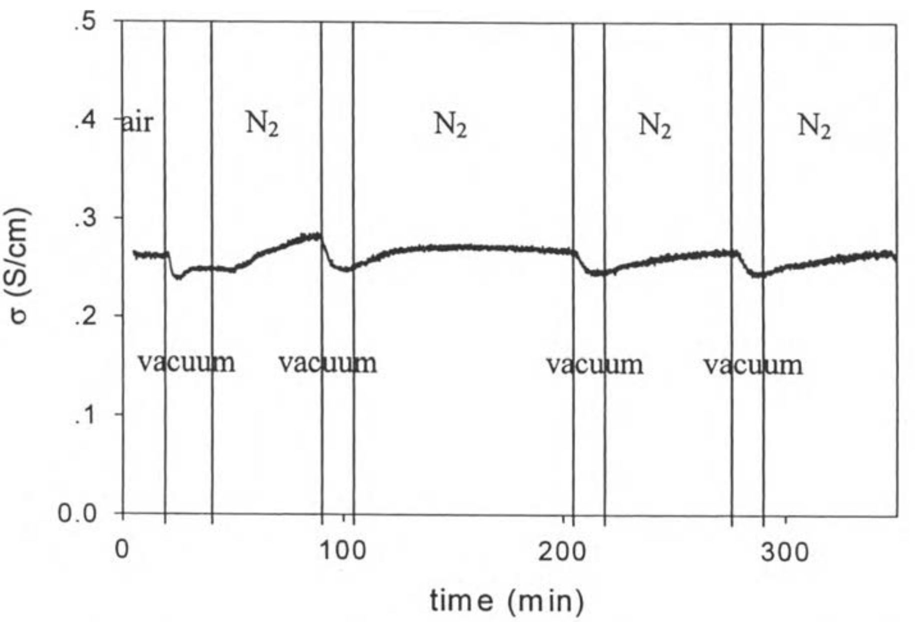


Figure S2 Specific conductivity of Ppy_ud(1) when exposed to 1000 ppm SO_2.

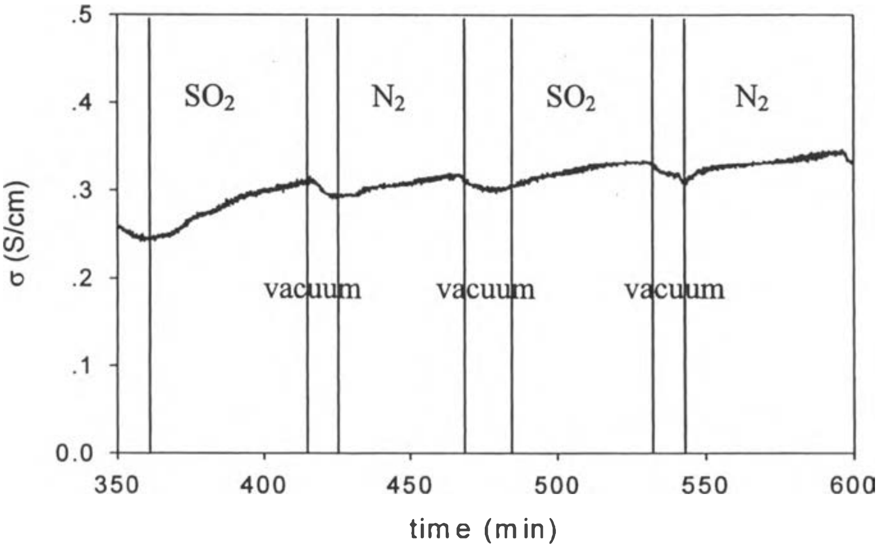


Figure S3 Specific conductivity of Ppy_ud(1) when exposed to 1000 ppm SO_2.

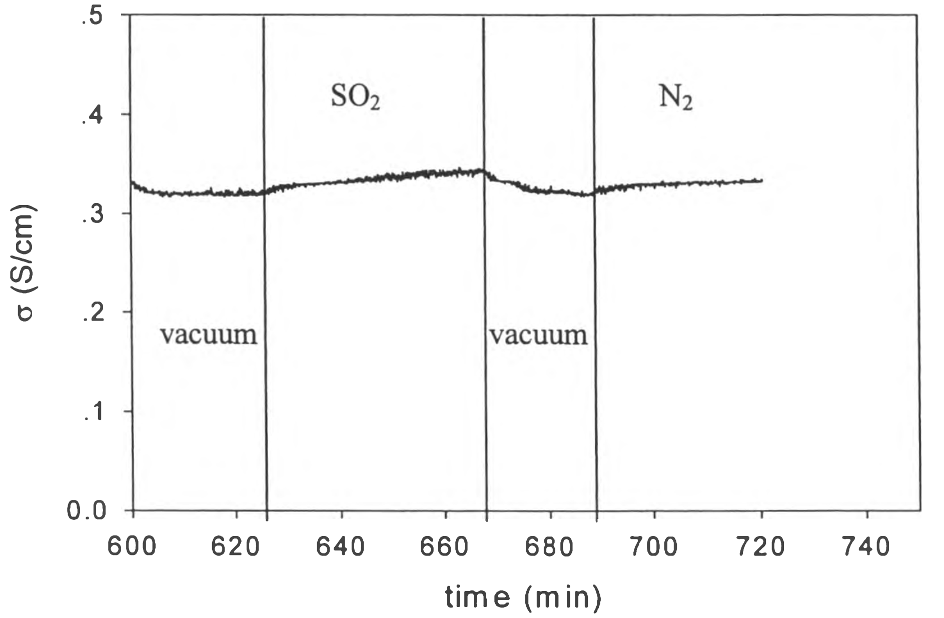


Figure S4 Specific conductivity of Ppy_ud(1) when exposed to 1000 ppm SO_2.

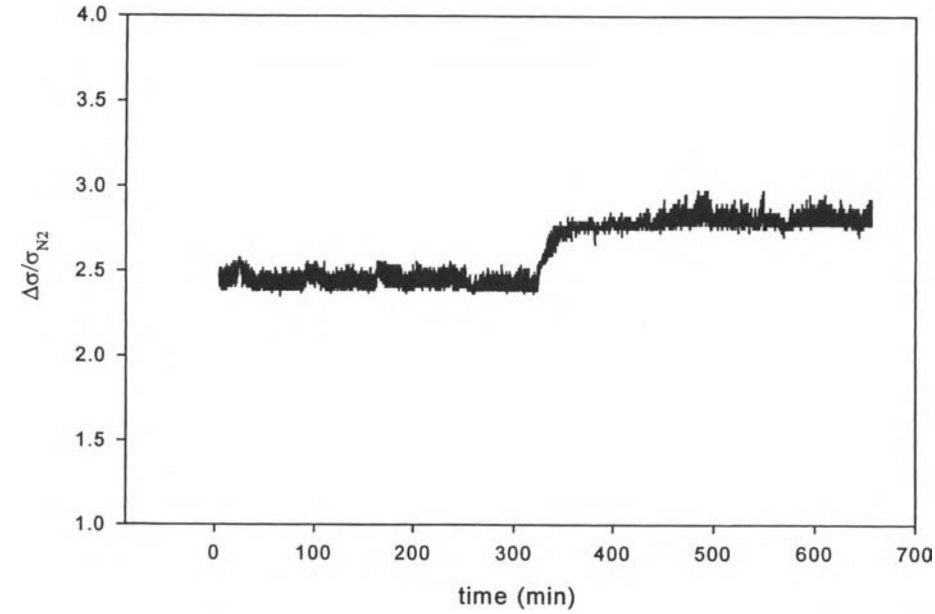


Figure S5 Specific conductivity of Ppy_1:6(1) when exposed to 1000 ppm SO_2.

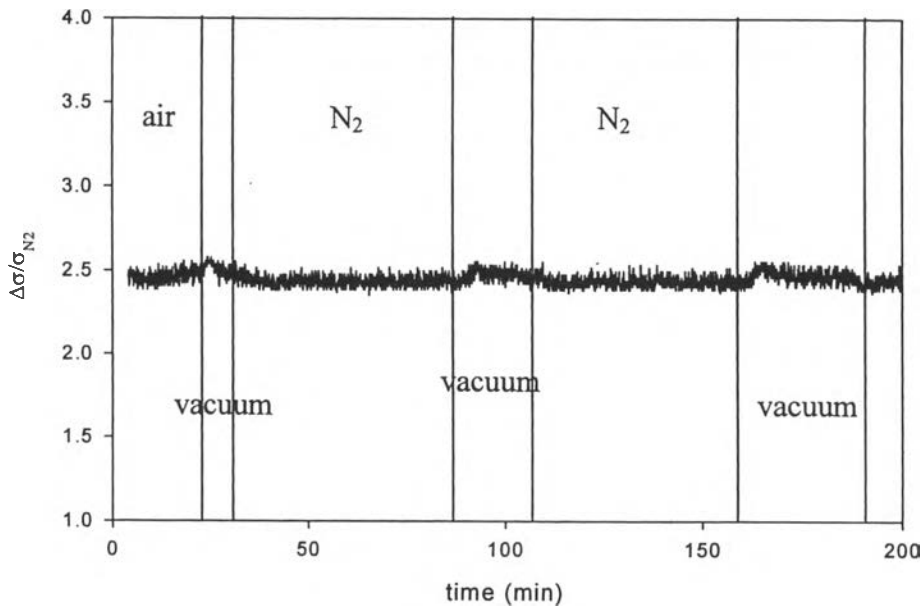


Figure S6 Specific conductivity of Ppy_1:6(1) when exposed to 1000 ppm SO_2.

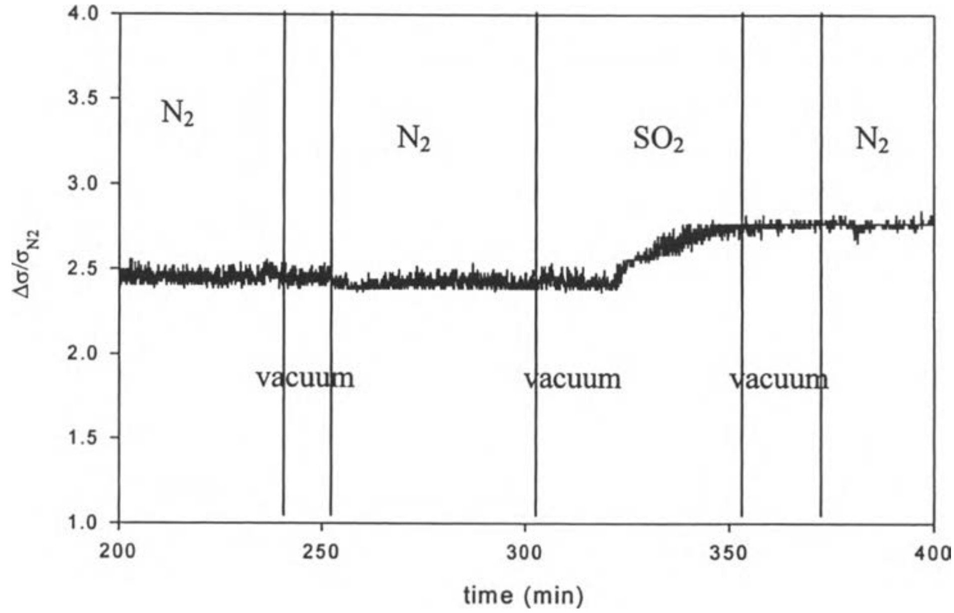


Figure S7 Specific conductivity of Ppy_1:6(1) when exposed to 1000 ppm SO_2.

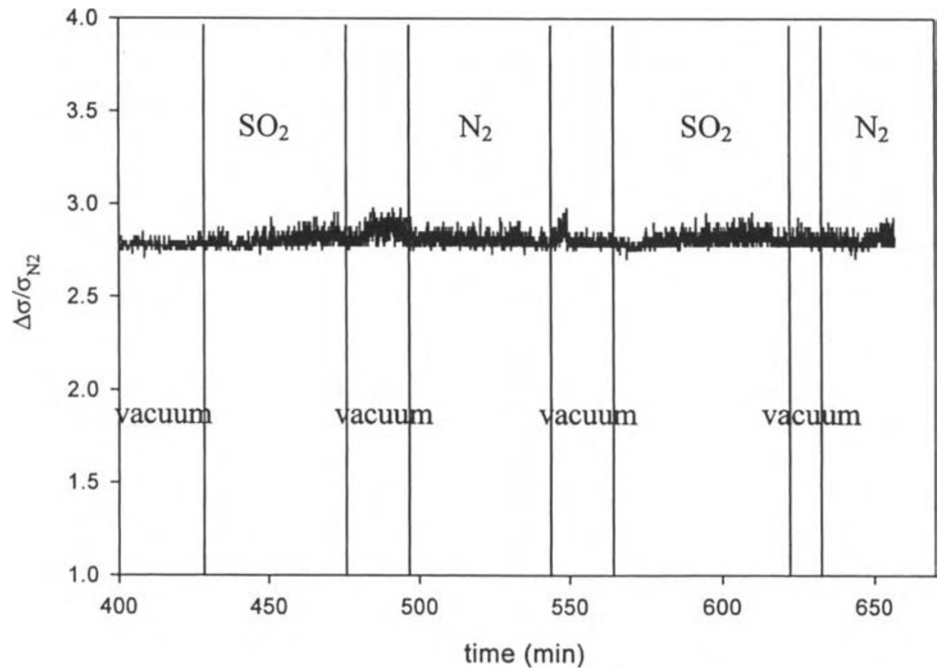


Figure S8 Specific conductivity of Ppy_1:6(1) when exposed to 1000 ppm SO_2.

