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APPENDICES

Appendix A Determination of functional groups by Fourier Transform Infrared Spectroscopy

The PPy, doped PPy and SSA were characterized by FT-IR spectroscopy in order to identify functional groups. Optical grade KBr (Carlo Erba Reagent) was used as the background material. 10 mg sample was mixed with 50 mg KBr. An FT-IR spectrum was observed by using an FT-IR spectrometer (Thermo Nicolet) in the absorption mode with 32 scans at a resolution of 4 cm^{-1}. For PAA drug load PAA and drug-load PPy/PAA blend film were using the ATR-FTIR spectrometer to investigate interaction between drugs and blend film.

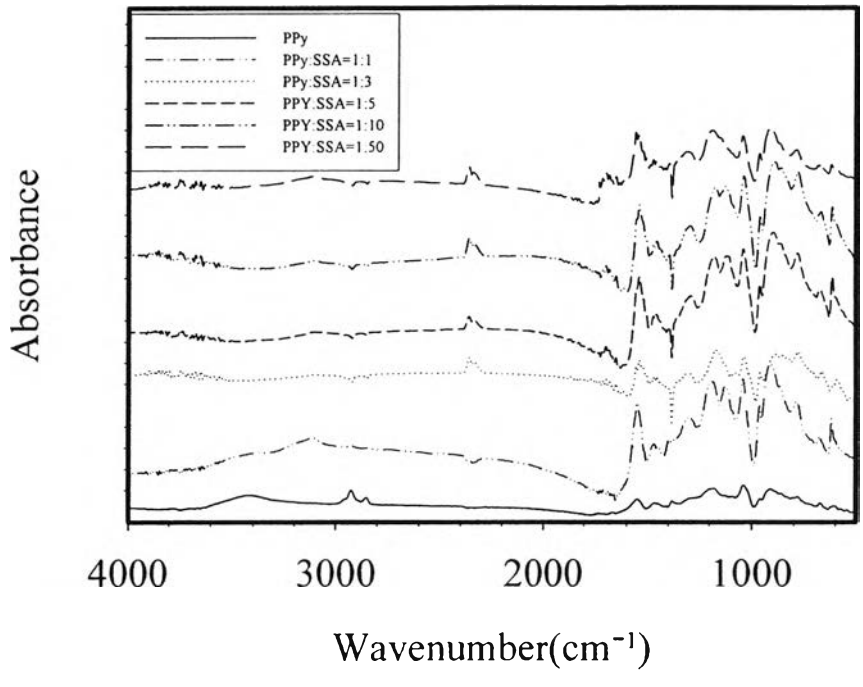


Figure A1 FT-IR spectra of PPy and doped PPy with 5-sulfosalicylic acid at various doping levels.

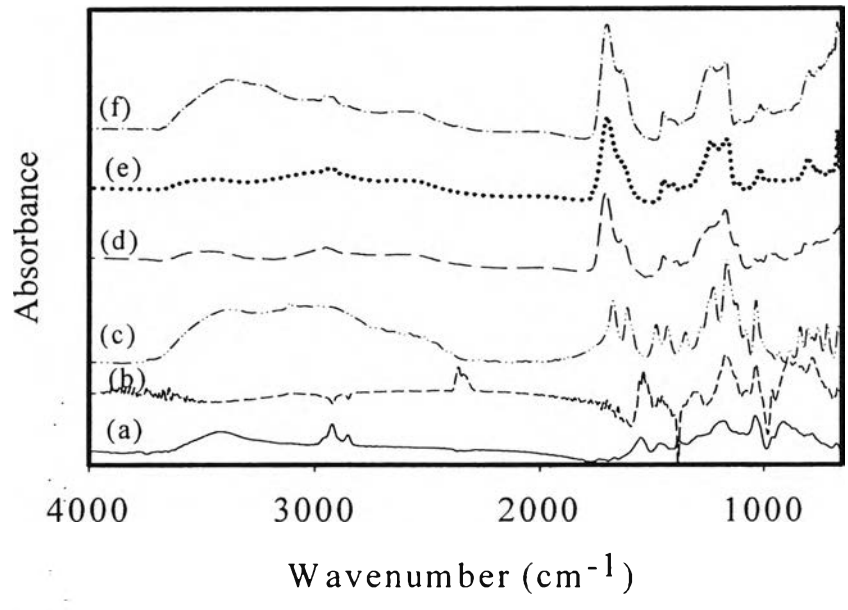


Figure A2 Absorption infrared spectra of: (a) PPy powder; (b) PPy doped with SSA; (c) SSA powder; (d) pure PAA hydrogel; (e) SSA-loaded PAA hydrogel; and (f) SSA-loaded PPy/PAA blend film.

The absorption infrared spectrum of PPy and doped PPy with 5-sulfosalicylic acid is shown in comparison in figure A1. The peak at 1280 cm^{-1} and a broad region at 3426 cm^{-1} are assigned to the stretching vibration and the bending vibration of N-H bond, respectively (Kang and Geckeler, 2000 and Tian and Zerbi, 1990). The peaks at 3000-2800 cm^{-1} represent the aliphatic C-H bonds and the peaks at 1543 and 1465 cm^{-1} can be identified as the asymmetric and the symmetric C=C /C-C stretching vibrations in pyrrole ring (Khatua and Hsieh, 1997, Rosner and Rubner, 1994, Wadhwa *et al.*, 2006, Toshima and Ihata, 1996 and Tian and Zerbi, 1990). After polypyrrole is doped with 5-sulfosalicylic acid, the peak at 3426 cm^{-1} disappears. The band at 1181 cm^{-1} and 590 cm^{-1} represent the S=O and S-O stretching vibration of sulfonate anions which compensated the positive charges in the polypyrrole chains (Gassner *et al.*, 1997 and Pouchert, *1997*).

Figure A2 show the absorption infrared spectra of PPy powder, PPy doped with SSA, SSA powder, pure PAA hydrogel, SSA-loaded PAA hydrogel and SSA-loaded PPy/PAA blend film. In pure PAA, drug-load PAA and drug-load PPy/PAA blend film, we observed a broad region around 3000 to 3600 cm^{-1} assigned to OH

stretching and C=O stretching and CO^{-} due to intermolecular hydrogen bonding in the same region (Peppas and Wright,1998). The peak at 1705 represents C=O starching in pure PAA but is seen at 1698 and 1701 in the drug-load PAA hydrogel and drug-load PPy/PAA blend film, respectively.

For pure SSA, two peaks at 1038 and around 670 cm^{-1} assigned to the sulfonate groups (SO^{3-}) stretching (Weast and Astle, 1978). For drug-loaded PAA hydrogel and drug-load PPy/PAA blend film, the sulfonate groups (SO^{3-}) stretching grows and has a gradual shift of OH stretching. These results indicate the H-bonding between the sulfonate groups of sulfosalicylic acid with hydroxyl group of PAA hydrogel (Wu et al., 2006).

Table A1 Peak positions from FT-IR spectra of PPy and doped PPy with 5-sulfosalicylic acid

Assigment	References	Wavenumber (cm^{-1})						
		Ref.	PPy	PPy:SSA=1:1	PPy:SSA=1:3	PPy:SSA=1:5	PPy:SSA=1:10	PPy:SSA=1:50
ν N-H	Kang and Geckeler, 2000	3420	3426	-	-	-	-	-
O-H	Wu *et al.* (2006)	3000-3600	-	3116	3095	3097	3118	3116
ν_{as} CH_2	Rosner and Rubner, 1994	2917	2923	-	-	-	-	-
ν_{as} CH_2	Khatua and Hsieh, 1997	2954						
ν_s CH_2	Rosner and Rubner, 1994	2851	2851	-	-	-	-	-
ν_s CH_2	Khatua and Hsieh, 1997	2852						
C=O	Gassner *et al.*, 1997	1720	-	1700	1700	1701	1699	1700
ν N-H	Wadhwa *et al.*, 2006	1550	1543	1544	1540	1541	1540	1542
ν C=C	Toshima and Ihata, 1996	1550						
ν C=C	Tian and Zerbi, 1990	1546						
ν_{as}C=C	Toshima and Ihata, 1996	1480	1465	1473	1470	1457	1456	1473
ν_{as}C=C	Tian and Zerbi, 1990	1470						
ν C-C & C-N	Tian and Zerbi, 1990	1391	-	-	-	-	-	-
ν C-N	Toshima and Ihata, 1996	1380	1383	1397	1314	1397	1397	1397
N/A		-	-	-	-	-	-	-
Deformation vib.	Toshima and Ihata, 1996	1300	1280	1294	1288	1291	1297	1297
C-H & N-H def.	Tian and Zerbi, 1990	1295						
ν C-C	Kang and Geckeler, 2000	1290						
C-H & N-H def.	Tian and Zerbi, 1990	1242	-	-	-	-	-	-
ν C-N	Kang and Geckeler, 2000	1190	-	-	-	-	-	-
ν S=O	Gassner *et al.*, 1997	1180	1176	1185	1172	1178	1174	1186
ν of Py ring	Kang and Geckeler, 2000	1167	-	-	-	-	-	-
ν C-C & C-N	Tian and Zerbi, 1990	1148	-	-	-	-	-	-
N/A		-	-	1126	1079	1121	1125	-
C-H def.	Tian and Zerbi, 1990	1050	-	-	-	-	-	-
ν of Py ring	Shen *et al.*, 1998	1045	1039	1042	1037	1041	1039	1043
in-plane N-H	Zaid *et al.*, 1994	1029						
ν of Py ring	Shen *et al.*, 1998	968	960	965	962	964	964	965
ν of Py ring	Shen *et al.*, 1999	922	-	-	-	-	-	-
out-of plane C-H	Zaid *et al.*, 1994	908	911	912	885	900	895	914
out-of plane C-H	Zaid *et al.*, 1995	767	780	785	783	784	783	786
SO_3^- group	Weast and Astle, 1978	670	674	672	668	671	670	670
ν S-O	Pouchert, *1997*	620	612	618	599	616	615	619

Table A2 The FT-IR absorption spectrum of pure PAA, pure SSA, drug-load PAA hydrogel and drug-load PPy/PAA blend film

Wavenumber (cm^{-1})	**Assignments**	**References**
3000-3600 [3000-3500]	O-H stretching	Wu *et al.* (2006)
2941 [2940]	CH_2 stretching	Bhat *et al.* (2005)
1421 [1430]	CH_2 bending	Bhat *et al.* (2005)
1330 [1300]	C-O stretching	Wu *et al.* (2006)
1089 [1096]	C=O stretching vibration	Bhat *et al.* (2005)
847 [850]	C-C stretching	Bhat *et al.* (2005)
1036 [1030]	S=O symmetric stretching	Wu *et al.* (2006)
716 [700]	S-O symmetric stretching	Wu *et al.* (2006)