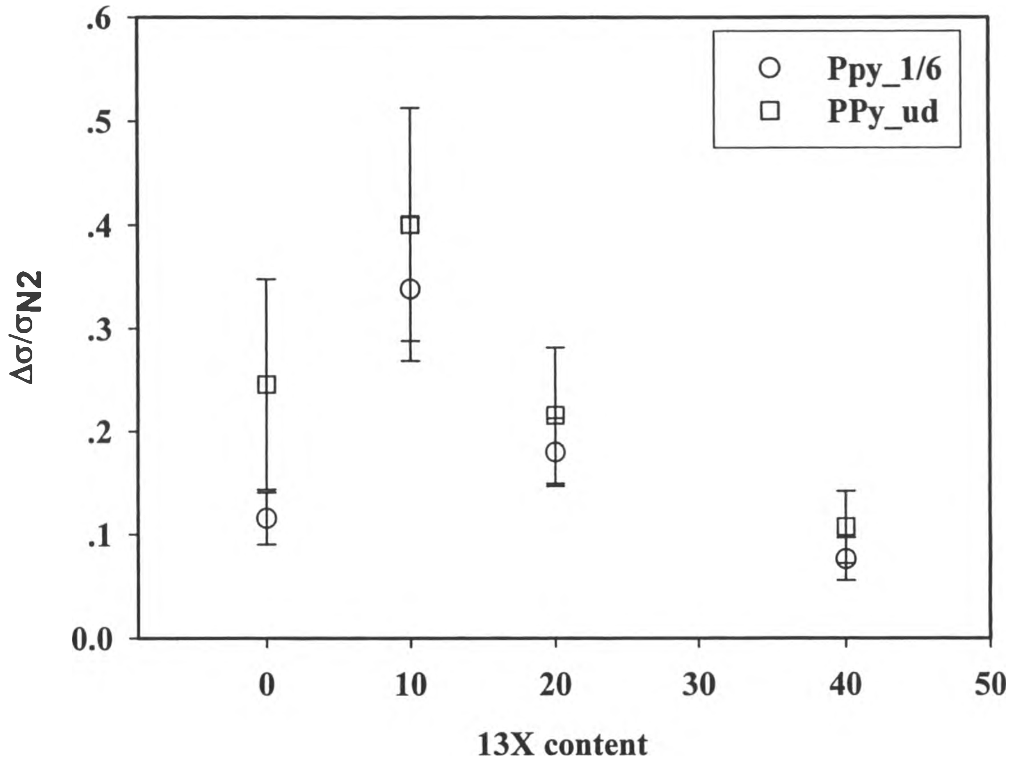


Figure S9 The electrical response of Ppy/13X composite of various 13X content.

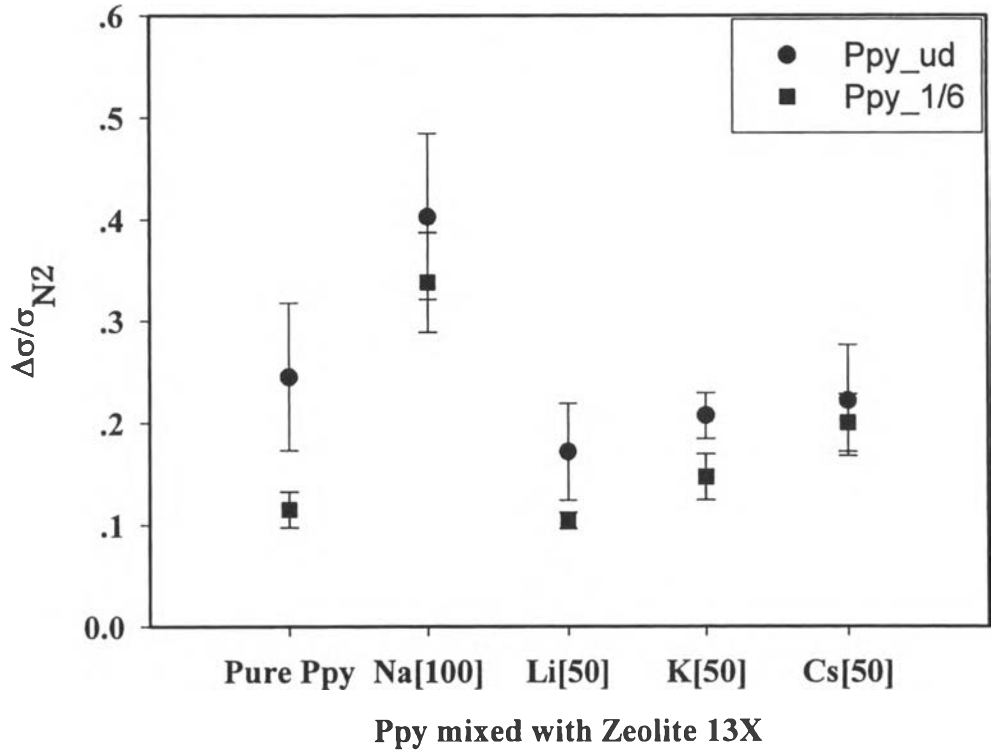


Figure S10 The electrical response of Ppy/13X composites of various cation types: Na[100], Li[50], K[50], and Cs[50] to 1000 ppm SO_2 .

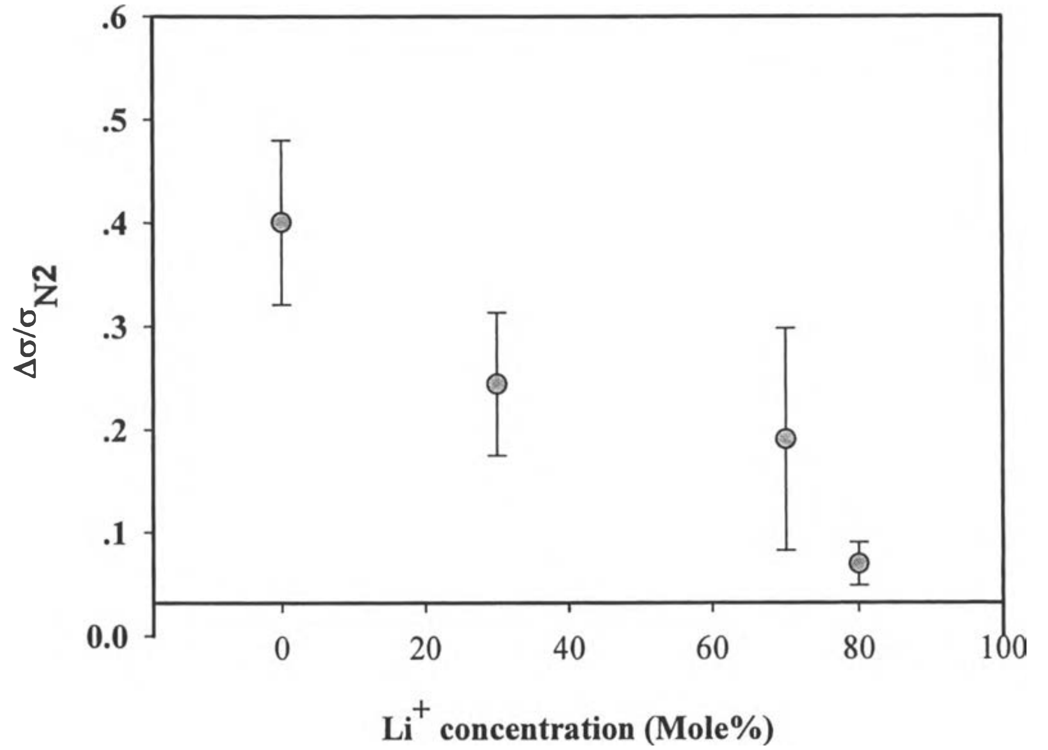


Figure S11 The electrical response of Ppy/13X composites of various Li^{+} concentrations to 1000 ppm SO_2.

Table S1 Specific conductivity and sensitivity of Ppy_ud(1) when exposed to 1000 ppm SO_2

Ppy_ud (1)		thickness	0.174 mm
K	10.66	T_r^a	32 °C
RH (%)	58	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma / \sigma_{N2}$
air	6.87E-01	4.07E-01	16	-	1.45E+00
vacuum	1.97E-01	-8.33E-02	27	24	-2.97E-01
N_2	3.10E-01	3.02E-02	39	35	1.08E-01
vacuum	2.49E-01	-3.09E-02	8	8	-1.10E-01
N_2	3.65E-01	8.49E-02	100	80	3.03E-01
vacuum	2.46E-01	-3.35E-02	16	12	-1.20E-01
N_2	3.29E-01	4.86E-02	54	50	1.74E-01
vacuum	2.18E-01	-6.17E-02	12	10	-2.21E-01
N2	2.80E-01	0.00E+00	52	54	0.00E+00
vacuum	2.35E-01	-4.49E-02	14	12	-1.61E-01
SO_2	3.69E-01	8.90E-02	47	48	3.18E-01
vacuum	2.51E-01	-2.85E-02	11	10	-1.02E-01
N_2	2.80E-01	-1.21E-04	31	32	-4.33E-04
vacuum	2.72E-01	-8.20E-03	13	5	-2.93E-02
SO_2	2.99E-01	1.89E-02	45	44	6.76E-02
vacuum	2.49E-01	-3.10E-02	13	9	-1.11E-01
N_2	2.73E-01	-6.49E-03	48	33	-2.32E-02
vacuum	2.65E-01	-1.48E-02	25	10	-5.29E-02
SO_2	2.75E-01	-4.52E-03	39	38	-1.61E-02
vacuum	2.73E-01	-6.82E-03	17	-	-2.44E-02
N_2	2.62E-01	-1.75E-02	31	23	-6.27E-02

Table S2 Specific conductivity and sensitivity of Ppy_ud(2) when exposed to 1000 ppm SO_2

Ppy_ud (2)		thickness	0.167 mm
K	11.23	T_r^a	32 °C
RH (%)	58	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.62E-01	7.13E-04	16	-	2.73E-03
vacuum	2.48E-01	-1.34E-02	27	-	-5.13E-02
N_2	2.77E-01	1.62E-02	39	30	6.19E-02
vacuum	2.49E-01	-1.26E-02	8	7	-4.83E-02
N_2	2.69E-01	7.83E-03	100	23	3.00E-02
vacuum	2.48E-01	-1.28E-02	16	7	-4.90E-02
N_2	2.65E-01	3.96E-03	54	37	1.52E-02
vacuum	2.47E-01	-1.45E-02	12	5	-5.54E-02
N2	2.61E-01	0.00E+00	52	40	0.00E+00
vacuum	2.47E-01	-1.41E-02	14	10	-5.39E-02
SO_2	3.06E-01	4.52E-02	47	40	1.73E-01
vacuum	2.96E-01	3.51E-02	11	6	1.34E-01
N_2	3.14E-01	5.24E-02	31	28	2.01E-01
vacuum	3.01E-01	4.02E-02	13	7	1.54E-01
SO_2	3.32E-01	7.05E-02	45	32	2.70E-01
vacuum	3.16E-01	5.46E-02	13	10	2.09E-01
N_2	3.39E-01	7.83E-02	48	35	3.00E-01
vacuum	3.20E-01	5.89E-02	25	6	2.26E-01
SO_2	3.34E-01	7.30E-02	39	29	2.79E-01
vacuum	3.22E-01	6.13E-02	17	8	2.35E-01
N_2	3.33E-01	7.14E-02	31	18	2.73E-01

Table S3 Specific conductivity and sensitivity of Ppy_1:6(1) when exposed to 1000 ppm SO_2

Ppy_1:6 (1)		thickness	0.182 mm
K	10.66	T_r^a	33 °C
RH (%)	62	T_c^b	29 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma / \sigma_{N2}$
air	6.66E+00	3.48E+00	17	-	1.10E+00
vacuum	3.82E+00	6.36E-01	14	10	2.00E-01
N_2	4.02E+00	8.39E-01	47	44	2.64E-01
vacuum	3.48E+00	3.01E-01	16	7	9.47E-02
N_2	3.58E+00	4.00E-01	48	40	1.26E-01
vacuum	2.89E+00	-2.93E-01	24	10	-9.23E-02
N_2	3.17E+00	-1.02E-02	47	30	-3.20E-03
vacuum	3.09E+00	-8.91E-02	18	-	-2.80E-02
N2	3.18E+00	0.00E+00	39	20	0.00E+00
vacuum	3.06E+00	-1.16E-01	20	15	-3.64E-02
SO_2	3.49E+00	3.10E-01	38	22	9.76E-02
vacuum	2.74E+00	-4.35E-01	14	10	-1.37E-01
*N_2	2.87E+00	-3.09E-01	29	18	-9.73E-02
vacuum	2.89E+00	-2.91E-01	21	-	-9.14E-02
SO_2	2.87E+00	-3.14E-01	36	17	-9.88E-02
vacuum	2.63E+00	-5.47E-01	16	10	-1.72E-01
N_2	8.08E-01	-2.37E+00	42	-	-7.46E-01
vacuum	3.66E-01	-2.81E+00	25	-	-8.85E-01
SO_2	5.53E-01	-2.63E+00	49	-	-8.26E-01
vacuum	2.24E-01	-2.96E+00	21	-	-9.30E-01
N_2	3.83E-01	-2.80E+00	14	6	-8.79E-01

* The sample was broken at this step.

Table S4 Specific conductivity and sensitivity of Ppy_1:6(2) when exposed to 1000 ppm SO_2

Ppy_1:6 (2)		thickness	0.165 mm
K	11.23	T_r^a	33 °C
RH (%)	62	T_c^b	29 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.46E+00	3.07E-02	17	-	1.26E-02
vacuum	2.47E+00	3.60E-02	14	-	1.48E-02
N_2	2.43E+00	4.94E-03	47	-	2.04E-03
vacuum	2.48E+00	5.07E-02	16	5	2.09E-02
N_2	2.44E+00	7.84E-03	48	-	3.23E-03
vacuum	2.47E+00	4.02E-02	24	10	1.65E-02
N_2	2.45E+00	2.27E-02	47	12	9.35E-03
vacuum	2.46E+00	2.77E-02	18	-	1.14E-02
N2	2.43E+00	0.00E+00	39	-	0.00E+00
vacuum	2.43E+00	3.77E-03	20	-	1.55E-03
SO_2	2.75E+00	3.23E-01	38	25	1.33E-01
vacuum	2.77E+00	3.40E-01	14	-	1.40E-01
N_2	2.77E+00	3.40E-01	29	-	1.40E-01
vacuum	2.78E+00	3.47E-01	21	-	1.43E-01
SO_2	2.82E+00	3.93E-01	36	12	1.62E-01
vacuum	2.86E+00	4.35E-01	16	-	1.79E-01
N_2	2.81E+00	3.82E-01	42	-	1.57E-01
vacuum	2.79E+00	3.65E-01	25	-	1.50E-01
SO_2	2.82E+00	3.94E-01	49	15	1.62E-01
vacuum	2.80E+00	3.75E-01	21	-	1.55E-01
N_2	2.82E+00	3.92E-01	14	-	1.61E-01

Table S5 Specific conductivity and sensitivity of Ppy_ud/13X-Na[100]_10(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Na[100]_10 (1)		thickness	0.173 mm
K	10.66	T_r^a	32 °C
RH (%)	65	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	5.15E-02	2.93E-02	14	-	1.32E+00
vacuum	2.41E-02	1.88E-03	16	7	8.46E-02
N_2	3.12E-02	9.01E-03	41	33	4.06E-01
vacuum	2.31E-02	9.22E-04	18	15	4.16E-02
N_2	2.58E-02	3.59E-03	39	36	1.62E-01
vacuum	2.21E-02	-4.43E-05	14	10	-2.00E-03
N_2	2.50E-02	2.77E-03	57	55	1.25E-01
vacuum	2.16E-02	-6.24E-04	6	6	-2.81E-02
N2	2.22E-02	0.00E+00	33	-	0.00E+00
vacuum	2.11E-02	-1.07E-03	12	-	-4.82E-02
SO_2	3.29E-02	1.08E-02	105	100	4.85E-01
vacuum	2.73E-02	5.10E-03	14	12	2.30E-01
N_2	2.70E-02	4.84E-03	28	24	2.18E-01
vacuum	2.65E-02	4.26E-03	7	5	1.92E-01
SO_2	2.96E-02	7.39E-03	64	60	3.33E-01
vacuum	2.85E-02	6.30E-03	14	15	2.84E-01
N_2	2.73E-02	5.12E-03	54	32	2.31E-01
vacuum	2.90E-02	6.83E-03	17	12	3.08E-01
SO_2	2.81E-02	5.91E-03	45	39	2.66E-01
vacuum	2.88E-02	6.58E-03	19	12	2.97E-01
N_2	2.85E-02	6.28E-03	40	30	2.83E-01

Table S6 Specific conductivity and sensitivity of Ppy_ud/13X-Na[100]_10(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-30Na[100]_10 (2)		thickness	0.183 mm
K	11.23	T_r^a	32 °C
RH (%)	65	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma / \sigma_{N2}$
air	5.21E-02	1.81E-02	14	-	5.36E-01
vacuum	3.54E-02	2.03E-03	16	9	5.61E-02
N_2	4.25E-02	9.16E-03	41	30	2.69E-01
vacuum	3.44E-02	1.07E-03	18	13	2.75E-02
N_2	3.71E-02	3.74E-03	39	35	1.07E-01
vacuum	3.34E-02	1.05E-04	14	10	-1.32E-03
N_2	3.63E-02	2.92E-03	57	50	8.28E-02
vacuum	3.29E-02	-4.75E-04	6	-	-1.86E-02
N2	3.33E-02	0.00E+00	33	-	0.00E+00
vacuum	3.24E-02	-9.21E-04	12	-	-3.19E-02
SO_2	4.42E-02	1.09E-02	105	90	3.21E-01
vacuum	3.86E-02	5.25E-03	14	10	1.52E-01
N_2	3.83E-02	4.99E-03	28	24	1.45E-01
vacuum	3.78E-02	4.41E-03	7	5	1.27E-01
SO_2	4.09E-02	7.54E-03	64	58	2.21E-01
vacuum	3.98E-02	6.44E-03	14	10	1.88E-01
N_2	3.86E-02	5.27E-03	54	41	1.53E-01
vacuum	4.03E-02	6.98E-03	17	10	2.04E-01
SO_2	3.94E-02	6.06E-03	45	42	1.77E-01
vacuum	4.01E-02	6.73E-03	19	15	1.97E-01
N_2	3.98E-02	6.43E-03	40	25	1.88E-01

Table S7 Specific conductivity and sensitivity of Ppy_ud/13X-Na[100]_20(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Na[100]_20 (1)		thickness	0.175 mm
K	10.66	T_r[a]	33 °C
RH (%)	56	T_c[b]	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.74E-02	8.57E-03	12	-	4.56E-01
vacuum	1.87E-02	-1.04E-04	6	2	-5.53E-03
N_2	2.23E-02	3.46E-03	38	29	1.84E-01
vacuum	1.74E-02	-1.44E-03	16	9	-7.67E-02
N_2	2.04E-02	1.60E-03	33	26	8.53E-02
vacuum	1.55E-02	-3.29E-03	17	10	-1.75E-01
N_2	1.89E-02	1.32E-04	47	39	7.04E-03
vacuum	1.66E-02	-2.22E-03	10	4	-1.18E-01
N2	1.88E-02	0.00E+00	59	49	0.00E+00
vacuum	1.60E-02	-2.76E-03	12	7	-1.47E-01
SO_2	2.37E-02	4.93E-03	69	51	2.62E-01
vacuum	2.16E-02	2.76E-03	14	5	1.47E-01
N_2	2.35E-02	4.66E-03	51	31	2.48E-01
vacuum	2.26E-02	3.80E-03	19	7	2.02E-01
SO_2	2.44E-02	5.64E-03	51	35	3.00E-01
vacuum	2.29E-02	4.12E-03	28	10	2.19E-01
N_2	2.35E-02	4.68E-03	39	20	2.49E-01
vacuum	2.25E-02	3.72E-03	15	9	1.98E-01
SO_2	2.43E-02	5.47E-03	59	35	2.91E-01
vacuum	2.34E-02	4.61E-03	17	6	2.45E-01
N_2	2.33E-02	4.53E-03	50	33	2.41E-01

Table S8 Specific conductivity and sensitivity of Ppy_ud/13X-Na[100]_20(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Na[100]_20 (2)		thickness	0.179 mm
K	11.23	T_r^a	33 °C
RH (%)	56	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	3.48E-02	-5.68E-03	12	-	-1.40E-01
vacuum	3.53E-02	-5.18E-03	6	-	-1.28E-01
N_2	3.59E-02	-4.63E-03	38	9	-1.14E-01
vacuum	3.61E-02	-4.37E-03	16	-	-1.08E-01
N_2	3.69E-02	-3.65E-03	33	16	-9.01E-02
vacuum	3.81E-02	-2.39E-03	17	-	-5.89E-02
N_2	3.87E-02	-1.78E-03	47	24	-4.38E-02
vacuum	3.98E-02	-7.22E-04	10	-	-1.78E-02
N2	4.05E-02	0.00E+00	59	17	0.00E+00
vacuum	4.16E-02	1.12E-03	12	-	2.76E-02
SO_2	4.73E-02	6.82E-03	69	53	1.68E-01
vacuum	5.18E-02	1.13E-02	14	5	2.80E-01
N_2	5.14E-02	1.09E-02	51	41	2.69E-01
vacuum	5.34E-02	1.29E-02	19	9	3.18E-01
SO_2	5.09E-02	1.04E-02	51	25	2.56E-01
vacuum	5.43E-02	1.38E-02	28	11	3.41E-01
N_2	5.40E-02	1.35E-02	39	-	3.33E-01
vacuum	5.40E-02	1.35E-02	15	-	3.33E-01
SO_2	5.28E-02	1.23E-02	59	43	3.03E-01
vacuum	5.45E-02	1.40E-02	17	12	3.46E-01
N_2	5.50E-02	1.45E-02	50	-	3.57E-01

Table S9 Specific conductivity and sensitivity of Ppy_ud/13X-Na[100]_40(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Na[100]_40 (1)		thickness	0.167 mm
K	10.66	T_r[a]	32 °C
RH (%)	60	T_c[b]	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.35E-02	8.95E-05	14	-	6.70E-03
vacuum	1.32E-02	-1.99E-04	6	4	-1.49E-02
N_2	1.34E-02	2.21E-07	32	-	1.66E-05
vacuum	1.29E-02	-4.25E-04	21	6	-3.18E-02
N_2	1.34E-02	1.49E-05	42	4	1.12E-03
vacuum	1.26E-02	-7.55E-04	13	7	-5.65E-02
N_2	1.33E-02	-9.06E-05	66	9	-6.78E-03
vacuum	1.26E-02	-7.69E-04	15	5	-5.76E-02
N2	1.34E-02	0.00E+00	54	-	0.00E+00
vacuum	1.27E-02	-7.11E-04	18	8	-5.32E-02
SO_2	1.45E-02	1.10E-03	72	55	8.24E-02
vacuum	1.38E-02	4.33E-04	16	7	3.24E-02
N_2	1.49E-02	1.52E-03	43	5	1.14E-01
vacuum	1.40E-02	6.65E-04	26	17	4.98E-02
SO_2	1.49E-02	1.54E-03	51	8	1.15E-01
vacuum	1.42E-02	8.07E-04	19	12	6.03E-02
N_2	1.49E-02	1.54E-03	39	5	1.15E-01
vacuum	1.41E-02	7.32E-04	16	5	5.48E-02
SO_2	1.50E-02	1.61E-03	47	8	1.20E-01
vacuum	1.40E-02	6.38E-04	12	6	4.77E-02
N_2	1.51E-02	1.69E-03	46	9	1.27E-01

Table S10 Specific conductivity and sensitivity of Ppy_ud/13X-Na[100]_40(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Na[100]_40 (2)		thickness	0.170 mm
K	10.66	T_r^a	32 °C
RH (%)	60	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.39E-02	3.62E-03	13	-	3.53E-01
vacuum	1.17E-02	1.46E-03	16	14	1.43E-01
N_2	1.20E-02	1.75E-03	55	17	1.71E-01
vacuum	1.12E-02	9.13E-04	14	11	8.91E-02
N_2	1.15E-02	1.25E-03	40	34	1.22E-01
vacuum	1.01E-02	-1.09E-04	22	16	-1.06E-02
N_2	1.03E-02	4.35E-05	37	26	4.25E-03
vacuum	1.01E-02	-1.70E-04	10	4	-1.66E-02
N2	1.02E-02	0.00E+00	36	28	0.00E+00
vacuum	9.15E-03	-1.09E-03	19	14	-1.07E-01
SO_2	1.16E-02	1.35E-03	74	72	1.32E-01
vacuum	1.08E-02	5.26E-04	10	6	5.13E-02
N_2	1.07E-02	4.10E-04	56	39	4.00E-02
vacuum	1.05E-02	2.34E-04	22	-	2.29E-02
SO_2	1.08E-02	5.06E-04	74	49	4.94E-02
vacuum	1.04E-02	1.74E-04	11	7	1.70E-02
N_2	1.05E-02	2.20E-04	53	14	2.14E-02
vacuum	1.03E-02	8.99E-05	7	5	8.78E-03
SO_2	1.06E-02	3.58E-04	70	60	3.49E-02
vacuum	1.03E-02	6.47E-05	18	10	6.31E-03
N_2	1.04E-02	1.04E-04	44	-	1.02E-02