Appendix B Scanning Electron Micrograph of PPy and doped PPy with 5-sulfosalicylic acid at various doping ratios

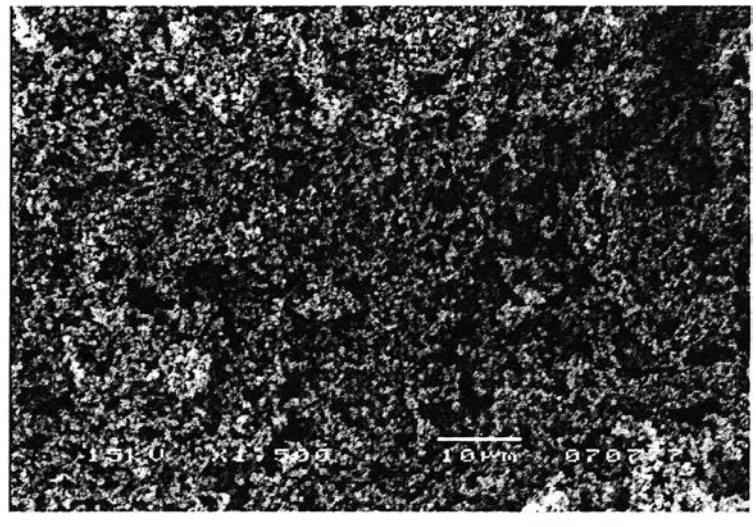


Figure B1 The morphology of polypyrrole powder at magnification x 1500.

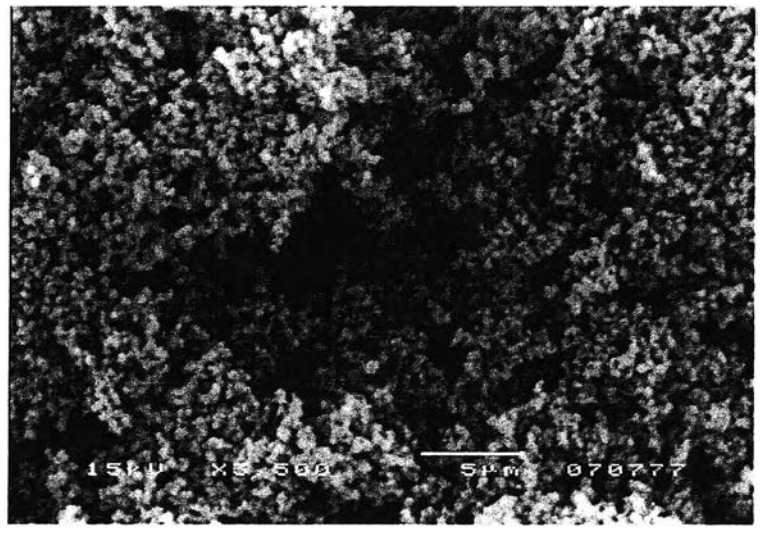


Figure B2 The morphology of polypyrrole powder at magnification x 3500.

Figure B3 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:1) at magnification x 1500.

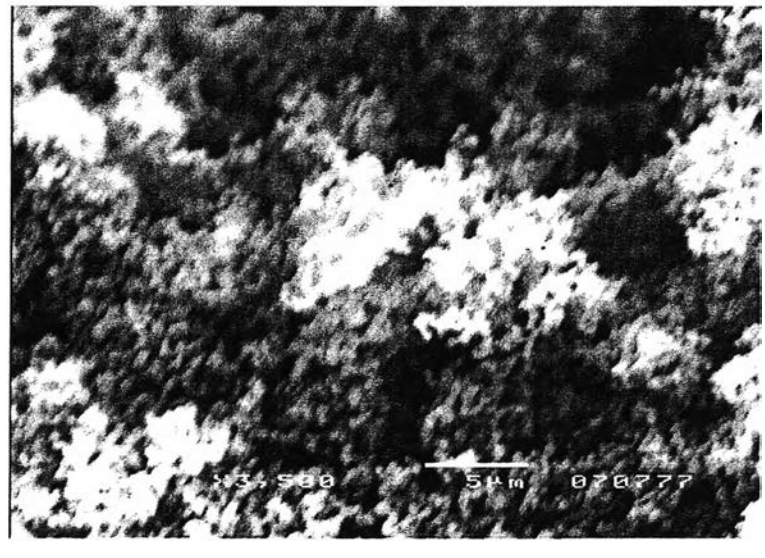


Figure B4 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:1) at magnification x 3500.

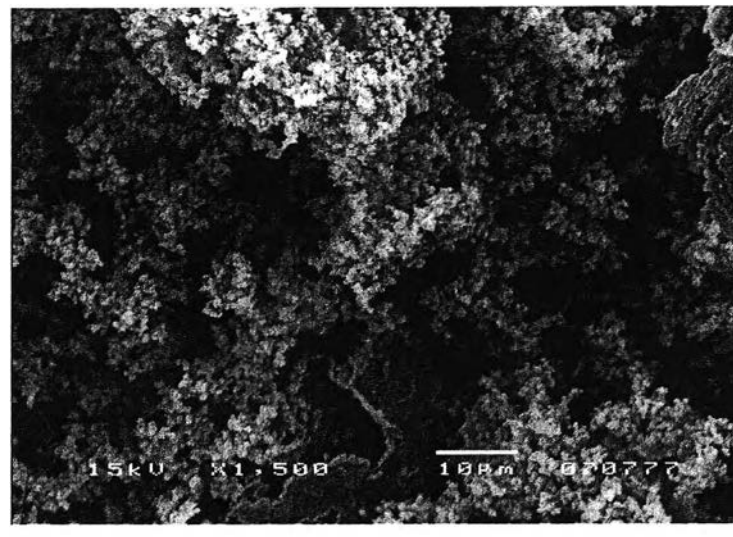


Figure B5 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:5) at magnification x 1500.

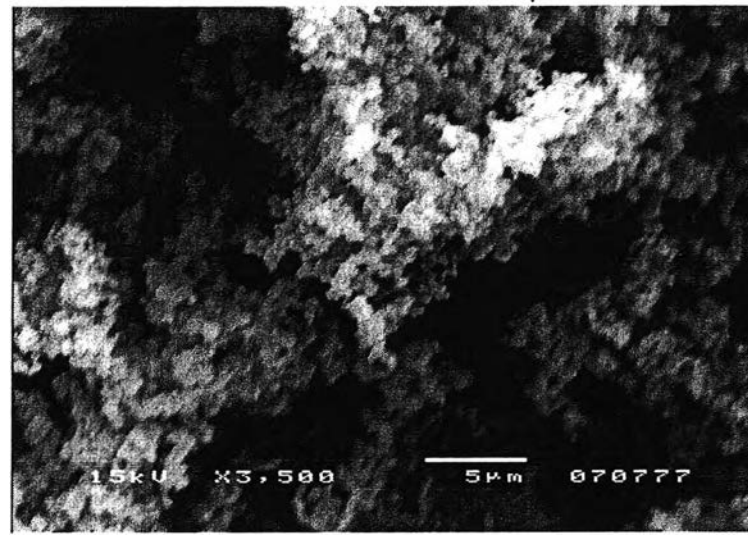


Figure B6 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:5) at magnification x 3500.

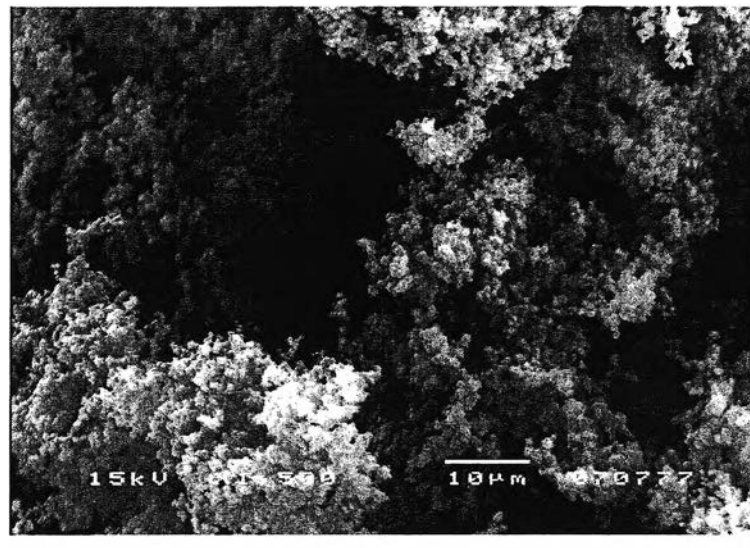


Figure B7 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:10) at magnification x 1500.

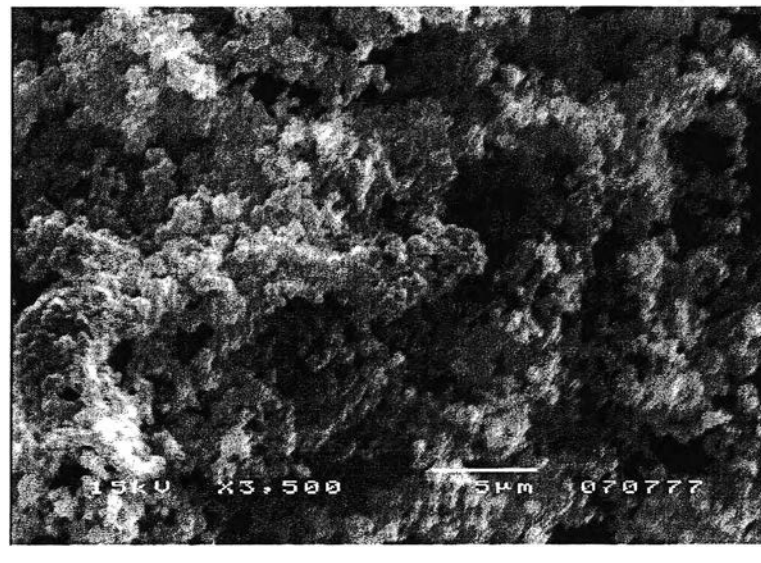


Figure B8 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:10) at magnification x 3500.