Table S11 Specific conductivity and sensitivity of Ppy_1:6/13X-Na[100]_10(1) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Na[100]_10 (1)		thickness	0.173 mm
K	11.26	T_r^a	32 °C
RH (%)	37	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	7.06E-01	3.93E-01	18	-	1.25E+00
vacuum	4.46E-01	1.33E-01	10	9	4.25E-01
N_2	5.16E-01	2.03E-01	42	33	6.50E-01
vacuum	3.89E-01	7.59E-02	13	11	2.42E-01
N_2	4.29E-01	1.16E-01	41	40	3.72E-01
vacuum	3.45E-01	3.22E-02	15	12	1.03E-01
N_2	3.53E-01	4.01E-02	31	28	1.28E-01
vacuum	3.29E-01	1.61E-02	14	-	5.15E-02
N2	3.13E-01	0.00E+00	40	-	0.00E+00
vacuum	2.71E-01	-4.23E-02	12	12	-1.35E-01
SO_2	4.34E-01	1.21E-01	98	90	3.87E-01
vacuum	3.22E-01	8.91E-03	13	10	2.85E-02
N_2	3.54E-01	4.14E-02	113	100	1.32E-01
vacuum	3.18E-01	4.92E-03	11	10	1.57E-02
SO_2	3.66E-01	5.27E-02	82	67	1.68E-01
vacuum	3.22E-01	9.43E-03	26	17	3.01E-02
N_2	3.27E-01	1.41E-02	42	-	4.49E-02
vacuum	3.17E-01	4.14E-03	13	7	1.32E-02
SO_2	3.21E-01	8.36E-03	35	-	2.67E-02
vacuum	3.13E-01	5.15E-04	12	10	1.64E-03
N_2	3.16E-01	2.75E-03	37	-	8.78E-03

Table S12 Specific conductivity and sensitivity of Ppy_1:6/13X-Na[100]_10(2) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Na[100]_10 (2)		thickness	0.173 mm
K	11.23	T_r^a	30 °C
RH (%)	63	T_c^b	28 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.36E+00	-4.88E-01	12	-	-2.65E-01
vacuum	1.64E+00	-2.02E-01	17	8	-1.10E-01
N_2	1.66E+00	-1.89E-01	38	-	-1.02E-01
vacuum	1.69E+00	-1.58E-01	16	-	-8.57E-02
N_2	1.75E+00	-9.00E-02	39	-	-4.88E-02
vacuum	1.81E+00	-2.95E-02	5	-	-1.60E-02
N_2	1.84E+00	-5.61E-03	43	-	-3.04E-03
vacuum	1.78E+00	-6.24E-02	26	-	-3.38E-02
N2	1.84E+00	0.00E+00	45	-	0.00E+00
vacuum	1.79E+00	-5.30E-02	10	-	-2.88E-02
SO_2	2.38E+00	5.33E-01	90	45	2.89E-01
vacuum	2.42E+00	5.78E-01	17	-	3.14E-01
N_2	2.49E+00	6.46E-01	44	-	3.50E-01
vacuum	2.46E+00	6.15E-01	14	-	3.34E-01
SO_2	2.52E+00	6.78E-01	67	-	3.67E-01
vacuum	2.53E+00	6.81E-01	22	-	3.69E-01
N_2	2.53E+00	6.84E-01	39	-	3.71E-01
vacuum	2.54E+00	6.94E-01	16	-	3.77E-01
SO_2	2.53E+00	6.83E-01	52	-	3.71E-01
vacuum	2.51E+00	6.61E-01	16	-	3.59E-01
N_2	2.51E+00	6.66E-01	28	-	3.61E-01

Table S13 Specific conductivity and sensitivity of Ppy_1:6/13X-Na[100]_20(1) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Na[100]_20 (1)		thickness	0.175 mm
K	10.66	T_r^a	33 °C
RH (%)	58	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.33E+00	2.01E-01	13	-	1.78E-01
vacuum	1.22E+00	9.09E-02	16	10	8.08E-02
N_2	1.22E+00	9.35E-02	32	-	8.31E-02
vacuum	1.08E+00	-4.55E-02	11	5	-4.04E-02
N_2	1.11E+00	-1.23E-02	31	-	-1.09E-02
vacuum	1.06E+00	-7.02E-02	17	-	-6.23E-02
N_2	1.09E+00	-3.83E-02	41	-	-3.40E-02
vacuum	1.09E+00	-3.60E-02	15	-	-3.20E-02
N2	1.13E+00	0.00E+00	48	-	0.00E+00
vacuum	1.12E+00	-3.26E-03	14	-	-2.90E-03
SO_2	1.30E+00	1.76E-01	68	60	1.56E-01
vacuum	1.28E+00	1.59E-01	21	10	1.41E-01
N_2	1.30E+00	1.70E-01	52	-	1.51E-01
vacuum	1.31E+00	1.85E-01	35	-	1.65E-01
SO_2	1.33E+00	2.04E-01	55	-	1.81E-01
vacuum	1.33E+00	2.06E-01	17	-	1.83E-01
N_2	1.33E+00	2.04E-01	30	-	1.82E-01
vacuum	1.33E+00	2.06E-01	77	-	1.83E-01
SO_2	1.34E+00	2.19E-01	37	6	1.94E-01
vacuum	1.33E+00	2.07E-01	35	8	1.84E-01
N_2	1.34E+00	2.12E-01	38	-	1.89E-01

Table S14 Specific conductivity and sensitivity of Ppy_1:6/13X-Na[100]_20(2) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Na[100]_20 (2)			thickness	0.166 mm
K	11.26		T_r^a	32 °C
RH (%)	60		T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.12E+00	1.23E-01	13	-	1.23E-01
vacuum	1.03E+00	3.76E-02	16	-	3.77E-02
N_2	1.04E+00	3.79E-02	32	-	3.80E-02
vacuum	9.73E-01	-2.38E-02	11	5	-2.38E-02
N_2	9.85E-01	-1.22E-02	31	24	-1.23E-02
vacuum	9.59E-01	-3.80E-02	17	10	-3.81E-02
N_2	1.00E+00	2.41E-03	41	24	2.42E-03
vacuum	9.76E-01	-2.15E-02	15	6	-2.16E-02
N2	9.97E-01	0.00E+00	48	20	0.00E+00
vacuum	9.75E-01	-2.21E-02	14	4	-2.22E-02
SO_2	1.20E+00	2.02E-01	68	61	2.03E-01
vacuum	1.15E+00	1.50E-01	21	7	1.51E-01
N_2	1.16E+00	1.64E-01	52	-	1.65E-01
vacuum	1.16E+00	1.66E-01	35	15	1.67E-01
SO_2	1.20E+00	1.98E-01	55	38	1.99E-01
vacuum	1.19E+00	1.92E-01	17	11	1.92E-01
N_2	1.19E+00	1.92E-01	30	-	1.92E-01
vacuum	1.19E+00	1.93E-01	77	-	1.93E-01
SO_2	1.21E+00	2.09E-01	37	-	2.09E-01
vacuum	1.19E+00	1.92E-01	35	-	1.92E-01
N_2	1.19E+00	1.93E-01	38	-	1.94E-01

Table S15 Specific conductivity and sensitivity of Ppy_1:6/13X-Na[100]_40(1) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Na[100]_40 (1)		thickness	0.180 mm
K	10.66	T_r^a	32 °C
RH (%)	60	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	5.16E-01	3.21E-01	18	-	1.64E+00
vacuum	3.13E-01	1.17E-01	16	6	6.00E-01
N_2	3.08E-01	1.12E-01	36	17	5.75E-01
vacuum	2.46E-01	5.10E-02	16	-	2.61E-01
N_2	2.76E-01	8.08E-02	48	29	4.14E-01
vacuum	2.80E-01	8.44E-02	14	-	4.32E-01
N_2	2.70E-01	7.42E-02	38	15	3.80E-01
vacuum	1.81E-01	-1.47E-02	17	12	-7.54E-02
N2	1.95E-01	0.00E+00	41	21	0.00E+00
vacuum	1.33E-01	-6.26E-02	25	11	-3.20E-01
SO_2	2.13E-01	1.77E-02	59	46	9.07E-02
vacuum	1.73E-01	-2.18E-02	15	12	-1.12E-01
N_2	1.83E-01	-1.24E-02	54	44	-6.36E-02
vacuum	5.46E-02	-1.41E-01	18	8	-7.20E-01
SO_2	1.30E-01	-6.49E-02	63	50	-3.32E-01
vacuum	7.67E-02	-1.19E-01	12	7	-6.07E-01
N_2	1.09E-01	-8.63E-02	36	21	-4.42E-01
vacuum	1.24E-01	-7.15E-02	14	5	-3.66E-01
SO_2	1.37E-01	-5.79E-02	58	38	-2.96E-01
vacuum	1.34E-01	-6.12E-02	16	8	-3.14E-01
N_2	1.27E-01	-6.82E-02	30	-	-3.49E-01

Table S16 Specific conductivity and sensitivity of Ppy_1:6/13X-Na[100]_40(2) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Na[100]_40 (2)		thickness	0.175 mm
K	11.26	T_r^a	32 °C
RH (%)	60	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.09E-01	1.39E-01	18	-	1.97E+00
vacuum	1.61E-01	9.04E-02	10	6	1.28E+00
N_2	1.54E-01	8.35E-02	42	12	1.18E+00
vacuum	1.12E-01	4.14E-02	13	5	5.87E-01
N_2	8.23E-02	1.17E-02	41	28	1.66E-01
vacuum	7.51E-02	4.54E-03	15	9	6.43E-02
N_2	7.55E-02	4.92E-03	31	-	6.97E-02
vacuum	7.00E-02	-5.36E-04	14	-	-7.60E-03
N2	7.05E-02	0.00E+00	40	-	0.00E+00
vacuum	6.15E-02	-9.04E-03	12	16	-1.28E-01
SO_2	7.49E-02	4.35E-03	98	22	6.16E-02
vacuum	6.92E-02	-1.32E-03	13	9	-1.87E-02
N_2	7.29E-02	2.30E-03	113	41	3.26E-02
vacuum	6.79E-02	-2.68E-03	11	9	-3.80E-02
SO_2	7.65E-02	5.93E-03	82	50	8.41E-02
vacuum	6.87E-02	-1.85E-03	26	9	-2.62E-02
N_2	6.59E-02	-4.68E-03	42	18	-6.63E-02
vacuum	6.67E-02	-3.84E-03	13	-	-5.45E-02
SO_2	6.90E-02	-1.58E-03	35	41	-2.24E-02
vacuum	6.68E-02	-3.75E-03	12	7	-5.31E-02
N_2	6.40E-02	-6.54E-03	37	8	-9.27E-02

Table S17 Specific conductivity and sensitivity of Ppy_ud/13X-Li[30]_10(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[30]_10 (1)		thickness	0.173 mm
K	10.66	T_r^a	32 °C
RH (%)	50	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	9.91E-02	3.45E-02	14	-	5.33E-01
vacuum	6.01E-02	-4.55E-03	13	8	-7.04E-02
N_2	6.31E-02	-1.58E-03	36	21	-2.45E-02
vacuum	6.03E-02	-4.36E-03	12	7	-6.75E-02
N_2	6.13E-02	-3.34E-03	32	16	-5.17E-02
vacuum	5.85E-02	-6.13E-03	14	-	-9.48E-02
N_2	6.08E-02	-3.80E-03	42	16	-5.88E-02
vacuum	5.76E-02	-7.08E-03	15	8	-1.10E-01
N2	6.46E-02	0.00E+00	47	18	0.00E+00
vacuum	5.96E-02	-4.99E-03	15	6	-7.72E-02
SO_2	8.49E-02	2.03E-02	66	39	3.14E-01
vacuum	7.94E-02	1.48E-02	26	-	2.28E-01
N_2	6.94E-02	4.74E-03	35	25	7.33E-02
vacuum	7.08E-02	6.21E-03	13	6	9.60E-02
SO_2	8.02E-02	1.56E-02	70	30	2.41E-01
vacuum	6.47E-02	8.24E-05	12	4	1.28E-03
N_2	6.19E-02	-2.70E-03	31	18	-4.18E-02
vacuum	6.23E-02	-2.32E-03	14	-	-3.59E-02
SO_2	7.53E-02	1.07E-02	55	40	1.65E-01
vacuum	6.48E-02	1.15E-04	19	4	1.77E-03
N_2	6.69E-02	2.25E-03	34	19	3.48E-02