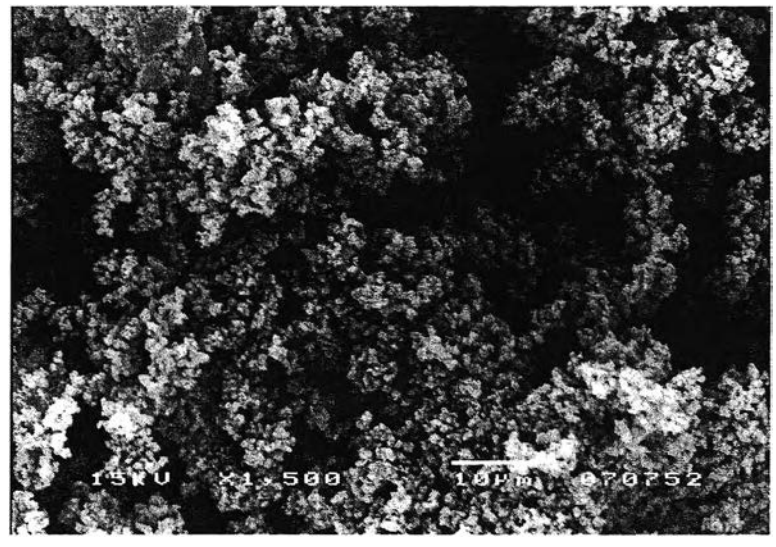


Figure B9 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:50) at magnification x 1500.

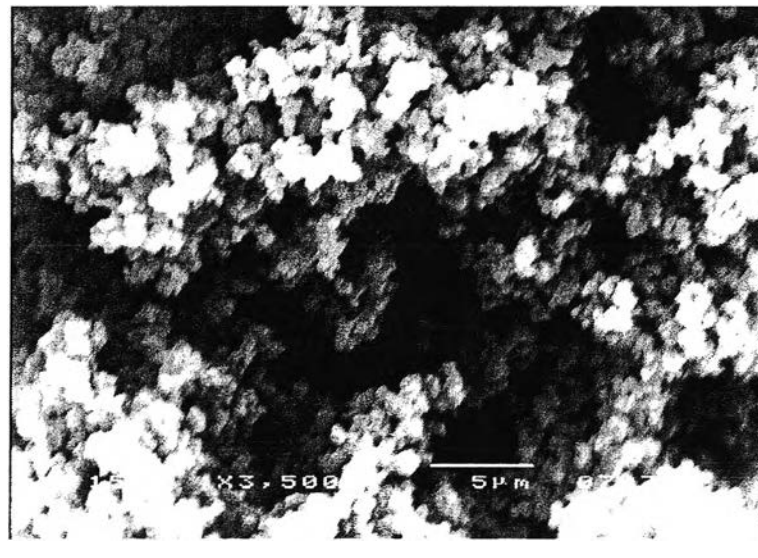


Figure B10 The morphology of doped polypyrrole powder with 5-sulfosalicylic acid (1:50) at magnification x 3500.

Appendix C Determination of the Correction Factor (K)

The electrical conductivity of sample was measured by a two-point probe meter. The meter consists of two probes, making contact on the surface of thin layer sample. These probes were connected to a source meter (Keithley, Model 6517A) for a constant voltage source and reading the resultant current.

The geometrical correction factor was taken into account of geometric effects, depending on the configuration and probe tip spacing:

$$K = \frac{w}{l} \tag{C.1}$$

where K is geometrical correction factor

w is width of probe tip spacing (cm)

l is the length between probe (cm)

In this measurement, the constant K value was determined by using a standard sheet with a known resistivity value; we used silicon wafer chips (SiO_2). K was calculated by using Equation C.2:

$$K = \frac{\rho}{R \times t} = \frac{I \times \rho}{V \times t} \tag{C.2}$$

where K = geometric correction factor

ρ = resistivity of standard silicon wafer which were calibrated by using a four point probe at King Mongkut's Institute Technology Lad Krabang (Ω.cm)

t = film thickness (cm)

R = film resistance (Ω)

I = measure current (A)

V = voltage drop (V)

Standard Si wafer were cleaned to remove organic impurities prior to be used according to the standard RCA method (Kern, 1993).

Table C1 The raw data of the determination of the geometric correction factor (K) of probe number 1 with silicon wafer whose sheet resistivity of 107.373 Ω/sq., 25 °C, R.H. 65%

Voltage (V)			**Current (A)**			**Correction factor (K)**		
1	2	3	1	2	3	1	2	3
0.1	0.1	0.1	1.52E-08	1.49E-08	1.50E-08	1.63E-05	1.60E-05	1.61E-05
0.3	0.3	0.3	1.43E-07	1.44E-07	1.43E-07	5.12E-05	5.14E-05	5.12E-05
0.5	0.5	0.5	1.02E-06	1.01E-06	9.59E-07	2.18E-04	2.18E-04	2.06E-04
0.8	0.8	0.8	4.42E-06	4.47E-06	4.41E-06	5.93E-04	6.00E-04	5.92E-04
1	1	1	8.01E-06	7.99E-06	7.94E-06	8.60E-04	8.58E-04	8.53E-04
1.5	1.5	1.5	1.41E-05	1.43E-05	1.42E-05	1.01E-03	1.02E-03	1.02E-03
2	2	2	1.76E-05	1.76E-05	1.77E-05	9.45E-04	9.47E-04	9.50E-04
2.5	2.5	2.5	1.98E-05	1.99E-05	1.98E-05	8.52E-04	8.54E-04	8.53E-04
3	3	3	2.22E-05	2.24E-05	2.21E-05	7.93E-04	8.00E-04	7.91E-04
4	4	4	2.65E-05	2.65E-05	2.65E-05	7.12E-04	7.11E-04	7.10E-04
5	5	5	3.10E-05	3.10E-05	3.09E-05	6.65E-04	6.66E-04	6.64E-04
6	6	6	3.72E-05	3.75E-05	3.72E-05	6.66E-04	6.72E-04	6.66E-04
7	7	7	4.49E-05	4.59E-05	4.54E-05	6.89E-04	7.05E-04	6.96E-04
Average						6.20E-04	6.25E-04	6.20E-04
Average						6.22E-04		
SD						3.18E-04		

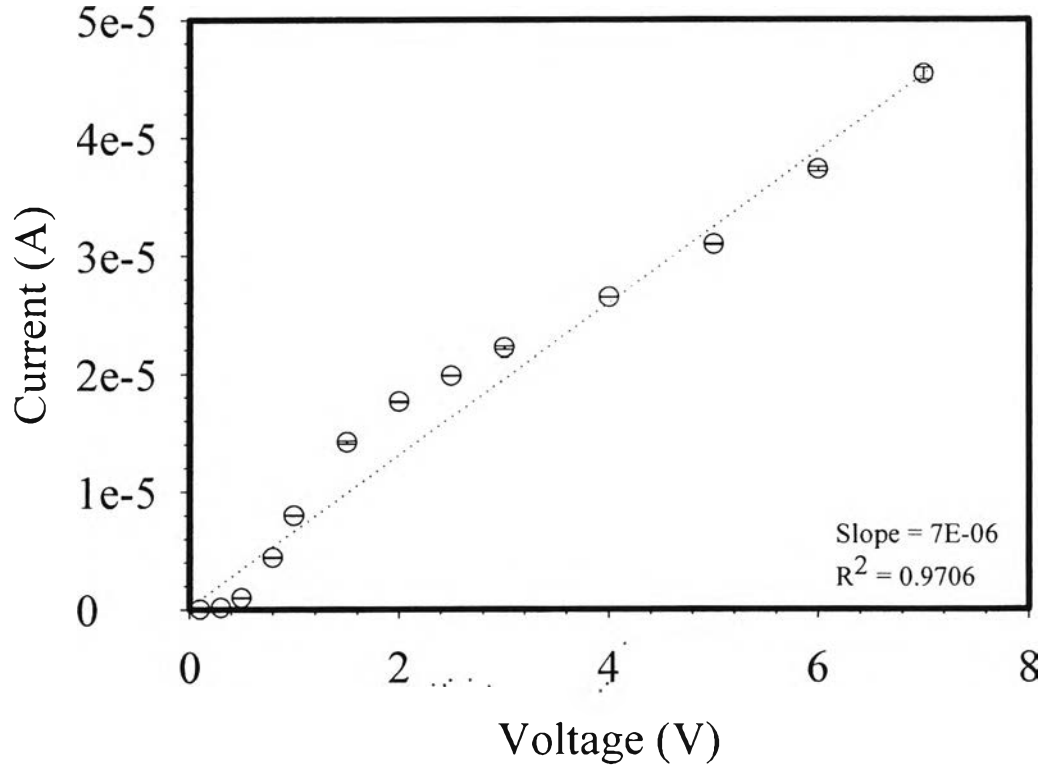


Figure C1 Voltage vs. current of the probe calibration with Si-wafer whose sheet resistivity of 107.373 Ω/sq., 25 °C, R.H. 65%.

Appendix D Conductivity Measurement

The specific conductivity which is the inversion of specific resistivity (ρ) of undoped PPy, doped PPy with sodiumsalicylate, and doped PPy with 5-sulfosalicylic acid dihydrate pellets were measured by using the two-point probe connected to a source meter (Keithley, Model 6517A) for a constant voltage source and reading resultant current. The thickness of pellets was measured by a thickness gauge. The applied voltage was plotted versus the current change to determine the linear ohmic regime of each sample. The applied voltage and the current change in the linear ohmic regime were converted to the electrical conductivity of the polymer by using equation (D.1) as follows:

$$\sigma = \frac{1}{\rho} = \frac{1}{R_s \times t} = \frac{I}{K \times V \times t} \qquad \text{(D.1)}$$

where σ = specific conductivity (S/cm)

ρ = specific resistivity (Ω.cm)

R_s = sheet resistivity (Ω)

I = measured current (A)

K = geometric correction factor

V = applied voltage (voltage drop) (V)

t = pellet thickness (cm).

From the geometric correction factor (K) = 6.22 x 10^{-4}, the specific conductivity of undoped Ppy was 1.149 S/cm with standard deviation of 0.039 S/cm. The electrical conductivity of undoped PPy is rather high due to APS, the oxidant used in the polymerization process, produced $HSO4^-$ which also acted as a dopant.

For doped PPy the specific conductivity increased as the doping level is increased as present in Table 1. The increase in electrical conductivity can be

attributed to the increases in the number of charge carriers, the degree of crystallinity and the charge mobility (Soontornworajit, 2007).