Table S18 Specific conductivity and sensitivity of Ppy_ud/13X-Li[30]_10(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[30]_10 (2)		thickness	0.177 mm
K	11.23	T_r^a	32 °C
RH (%)	50	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.02E-01	-9.46E-04	14	-	-9.21E-03
vacuum	1.02E-01	-9.91E-04	13	5	-9.65E-03
N_2	1.03E-01	1.86E-04	36	18	1.81E-03
vacuum	1.02E-01	-8.36E-04	12	-	-8.14E-03
N_2	1.02E-01	-9.07E-04	32	-	-8.83E-03
vacuum	1.02E-01	-6.37E-04	14	-	-6.20E-03
N_2	1.03E-01	2.54E-04	42	22	2.47E-03
vacuum	1.02E-01	-6.93E-04	15	-	-6.75E-03
N2	1.03E-01	0.00E+00	47	34	0.00E+00
vacuum	1.01E-01	-1.64E-03	15	8	-1.60E-02
SO_2	1.21E-01	1.80E-02	66	50	1.75E-01
vacuum	1.23E-01	2.00E-02	26	-	1.94E-01
N_2	1.23E-01	2.07E-02	35	-	2.02E-01
vacuum	1.22E-01	1.93E-02	13	-	1.88E-01
SO_2	1.24E-01	2.11E-02	70	10	2.05E-01
vacuum	1.23E-01	2.05E-02	12	-	2.00E-01
N_2	1.25E-01	2.24E-02	31	-	2.18E-01
vacuum	1.24E-01	2.17E-02	14	-	2.11E-01
SO_2	1.26E-01	2.32E-02	55	10	2.26E-01
vacuum	1.23E-01	2.07E-02	19	8	2.02E-01
N_2	1.24E-01	2.10E-02	34	-	2.05E-01

Table S19 Specific conductivity and sensitivity of Ppy_ud/13X-Li[50]_10(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[50]_10 (1)		thickness	0.182 mm
K	10.66	T_r^a	32 °C
RH (%)	53	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	7.85E-02	5.12E-02	14	-	1.88E+00
vacuum	2.65E-02	-7.61E-04	22	15	-2.79E-02
N_2	2.71E-02	-1.50E-04	37	11	-5.51E-03
vacuum	1.88E-02	-8.50E-03	15	11	-3.11E-01
N_2	2.63E-02	-9.39E-04	42	20	-3.44E-02
vacuum	2.20E-02	-5.28E-03	18	13	-1.93E-01
N_2	2.73E-02	0.00E+00	47	15	0.00E+00
vacuum	2.02E-02	-7.03E-03	13	8	-2.58E-01
SO_2	3.45E-02	7.22E-03	80	58	2.65E-01
vacuum	2.76E-02	2.86E-04	21	14	1.05E-02
N_2	3.03E-02	3.04E-03	42	30	1.11E-01
vacuum	2.70E-02	-2.44E-04	17	14	-8.95E-03
SO_2	3.07E-02	3.39E-03	59	22	1.24E-01
vacuum	2.71E-02	-1.60E-04	15	12	-5.88E-03
N_2	3.07E-02	3.43E-03	26	8	1.26E-01
vacuum	2.71E-02	-2.27E-04	14	5	-8.33E-03
SO_2	3.04E-02	3.11E-03	49	14	1.14E-01
vacuum	2.66E-02	-7.05E-04	15	7	-2.58E-02
N_2	2.98E-02	2.56E-03	55	20	9.38E-02

Table S20 Specific conductivity and sensitivity of Ppy_ud/13X-Li[50]_10(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[50]_10 (2)		thickness	0.175 mm
K	11.23	T_r^a	32 °C
RH (%)	53	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	6.80E-02	2.28E-03	14	-	3.46E-02
vacuum	6.71E-02	1.37E-03	22	3	2.08E-02
N_2	6.60E-02	2.42E-04	37	30	3.68E-03
vacuum	6.51E-02	-6.48E-04	15	9	-9.85E-03
N_2	6.59E-02	1.21E-04	42	33	1.83E-03
vacuum	6.50E-02	-7.30E-04	18	13	-1.11E-02
N_2	6.58E-02	0.00E+00	47	32	0.00E+00
vacuum	6.52E-02	-5.53E-04	13	8	-8.41E-03
SO_2	8.02E-02	1.44E-02	80	77	2.19E-01
vacuum	8.04E-02	1.47E-02	21	-	2.23E-01
N_2	8.02E-02	1.45E-02	42	-	2.20E-01
vacuum	7.97E-02	1.40E-02	17	-	2.13E-01
SO_2	8.02E-02	1.44E-02	59	30	2.20E-01
vacuum	8.02E-02	1.45E-02	15	-	2.20E-01
N_2	8.02E-02	1.44E-02	26	-	2.20E-01
vacuum	8.00E-02	1.43E-02	14	-	2.17E-01
SO_2	8.01E-02	1.43E-02	49	-	2.17E-01
vacuum	8.00E-02	1.43E-02	15	-	2.17E-01
N_2	8.01E-02	1.44E-02	55	-	2.19E-01

Table S21 Specific conductivity and sensitivity of Ppy_ud/13X-Li[70]_10(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[70]_10 (1)		thickness	0.175 mm
K	10.66	T_r^a	32 °C
RH (%)	52	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	4.34E-02	2.64E-02	9	-	1.55E+00
vacuum	2.62E-02	9.18E-03	17	13	5.38E-01
N_2	2.46E-02	7.51E-03	35	15	4.40E-01
vacuum	1.73E-02	2.39E-04	17	7	1.40E-02
N_2	1.82E-02	1.09E-03	28	10	6.40E-02
vacuum	1.75E-02	4.41E-04	8	-	2.59E-02
N_2	1.75E-02	4.54E-04	39	20	2.66E-02
vacuum	1.60E-02	-1.02E-03	11	7	-5.96E-02
N2	1.71E-02	0.00E+00	32	13	0.00E+00
vacuum	1.53E-02	-1.79E-03	12	9	-1.05E-01
SO_2	1.85E-02	1.41E-03	77	62	8.28E-02
vacuum	1.66E-02	-4.93E-04	14	8	-2.89E-02
N_2	1.70E-02	-5.57E-05	27	15	-3.27E-03
vacuum	1.68E-02	-3.05E-04	16	10	-1.79E-02
SO_2	1.74E-02	3.07E-04	43	31	1.80E-02
vacuum	1.60E-02	-1.08E-03	18	10	-6.33E-02
N_2	1.66E-02	-4.76E-04	40	10	-2.79E-02
vacuum	1.58E-02	-1.30E-03	14	5	-7.63E-02
SO_2	1.67E-02	-3.12E-04	58	39	-1.83E-02
vacuum	1.59E-02	-1.17E-03	17	13	-6.84E-02
N_2	1.60E-02	-1.06E-03	20	-	-6.22E-02

Table S22 Specific conductivity and sensitivity of Ppy_ud/13X-Li[70]_10(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[70]_10 (2)		thickness	0.175 mm
K	11.23	T_r^a	32 °C
RH (%)	52	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	6.96E-02	2.47E-03	9	-	3.67E-02
vacuum	5.90E-02	-8.14E-03	17	8	-1.21E-01
N_2	6.01E-02	-7.02E-03	35	11	-1.05E-01
vacuum	5.92E-02	-7.88E-03	17	10	-1.17E-01
N_2	6.23E-02	-4.78E-03	28	9	-7.12E-02
vacuum	5.97E-02	-7.43E-03	8	6	-1.11E-01
N_2	6.29E-02	-4.26E-03	39	8	-6.35E-02
vacuum	6.29E-02	-4.26E-03	11	9	-6.35E-02
N2	6.71E-02	0.00E+00	32	14	0.00E+00
vacuum	6.57E-02	-1.38E-03	12	5	-2.06E-02
SO_2	8.72E-02	2.00E-02	77	59	2.98E-01
vacuum	8.34E-02	1.63E-02	14	5	2.42E-01
N_2	8.48E-02	1.77E-02	27	-	2.64E-01
vacuum	8.40E-02	1.69E-02	16	2	2.52E-01
SO_2	8.70E-02	1.99E-02	43	-	2.97E-01
vacuum	8.29E-02	1.58E-02	18	5	2.35E-01
N_2	8.45E-02	1.74E-02	40	14	2.59E-01
vacuum	8.08E-02	1.36E-02	14	-	2.03E-01
SO_2	8.84E-02	2.13E-02	58	34	3.17E-01
vacuum	8.15E-02	1.44E-02	17	7	2.14E-01
N_2	8.30E-02	1.59E-02	20	9	2.37E-01

Table S23 Specific conductivity and sensitivity of Ppy_ud/13X-Li[80]_10(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[80]_10 (1)		thickness	0.168 mm
K	10.66	T_r^a	32 °C
RH (%)	60	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	6.79E-02	3.82E-02	14	-	1.28E+00
vacuum	3.73E-02	7.54E-03	11	9	2.54E-01
N_2	4.45E-02	1.47E-02	33	27	4.95E-01
vacuum	3.71E-02	7.32E-03	14	11	2.46E-01
N_2	3.58E-02	6.03E-03	61	43	2.03E-01
vacuum	2.97E-02	-3.71E-05	11	8	-1.25E-03
N_2	3.02E-02	4.54E-04	45	-	1.52E-02
vacuum	2.95E-02	-2.22E-04	13	-	-7.46E-03
N2	2.98E-02	0.00E+00	41	-	0.00E+00
vacuum	2.94E-02	-3.40E-04	25	-	-1.14E-02
SO_2	3.25E-02	2.69E-03	84	60	9.04E-02
vacuum	3.22E-02	2.41E-03	7	5	8.11E-02
N_2	3.22E-02	2.47E-03	41	-	8.32E-02
vacuum	3.23E-02	2.55E-03	22	-	8.56E-02
SO_2	3.24E-02	2.61E-03	80	-	8.77E-02
vacuum	3.24E-02	2.62E-03	27	-	8.81E-02
N_2	3.23E-02	2.51E-03	43	-	8.45E-02
vacuum	3.23E-02	2.54E-03	17	-	8.54E-02
SO_2	3.24E-02	2.62E-03	60	-	8.80E-02
vacuum	3.24E-02	2.64E-03	32	-	8.85E-02
N_2	3.22E-02	2.47E-03	21	-	8.31E-02

Table S24 Specific conductivity and sensitivity of Ppy_ud/13X-Li[80]_10(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Li[80]_10 (2)		thickness	0.173 mm
K	11.23	T_r^a	32 °C
RH (%)	60	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	3.32E-02	2.29E-02	14	-	2.22E+00
vacuum	9.91E-03	-4.09E-04	11	8	-3.97E-02
N_2	1.08E-02	4.87E-04	33	12	4.72E-02
vacuum	1.03E-02	-4.08E-05	14	8	-3.95E-03
N_2	1.07E-02	3.38E-04	61	20	3.28E-02
vacuum	1.01E-02	-2.08E-04	11	8	-2.01E-02
N_2	1.03E-02	2.01E-05	45	-	1.94E-03
vacuum	1.01E-02	-2.59E-04	13	6	-2.51E-02
N2	1.03E-02	0.00E+00	41	24	0.00E+00
vacuum	9.92E-03	-3.94E-04	25	16	-3.82E-02
SO_2	1.08E-02	5.02E-04	84	40	4.87E-02
vacuum	1.05E-02	1.77E-04	7	6	1.72E-02
N_2	1.06E-02	2.95E-04	41	-	2.86E-02
vacuum	1.06E-02	2.78E-04	22	-	2.70E-02
SO_2	1.08E-02	4.38E-04	80	22	4.25E-02
vacuum	1.04E-02	1.30E-04	27	17	1.26E-02
N_2	1.05E-02	1.94E-04	43	-	1.88E-02
vacuum	1.04E-02	1.34E-04	17	-	1.29E-02
SO_2	1.06E-02	2.69E-04	60	30	2.61E-02
vacuum	1.05E-02	1.79E-04	32	-	1.74E-02
N_2	1.04E-02	1.25E-04	21	-	1.21E-02

Table S25 Specific conductivity and sensitivity of Ppy_1:6/13X-Li[50]_10(1) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Li[50]_10 (1)		thickness	0.181 mm
K	10.66	T_r^a	33 °C
RH (%)	56	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	5.98E-01	1.01E-02	18	-	1.72E-02
vacuum	6.69E-01	8.14E-02	12	5	1.38E-01
N_2	6.96E-01	1.08E-01	41	8	1.84E-01
vacuum	5.91E-01	3.25E-03	11	4	5.52E-03
N_2	6.33E-01	4.55E-02	44	28	7.73E-02
vacuum	6.01E-01	1.28E-02	19	12	2.18E-02
N_2	5.98E-01	1.05E-02	33	23	1.79E-02
vacuum	4.80E-01	-1.08E-01	12	6	-1.83E-01
N2	5.88E-01	0.00E+00	29	12	0.00E+00
vacuum	5.71E-01	-1.68E-02	15	7	-2.86E-02
SO_2	6.45E-01	5.68E-02	51	36	9.66E-02
vacuum	5.86E-01	-1.73E-03	12	-	-2.94E-03
N_2	6.48E-01	6.01E-02	39	-	1.02E-01
vacuum	6.43E-01	5.48E-02	14	-	9.33E-02
SO_2	6.37E-01	4.92E-02	41	-	8.37E-02
vacuum	6.25E-01	3.71E-02	14	9	6.31E-02
N_2	6.30E-01	4.19E-02	27	-	7.13E-02
vacuum	6.28E-01	3.99E-02	19	-	6.79E-02
SO_2	6.36E-01	4.78E-02	40	-	8.14E-02
vacuum	6.30E-01	4.24E-02	15	-	7.22E-02
N_2	6.50E-01	6.18E-02	28	-	1.05E-01