Table D1 Determination the specific conductivity (S/cm) of PPy and doped PPy with 5-sulfosodiumsalicylic acid

Sample	Specific conductivity (S/cm)	SD
PPy	1.149	0.039
PPy:SSA=1:1	1.154	0.040
PPy:SSA=1:5	2.072	0.038
PPy:SSA=1:10	3.312	0.093
PPy:SSA=1:50	51.836	1.605

Table D2 The raw data of the determination of the polypyrrole, thickness = 0.055 cm, at 25 °C, R.H. 65%

Voltage (V)			Current (A)			Correction factor (K)		
1	2	3	1	2	3	1	2	3
0.02	0.02	0.02	7.03E-07	7.04E-07	7.05E-07	1.054	1.055	1.058
0.04	0.04	0.04	1.44E-06	1.44E-06	1.44E-06	1.081	1.083	1.083
0.06	0.06	0.06	2.30E-06	2.31E-06	2.31E-06	1.152	1.153	1.155
0.08	0.08	0.08	3.05E-06	3.05E-06	3.05E-06	1.143	1.144	1.144
0.1	0.1	0.1	3.80E-06	3.80E-06	3.80E-06	1.140	1.140	1.139
0.12	0.12	0.12	4.67E-06	4.67E-06	4.67E-06	1.166	1.167	1.168
0.14	0.14	0.14	5.42E-06	5.42E-06	5.43E-06	1.161	1.162	1.163
0.16	0.16	0.16	6.30E-06	6.30E-06	6.30E-06	1.180	1.181	1.182
0.18	0.18	0.18	7.06E-06	7.05E-06	7.05E-06	1.176	1.175	1.175
0.2	0.2	0.2	7.80E-06	7.81E-06	7.81E-06	1.170	1.171	1.172
0.23	0.23	0.23	9.07E-06	9.06E-06	9.07E-06	1.182	1.182	1.183
0.25	0.25	0.25	9.83E-06	9.84E-06	9.84E-06	1.180	1.180	1.181
0.28	0.28	0.28	1.11E-05	1.11E-05	1.11E-05	1.189	1.189	1.189
0.3	0.3	0.3	1.15E-05	1.16E-05	1.16E-05	1.148	1.155	1.160
Average						1.149	1.149	1.150
Average						1.149		
SD						0.039		

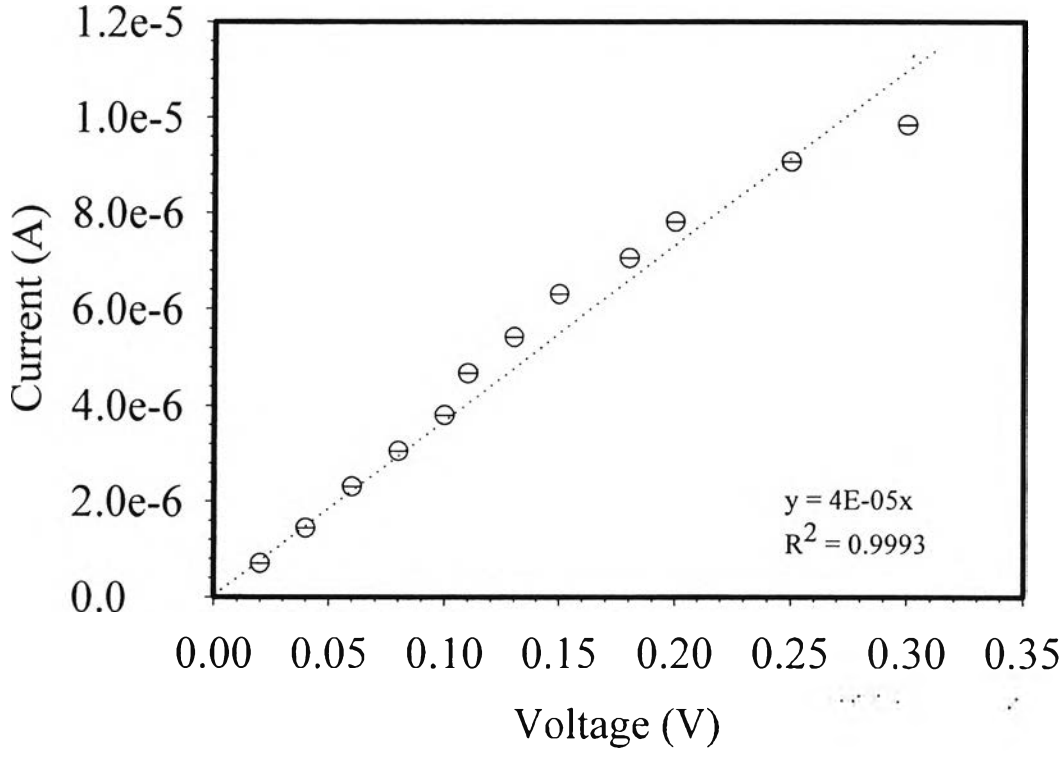


Figure D1 Determine the ohmic regime of polypyrrole, thickness = 0.055 cm, at 27 °C, R.H. 65%.