Table S26 Specific conductivity and sensitivity of Ppy_1:6/13X-LI[50]_10(2) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Li[50]_10 (2)		thickness	0.173 mm
K	11.23	T_r^a	33 °C
RH (%)	56	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.37E+00	-4.81E-02	18	-	-1.98E-02
vacuum	2.18E+00	-2.44E-01	12	6	-1.01E-01
N_2	2.38E+00	-4.21E-02	41	20	-1.74E-02
vacuum	2.25E+00	-1.72E-01	11	7	-7.11E-02
N_2	2.41E+00	-8.01E-03	44	20	-3.31E-03
vacuum	2.29E+00	-1.31E-01	19	-	-5.42E-02
N_2	2.43E+00	1.06E-02	33	7	4.37E-03
vacuum	2.30E+00	-1.25E-01	12	5	-5.15E-02
N2	2.42E+00	0.00E+00	29	18	0.00E+00
vacuum	2.33E+00	-9.19E-02	15	6	-3.79E-02
SO_2	2.69E+00	2.72E-01	51	30	1.12E-01
vacuum	2.40E+00	-2.65E-02	12	-	-1.09E-02
N_2	2.68E+00	2.59E-01	39	25	1.07E-01
vacuum	2.56E+00	1.33E-01	14	-	5.49E-02
SO_2	2.71E+00	2.86E-01	41	13	1.18E-01
vacuum	2.56E+00	1.39E-01	14	-	5.74E-02
N_2	2.60E+00	1.78E-01	27	-	7.36E-02
vacuum	2.60E+00	1.81E-01	19	-	7.46E-02
SO_2	2.71E+00	2.89E-01	40	20	1.19E-01
vacuum	2.59E+00	1.72E-01	15	-	7.08E-02
N_2	2.64E+00	2.17E-01	28	-	8.97E-02

Table S27 Specific conductivity and sensitivity of Ppy_ud/13X-K[50]_10(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-K[50]_10 (1)		thickness	0.172 mm
K	11.23	T_r^a	33°C
RH (%)	63	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	6.87E-02	9.43E-04	28	-	1.39E-02
vacuum	6.51E-02	-2.62E-03	20	14	-3.87E-02
N_2	6.71E-02	-6.73E-04	40	25	-9.93E-03
vacuum	6.48E-02	-2.98E-03	14	10	-4.39E-02
N_2	6.83E-02	5.40E-04	73	68	7.97E-03
vacuum	6.67E-02	-1.04E-03	24	11	-1.53E-02
N_2	6.91E-02	1.36E-03	67	45	2.00E-02
vacuum	6.65E-02	-1.22E-03	20	12	-1.81E-02
N2	6.78E-02	0.00E+00	24	11	0.00E+00
vacuum	6.66E-02	-1.16E-03	21	8	-1.71E-02
SO_2	8.33E-02	1.56E-02	117	90	2.30E-01
vacuum	8.18E-02	1.40E-02	18	9	2.07E-01
N_2	8.28E-02	1.50E-02	52	21	2.21E-01
vacuum	8.11E-02	1.33E-02	14	7	1.96E-01
SO_2	8.33E-02	1.55E-02	76	57	2.29E-01
vacuum	8.13E-02	1.35E-02	21	9	1.99E-01
N_2	8.20E-02	1.42E-02	34	-	2.10E-01
vacuum	8.06E-02	1.28E-02	16	10	1.89E-01
SO_2	8.16E-02	1.38E-02	25	19	2.04E-01
vacuum	8.01E-02	1.23E-02	20	12	1.82E-01
N_2	8.01E-02	1.23E-02	19	10	1.81E-01

Table S28 Specific conductivity and sensitivity of Ppy_ud/13X-K[50]_10(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-K[50]_10 (2)		thickness	0.176 mm
K	10.66	T_r^a	33°C
RH (%)	63	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	3.25E-02	1.97E-02	28	-	1.53E+00
vacuum	1.73E-02	4.41E-03	20	15	3.42E-01
N_2	3.36E-02	2.07E-02	40	38	1.61E+00
vacuum	1.35E-02	5.83E-04	14	12	4.53E-02
N_2	1.97E-02	6.87E-03	73	70	5.34E-01
vacuum	1.32E-02	3.69E-04	24	12	2.87E-02
N_2	1.53E-02	2.46E-03	67	60	1.91E-01
vacuum	1.26E-02	-2.31E-04	20	13	-1.79E-02
N2	1.29E-02	0.00E+00	24	22	0.00E+00
vacuum	1.23E-02	-5.53E-04	21	12	-4.30E-02
SO_2	1.52E-02	2.38E-03	117	114	1.85E-01
vacuum	1.27E-02	-1.19E-04	18	16	-9.22E-03
N_2	1.32E-02	3.50E-04	52	45	2.72E-02
vacuum	1.26E-02	-2.30E-04	14	9	-1.78E-02
SO_2	1.36E-02	7.35E-04	76	70	5.71E-02
vacuum	1.26E-02	-2.95E-04	21	15	-2.29E-02
N_2	1.26E-02	-2.20E-04	34	23	-1.71E-02
vacuum	1.24E-02	-4.91E-04	16	11	-3.81E-02
SO_2	1.27E-02	-2.16E-04	25	24	-1.68E-02
vacuum	1.23E-02	-5.66E-04	20	13	-4.40E-02
N_2	1.23E-02	-5.47E-04	19	-	-4.25E-02

Table S29 Specific conductivity and sensitivity of Ppy_1:6/13X-K[50]_10(1) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-K[50]_10 (1)		thickness	0.174 mm
K	10.66	T_r^a	33 °C
RH (%)	41	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	8.77E-01	2.57E-01	21	-	4.15E-01
vacuum	8.26E-01	2.07E-01	14	10	3.33E-01
N_2	7.39E-01	1.19E-01	32	-	1.92E-01
vacuum	7.03E-01	8.37E-02	6	5	1.35E-01
N_2	6.82E-01	6.24E-02	36	11	1.01E-01
vacuum	6.58E-01	3.85E-02	8	6	6.22E-02
N_2	6.20E-01	0.00E+00	46	17	0.00E+00
vacuum	6.19E-01	-2.37E-04	18	5	-3.83E-04
SO_2	6.97E-01	7.72E-02	50	45	1.25E-01
vacuum	7.08E-01	8.80E-02	11	9	1.42E-01
N_2	7.14E-01	9.47E-02	41	23	1.53E-01
vacuum	7.31E-01	1.11E-01	19	6	1.80E-01
SO_2	7.26E-01	1.06E-01	53	31	1.71E-01
vacuum	7.28E-01	1.08E-01	14	-	1.75E-01
N_2	7.15E-01	9.51E-02	27	20	1.53E-01
vacuum	7.17E-01	9.75E-02	10	-	1.57E-01
SO_2	7.21E-01	1.01E-01	39	22	1.63E-01
vacuum	7.15E-01	9.49E-02	9	-	1.53E-01
N_2	6.65E-01	4.54E-02	18	12	7.33E-02

Table S30 Specific conductivity and sensitivity of Ppy_1:6/13X-K[50]_10(2) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-K[50]_10 (2)		thickness	0.176 mm
K	11.23	T_r^a	33 °C
RH (%)	41	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.44E-01	-2.67E-03	21	-	-1.82E-02
vacuum	1.45E-01	-1.60E-03	14	-	-1.09E-02
N_2	1.46E-01	-5.02E-04	32	-	-3.42E-03
vacuum	1.46E-01	-4.33E-04	6	-	-2.95E-03
N_2	1.46E-01	-5.41E-04	36	-	-3.69E-03
vacuum	1.46E-01	-2.66E-04	8	-	-1.82E-03
N_2	1.47E-01	0.00E+00	46	-	0.00E+00
vacuum	1.47E-01	6.92E-04	18	-	4.72E-03
SO_2	1.72E-01	2.49E-02	50	35	1.70E-01
vacuum	1.72E-01	2.54E-02	11	-	1.73E-01
N_2	1.72E-01	2.58E-02	41	-	1.76E-01
vacuum	1.75E-01	2.81E-02	19	-	1.92E-01
SO_2	1.78E-01	3.12E-02	53	27	2.13E-01
vacuum	1.79E-01	3.21E-02	14	-	2.19E-01
N_2	1.78E-01	3.16E-02	27	-	2.16E-01
vacuum	1.79E-01	3.19E-02	10	-	2.17E-01
SO_2	1.79E-01	3.22E-02	39	-	2.19E-01
vacuum	1.79E-01	3.26E-02	9	-	2.23E-01
N_2	1.79E-01	3.21E-02	18	-	2.19E-01

Table S31 Specific conductivity and sensitivity of Ppy_ud/13X-Cs[50]_10(1) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Cs[50]_10 (1)		thickness	0.182 mm
K	11.26	T_r^a	32 °C
RH (%)	48	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	5.95E-02	4.03E-02	15	-	2.09E+00
vacuum	2.32E-02	3.92E-03	23	14	2.04E-01
N_2	2.58E-02	6.52E-03	53	50	3.39E-01
vacuum	2.02E-02	9.40E-04	20	15	4.88E-02
N_2	2.13E-02	2.07E-03	38	37	1.08E-01
vacuum	1.91E-02	-1.36E-04	24	16	-7.04E-03
N_2	1.96E-02	3.35E-04	35	27	1.74E-02
vacuum	1.85E-02	-7.38E-04	19	12	-3.83E-02
N2	1.93E-02	0.00E+00	48	43	0.00E+00
vacuum	1.76E-02	-1.69E-03	12	10	-8.78E-02
SO_2	2.46E-02	5.32E-03	132	128	2.76E-01
vacuum	2.19E-02	2.67E-03	20	12	1.39E-01
N_2	2.19E-02	2.61E-03	40	-	1.36E-01
vacuum	2.17E-02	2.44E-03	16	-	1.27E-01
SO_2	2.20E-02	2.79E-03	48	23	1.45E-01
vacuum	2.15E-02	2.24E-03	10	6	1.16E-01
N_2	2.15E-02	2.22E-03	43	-	1.15E-01
vacuum	2.15E-02	2.27E-03	9	-	1.18E-01
SO_2	2.15E-02	2.23E-03	34	15	1.16E-01
vacuum	1.92E-02	-4.94E-05	12	-	-2.57E-03
N_2	2.14E-02	2.15E-03	55	-	1.12E-01

Table S32 Specific conductivity and sensitivity of Ppy_ud/13X-Cs[50]_10(2) when exposed to 1000 ppm SO_2

Ppy_ud/13X-Cs[50]_10 (2)		thickness	0.163 mm
K	10.66	T_r^a	32 °C
RH (%)	60	T_c^b	31 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	5.60E-02	5.14E-02	14	-	1.11E+01
vacuum	8.05E-03	3.43E-03	6	5	7.42E-01
N_2	1.09E-02	6.24E-03	32	20	1.35E+00
vacuum	7.39E-03	2.77E-03	21	14	6.00E-01
N_2	7.70E-03	3.08E-03	42	25	6.66E-01
vacuum	5.81E-03	1.19E-03	13	8	2.57E-01
N_2	6.57E-03	1.94E-03	66	40	4.20E-01
vacuum	3.53E-03	-1.09E-03	15	9	-2.35E-01
N2	4.62E-03	0.00E+00	54	32	0.00E+00
vacuum	3.41E-03	-1.21E-03	20	13	-2.63E-01
SO_2	5.40E-03	7.76E-04	72	60	1.68E-01
vacuum	3.34E-03	-1.28E-03	16	8	-2.77E-01
N_2	4.06E-03	-5.63E-04	43	27	-1.22E-01
vacuum	3.08E-03	-1.54E-03	26	17	-3.34E-01
SO_2	3.98E-03	-6.45E-04	51	43	-1.40E-01
vacuum	2.94E-03	-1.68E-03	19	10	-3.64E-01
N_2	3.51E-03	-1.12E-03	39	16	-2.41E-01
vacuum	3.60E-03	-1.02E-03	15	7	-2.21E-01
SO_2	3.56E-03	-1.06E-03	47	35	-2.29E-01
vacuum	2.45E-03	-2.17E-03	12	9	-4.69E-01
N_2	3.23E-03	-1.39E-03	46	20	-3.01E-01

Table S33 Specific conductivity and sensitivity of Ppy_1:6/13X-Cs[50]_10(1) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Cs[50]_10 (1)		thickness	0.168 mm
K	10.66	T_r^a	33 °C
RH (%)	53	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	1.42E+00	1.44E-01	18	-	1.13E-01
vacuum	1.28E+00	7.91E-04	11	5	6.20E-04
N_2	1.32E+00	4.33E-02	54	-	3.39E-02
vacuum	1.23E+00	-4.26E-02	8	-	-3.34E-02
N_2	1.30E+00	2.46E-02	32	16	1.93E-02
vacuum	1.25E+00	-2.43E-02	11	7	-1.90E-02
N_2	1.29E+00	1.87E-02	39	26	1.46E-02
vacuum	1.21E+00	-6.49E-02	11	5	-5.09E-02
N2	1.27E+00	0.00E+00	33	17	0.00E+00
vacuum	1.20E+00	-7.21E-02	12	5	-5.65E-02
SO_2	1.49E+00	2.19E-01	73	50	1.72E-01
vacuum	1.41E+00	1.32E-01	14	6	1.03E-01
N_2	1.45E+00	1.71E-01	17	14	1.34E-01
vacuum	1.41E+00	1.36E-01	12	8	1.07E-01
SO_2	1.52E+00	2.46E-01	61	16	1.93E-01
vacuum	1.43E+00	1.53E-01	14	7	1.20E-01
N_2	1.52E+00	2.49E-01	110	20	1.95E-01
vacuum	1.42E+00	1.50E-01	11	4	1.18E-01
SO_2	1.53E+00	2.55E-01	88	18	2.00E-01
vacuum	1.45E+00	1.75E-01	20	9	1.38E-01
N_2	1.50E+00	2.28E-01	31	17	1.79E-01

Table S34 Specific conductivity and sensitivity of Ppy_1:6/13X-Cs[50]_10(2) when exposed to 1000 ppm SO_2

Ppy_1:6/13X-Cs[50]_10 (2)		thickness	0.173 mm
K	11.23	T_r^a	33 °C
RH (%)	53	T_c^b	30 °C

gas	σ (S/cm)	Δ σ (S/cm)	time (min)	t_r (min)	$\Delta\sigma/\sigma_{N2}$
air	2.95E+00	1.74E+00	18	-	1.44E+00
vacuum	1.35E+00	1.37E-01	11	9	1.13E-01
N_2	1.47E+00	2.59E-01	54	34	2.14E-01
vacuum	1.23E+00	1.71E-02	8	5	1.41E-02
N_2	1.27E+00	5.99E-02	32	20	4.95E-02
vacuum	1.18E+00	-2.78E-02	11	5	-2.30E-02
N_2	1.24E+00	2.79E-02	39	25	2.31E-02
vacuum	1.17E+00	-4.45E-02	11	6	-3.68E-02
N2	1.21E+00	0.00E+00	33	-	0.00E+00
vacuum	1.12E+00	-9.03E-02	12	-	-7.46E-02
SO_2	1.49E+00	2.77E-01	73	50	2.29E-01
vacuum	1.29E+00	7.52E-02	14	7	6.21E-02
N_2	1.30E+00	8.69E-02	17	-	7.18E-02
vacuum	1.29E+00	7.57E-02	12	-	6.25E-02
SO_2	1.38E+00	1.73E-01	61	15	1.43E-01
vacuum	1.29E+00	8.32E-02	14	9	6.88E-02
N_2	1.36E+00	1.47E-01	110	-	1.21E-01
vacuum	1.28E+00	7.01E-02	11	-	5.79E-02
SO_2	1.38E+00	1.66E-01	88	40	1.37E-01
vacuum	1.31E+00	9.91E-02	20	-	8.18E-02
N_2	1.34E+00	1.27E-01	31	-	1.05E-01

Table S35 The Ppy/zeolite13X samples and their % apparent doping levels (DL), % degrees of crystallinity (DC), the induction times (t_i), the recovery time (t_{re}), electrical conductivity values in air, electrical conductivity values in N_2, electrical conductivity values in SO_2 and the electrical response ($\Delta\sigma/\sigma_{N2}$) upon exposed to 1000 ppm SO_2 /NO_2 mixture at 28 ^oC, at atmospheric pressure

Sample	DL	DC	t_i	t_{re}	σ (S/cm)			$\Delta\sigma$	$\Delta\sigma/\sigma_{N2}$
			(min)	(min)	air	N_2	SO_2	(S/cm)	
Ppy_ud	0.26	54.3	44±6	8±2	(4.74±3.00) x 10^{-1}	(2.71±0.13) x 10^{-1}	(3.38±0.44) x 10^{-1}	(6.71±3.10) x 10^{-2}	(2.46±1.02) x 10^{-1}
Ppy_ud/13X-Na[100]_10	0.26	54.3	95±7	11±1	(5.21±0.09) x 10^{-2}	(2.78±0.80) x 10^{-2}	(3.86±0.80) x 10^{-2}	(1.09±0.01) x 10^{-2}	(4.00±1.16) x 10^{-1}
Ppy_ud/13X-Na[100]_20	0.26	54.3	52±1	5	(3.11±0.52) x 10^{-2}	(2.97±1.53) x 10^{-2}	(3.55±1.67) x 10^{-2}	(5.88±1.33) x 10^{-3}	(2.15±0.66) x 10^{-1}
Ppy_ud/13X-Na[100]_40	0.26	54.3	64±8	6±1	(1.37±0.03) x 10^{-2}	(1.18±0.23) x 10^{-2}	(1.31±0.21) x 10^{-2}	(1.23±0.18) x 10^{-3}	(1.07±0.35) x 10^{-1}
Ppy_ud/13X-Li[30]_10	0.26	54.3	44±7	-	(1.00±0.002) x 10^{-1}	(8.37±2.69) x 10^{-2}	(1.03±0.25) x 10^{-2}	(1.92±0.16) x 10^{-2}	(2.44±0.98) x 10^{-1}
Ppy_ud/13X-Li[50]_10	0.26	54.3	67±13	10	(7.33±0.74) x 10^{-2}	(4.80±2.51) x 10^{-2}	(5.54±3.50) x 10^{-2}	(8.90±7.79) x 10^{-3}	(1.72±0.67) x 10^{-1}
Ppy_ud/13X-Li[70]_10	0.26	54.3	60±2	6±2	(5.65±1.85) x 10^{-2}	(4.21±3.54) x 10^{-2}	(5.28±4.86) x 10^{-2}	(1.07±1.32) x 10^{-2}	(1.91±1.52) x 10^{-1}
Ppy_ud/13X-Li[80]_10	0.26	54.3	50±14	6	(5.06±2.45) x 10^{-2}	(2.00±1.37) x 10^{-2}	(2.16±1.53) x 10^{-2}	(1.60±1.55) x10^{-3}	(6.96±2.95) x 10^{-2}
Ppy_ud/13X-K[50]_10	0.26	54.3	102±17	12±4	(5.06±2.56) x 10^{-2}	(4.03±3.88) x 10^{-2}	(4.93±4.82) x 10^{-2}	(8.99±9.35) x 10^{-3}	(2.07±0.32) x 10^{-1}
Ppy_ud/13X-Cs[50]_10	0.26	54.3	94±48	12±1	(5.78±0.25) x 10^{-2}	(1.19±1.03) x 10^{-2}	(1.50±1.36) x 10^{-2}	(3.05±3.21) x 10^{-3}	(2.22±0.77) x 10^{-1}
Ppy_1:6	0.51	80.4	24±2	10	4.56±2.97	2.80±0.53	3.12±0.52	(3.17±0.09) x 10^{-1}	(1.15±0.25) x 10^{-1}
Ppy_1:6/13X-Na[100]_10	0.51	80.4	68±32	10	1.03±0.46	1.08±1.08	1.41±1.38	(3.27±2.91) x 10^{-1}	(3.38±0.70) x 10^{-1}
Ppy_1:6/13X-Na[100]_20	0.51	80.4	60±1	10±1	1.23±0.15	1.06±0.09	1.25±0.07	(1.89±0.18) x 10^{-1}	(1.79±0.33) x 10^{-1}
Ppy_1:6/13X-Na[100]_40	0.51	80.4	34±12	10±2	(3.63±2.17) x 10^{-1}	(1.33±0.88) x 10^{-1}	(1.44±0.98) x 10^{-1}	(1.10±0.94) x 10^{-2}	(7.61±2.1) x 10^{-2}
Ppy_1:6/13X-Li[50]_10	0.51	80.4	33±4	-	1.49±1.26	1.51±1.30	1.67±1.45	(1.64±1.52) x 10^{-1}	(1.04±0.11) x 10^{-1}
Ppy_1:6/13X-K[50]_10	0.51	80.4	40±7	6	(5.10±5.18) x 10^{-1}	(3.83±3.34) x 10^{-1}	(4.34±4.71) x 10^{-1}	(5.11±3.70) x 10^{-2}	(1.47±0.32) x 10^{-1}
Ppy_1:6/13X-Cs[50]_10	0.51	80.4	50	6±1	2.19±1.08	1.24±0.05	1.49±0.005	(2.48±0.41) x 10^{-1}	(2.00±0.40) x 10^{-1}

Appendix T The Interaction between Ppy, 13X, and SO_2 by FTIR

FTIR spectra of Ppy_ud, Ppy_1:6,13X, Ppy_ud/13X-Na[100]_40, and Ppy_1:6/13X-Na[100]_40 were taken by KBr pellet technique at 26°C, before SO_2 exposure step and after 6-hour SO_2 exposure step to study interaction between these samples and SO_2.

Table T1 Peak position in FT-IR spectra of Ppy_ud and Ppy_1/6 before and after exposed to SO_2

	Ref.	Wavenumber [cm^{-1}]			
		Ppy_ud		Ppy_1:6	
		before	after	before	after
$C=C_{sym}$ /$C-C_{asm}$ in pyrrole ring	1600-1300[g] 1560[f] 1575[a]	1558	1552	1544	1540
$N-H_{bend}$	1445[e]	1472	1460	1451	1457
S=O	1400[c]	-	1400	-	-
C-H&N-H def.	1298[h]	1301	1300	1300	1296
$S=O_{str}$	1183[f] 1175[c]	1189	1184	-	-
ν of Py ring	1165[h]			1163	1164
$C-N_{str}$	1200-1000[g] 1034[h]	1107	1105	1030	1031
ν In plane C-H/N-H	968[d]	966	-	962	962
ν out of plane C-H/N-H	922[d]	924	924	-	-
N/A				886	849
Out of plane C-H	779[b]	795	790	781	780
N/A	-	618	615	615	616

before = before SO_2 exposure step. after = after SO_2 exposure step

str = stretching, asm = asymmetric vibration

bend = bending, sym = symmetric vibration

[a] Khulbe, and Mann, 1982 [b] Bogang, and Zerbi, 1989

[c] Silverstien *et al.*, 1991 [d] Shen, and Wan,1998

[e] Kang, and Geckeler, 2000 [f] Prisanaroon et al., 2000

[g] Yadong *et al.*, 2002 [h] Ruangchauy, 2003

Table T2 Peak position in FT-IR spectra of 13X before and after exposed to SO_2

	Ref.	Wave number [cm^{-1}]	
		13X	
		before	after
	N/A	1647	1648
Si-O-Si	1000-1110[I]	1064	1066
Si-O-C	920-1100[J]	977	975
	N/A	751	749
	N/A	669	673
	N/A	562	560
	N/A	461	463

[I] Sigma-Aldrich Library of FTIR, 1997 [J] Skoog, Holler, Nieman, 1998

Table T3 Peak position in FT-IR spectra of Ppy/13X composite before and after exposed to SO_2

	Ref.	Wave number [cm^{-1}]			
		Ppy_ud/13X-Na[100]_10		Ppy_1:6/13X-Na[100]_10	
		before	after	before	after
	N/A	1635	1634	-	-
C=C_{sym} /C-C_{asm} in pyrrole ring	1600-1300 1560 1575	1556	1552	1544	1541
N-H_{bend}	1445	1471	1467	1453	1450
C-H&N-H def.	1298	1296	1295	1307	1300
S=O_{str}	1183 1175	1188	1189	-	-
ν of Py ring	1165	-	-	1163	1161
Si-O-Si	1110-1000	1038	1039	1029	1028
Si-O-C	968	968	964	964	965
Out of plane C-H	779	782	782	781	780
	N/A	675	673	671	672
	N/A	562	563	560	560
	N/A	456	456	459	458

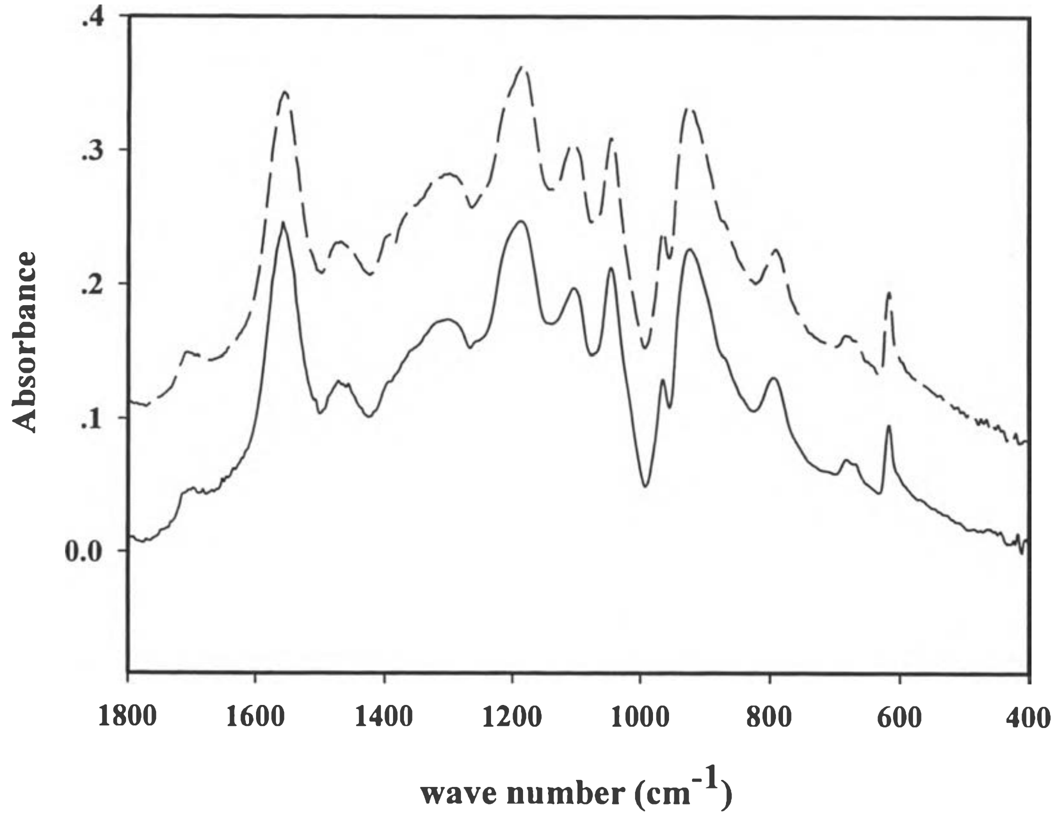


Figure T1 The FTIR spectra of Ppy_ud: before the SO_2 exposure (solid line) and after the SO_2 exposure (broken line).

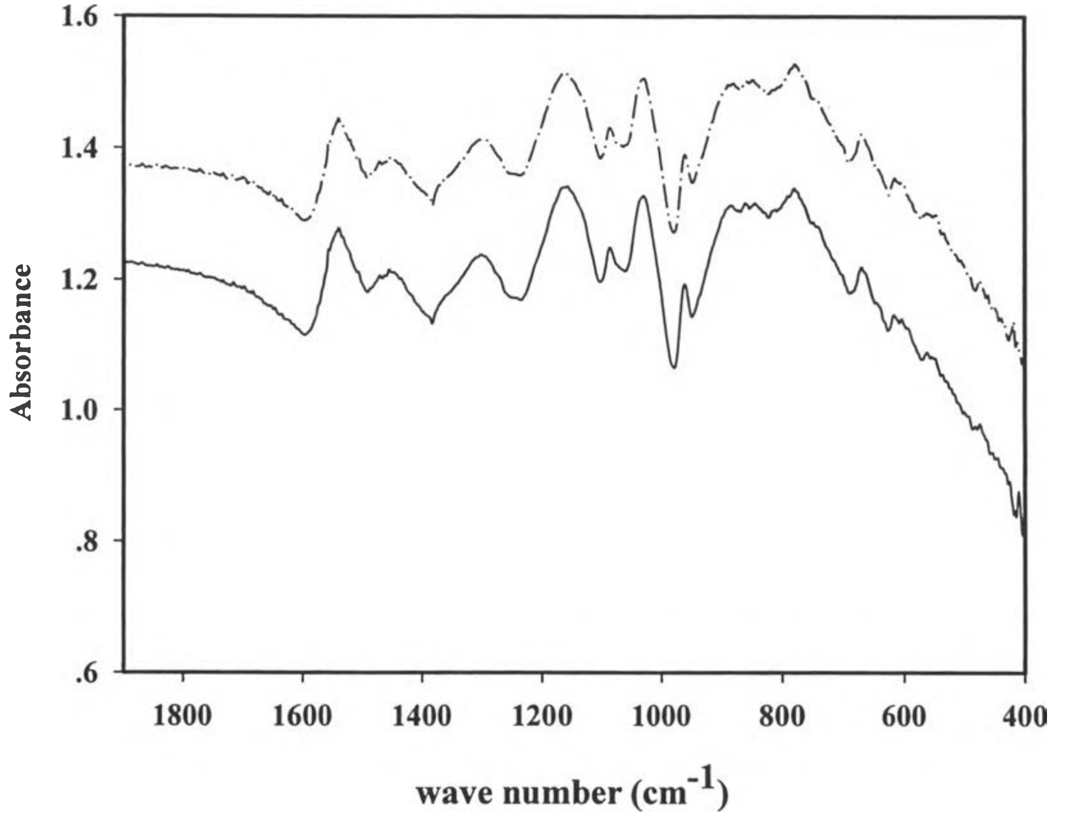


Figure T2 The FTIR spectra of Ppy_1:6: before the SO_2 exposure (solid line) and after the SO_2 exposure (broken line).

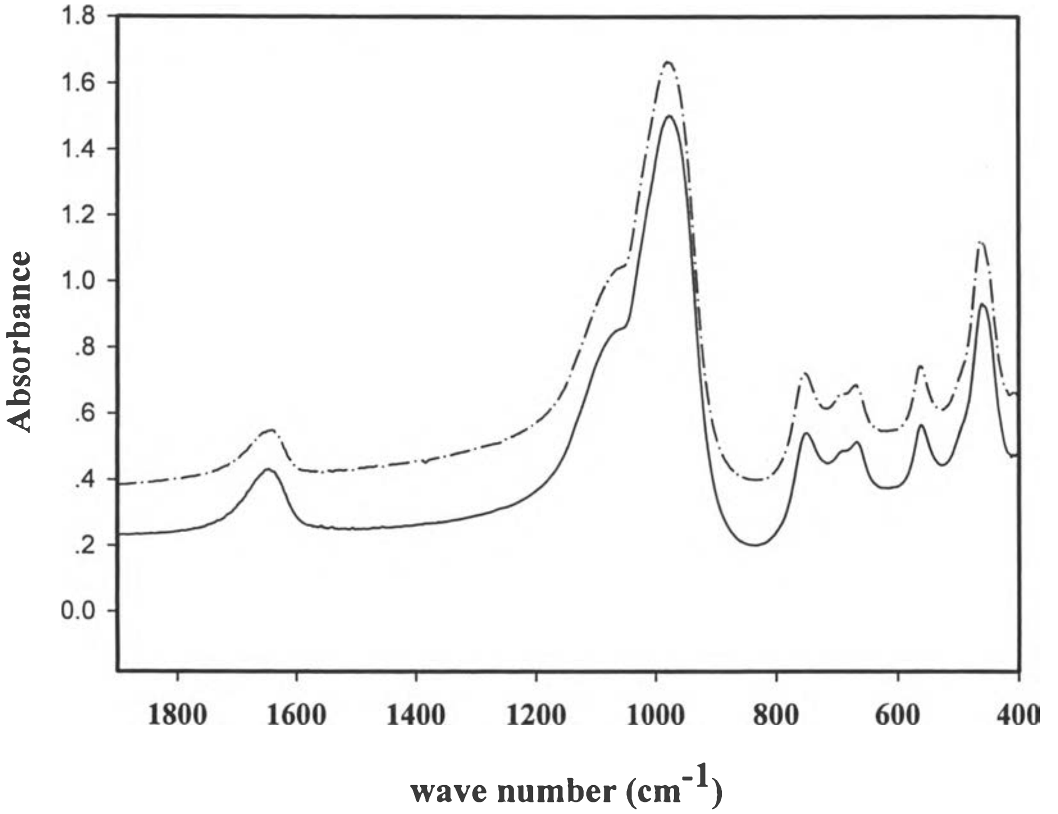


Figure T3 The FTIR spectra of 13X: before the SO_2 exposure (solid line) and after the SO_2 exposure (broken line).

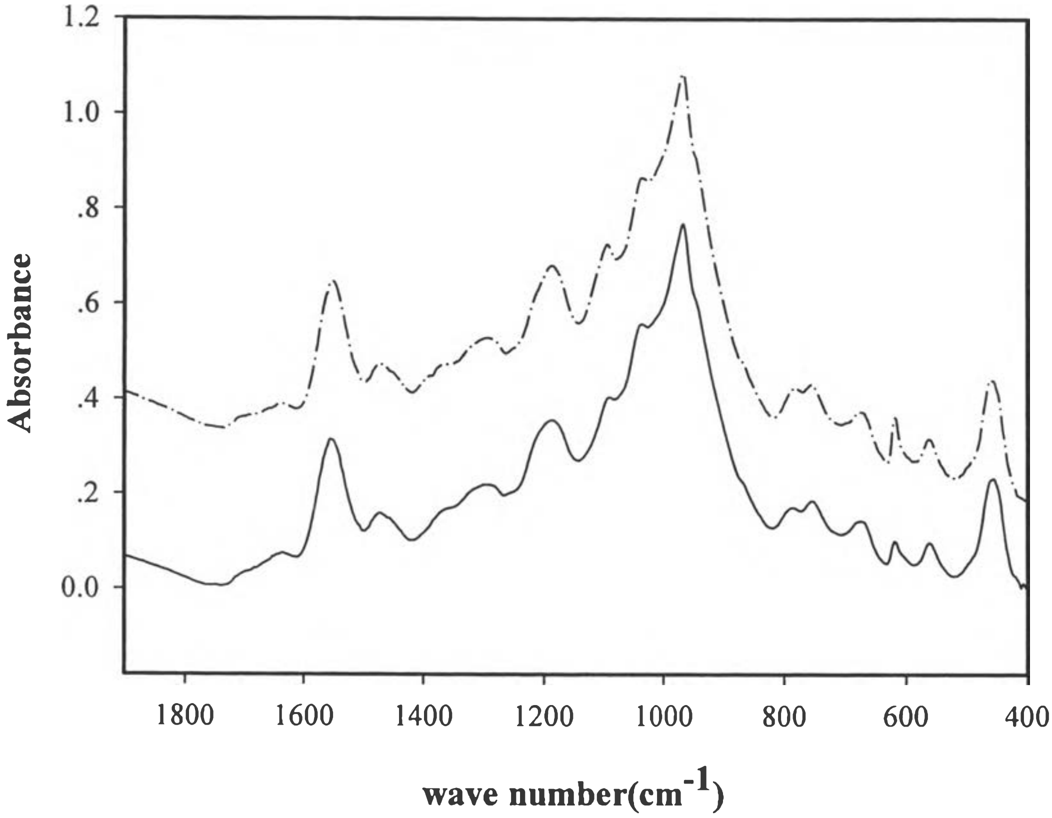


Figure T4 The FTIR spectra of Ppy_ud/13X-Na[100]_10: before the SO_2 exposure (solid line) and after the SO_2 exposure (broken line).

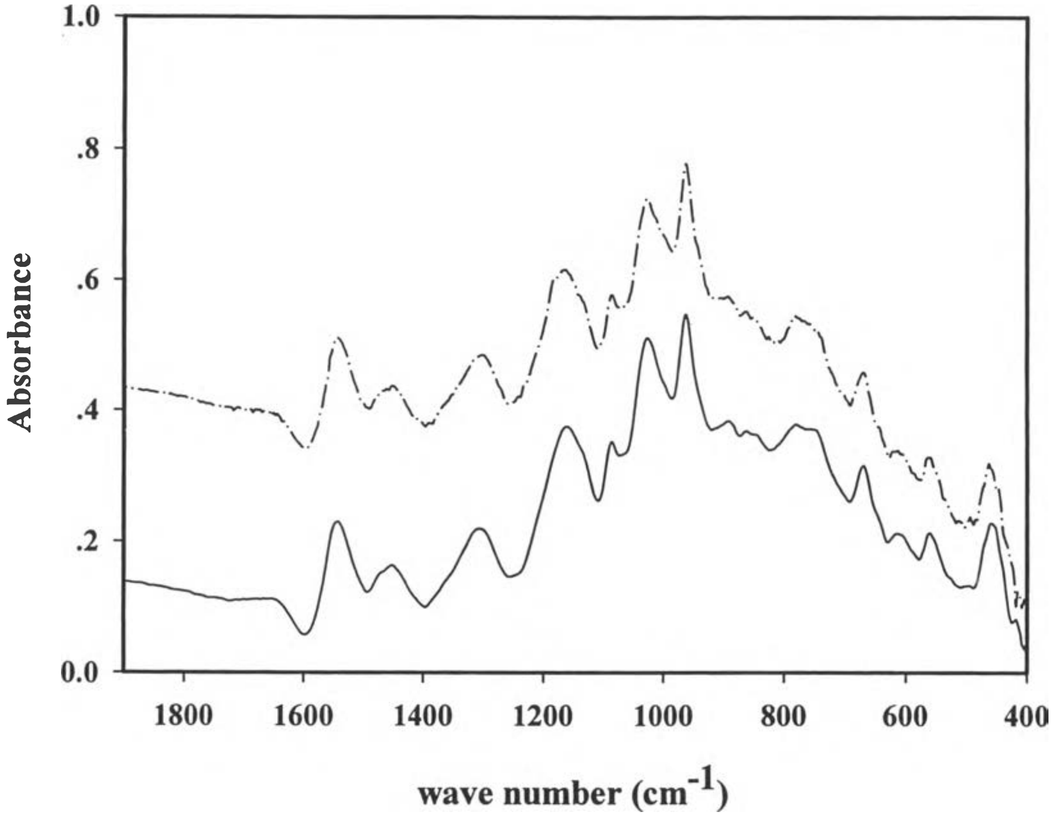


Figure T5 The FTIR spectra of Ppy_1/6//13X-Na[100]_10: before the SO_2 exposure (solid line) and after the SO_2 exposure (broken line).

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