Table D3 The raw data of the determination of doped polypyrrole with 5-sulfosalicylic acid at 1:1 ratio, thickness = 0.047 cm, at 25 °C, R.H. 65%

Voltage (V)			**Current (A)**			**Conductivity (S/cm)**		
1	2	3	1	2	3	1	2	3
0.02	0.02	0.02	7.93E-07	7.92E-07	7.92E-07	1.158	1.158	1.157
0.04	0.04	0.04	1.57E-06	1.57E-06	1.56E-06	1.145	1.145	1.143
0.06	0.06	0.06	2.47E-06	2.46E-06	2.46E-06	1.202	1.198	1.199
0.08	0.08	0.08	3.24E-06	3.25E-06	3.24E-06	1.184	1.186	1.184
0.1	0.1	0.1	3.62E-06	3.63E-06	3.65E-06	1.060	1.061	1.067
0.12	0.12	0.12	4.90E-06	4.89E-06	4.90E-06	1.193	1.191	1.194
0.14	0.14	0.14	5.62E-06	5.63E-06	5.64E-06	1.174	1.176	1.177
0.16	0.16	0.16	6.48E-06	6.49E-06	6.50E-06	1.183	1.186	1.188
0.18	0.18	0.18	7.18E-06	7.22E-06	7.22E-06	1.167	1.172	1.172
0.2	0.2	0.2	7.51E-06	7.59E-06	7.60E-06	1.098	1.109	1.111
0.25	0.25	0.25	9.84E-06	9.87E-06	9.88E-06	1.151	1.154	1.155
0.3	0.3	0.3	1.15E-05	1.15E-05	1.15E-05	1.117	1.120	1.121
Average						1.153	1.155	1.156
Average						1.154		
SD						0.040		

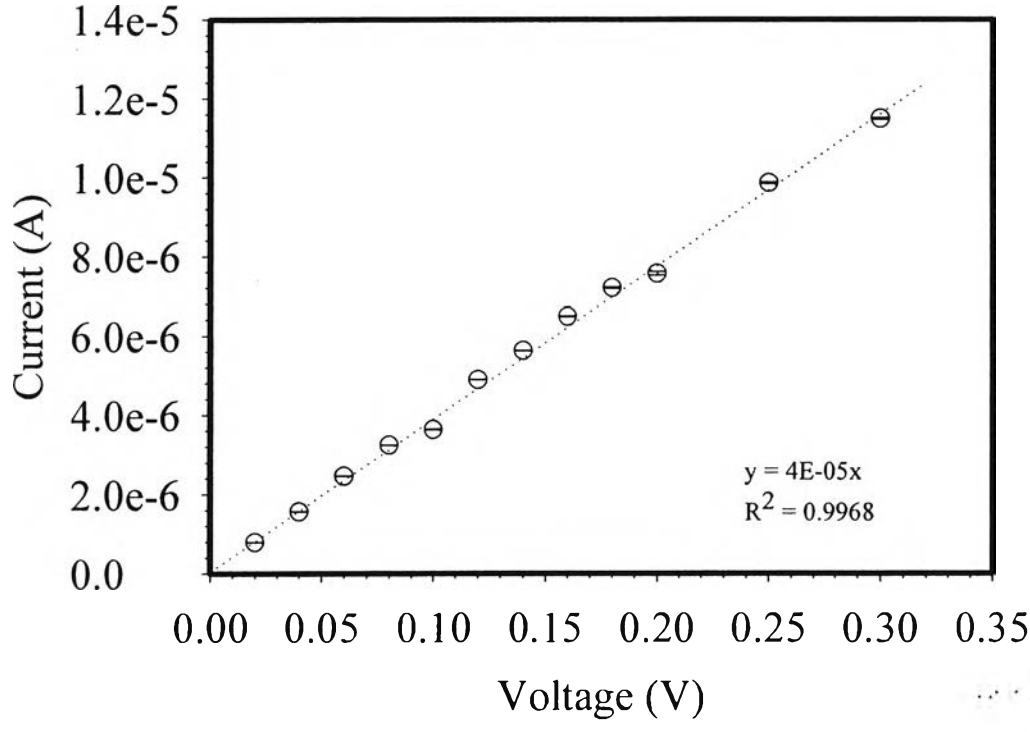


Figure D2 Determine the ohmic regime of doped polypyrrole with 5-sulfosalicylic acid at 1:1 ratio, thickness = 0.047 cm, at 25 °C, R.H. 65%.

Table D4 The raw data of the determination of doped polypyrrole with 5-sulfosalicylic acid at 1:5 ratio, thickness = 0.054 cm, at 25 °C, R.H. 65%

Voltage (V)			**Current (A)**			**Conductivity (S/cm)**		
1	2	3	1	2	3	1	2	3
0.02	0.02	0.02	1.18E-06	1.18E-06	1.17E-06	2.013	2.011	1.997
0.04	0.04	0.04	2.39E-06	2.39E-06	2.39E-06	2.044	2.044	2.047
0.06	0.06	0.06	3.76E-06	3.76E-06	3.76E-06	2.145	2.145	2.145
0.08	0.08	0.08	4.92E-06	4.92E-06	4.92E-06	2.102	2.102	2.103
0.1	0.1	0.1	6.05E-06	6.05E-06	6.06E-06	2.068	2.070	2.071
0.11	0.11	0.11	6.81E-06	6.82E-06	6.82E-06	2.118	2.120	2.121
0.13	0.13	0.13	7.95E-06	7.96E-06	7.97E-06	2.093	2.096	2.096
0.15	0.15	0.15	9.03E-06	9.05E-06	9.06E-06	2.060	2.063	2.067
0.18	0.18	0.18	1.10E-05	1.10E-05	1.10E-05	2.088	2.092	2.096
0.2	0.2	0.2	1.19E-05	1.19E-05	1.19E-05	2.032	2.032	2.034
0.25	0.25	0.25	1.50E-05	1.52E-05	1.49E-05	2.052	2.080	2.039
0.3	0.3	0.3	1.80E-05	1.82E-05	1.81E-05	2.052	2.075	2.064
Average						2.072	2.077	2.073
Average						2.072		
SD						0.038		

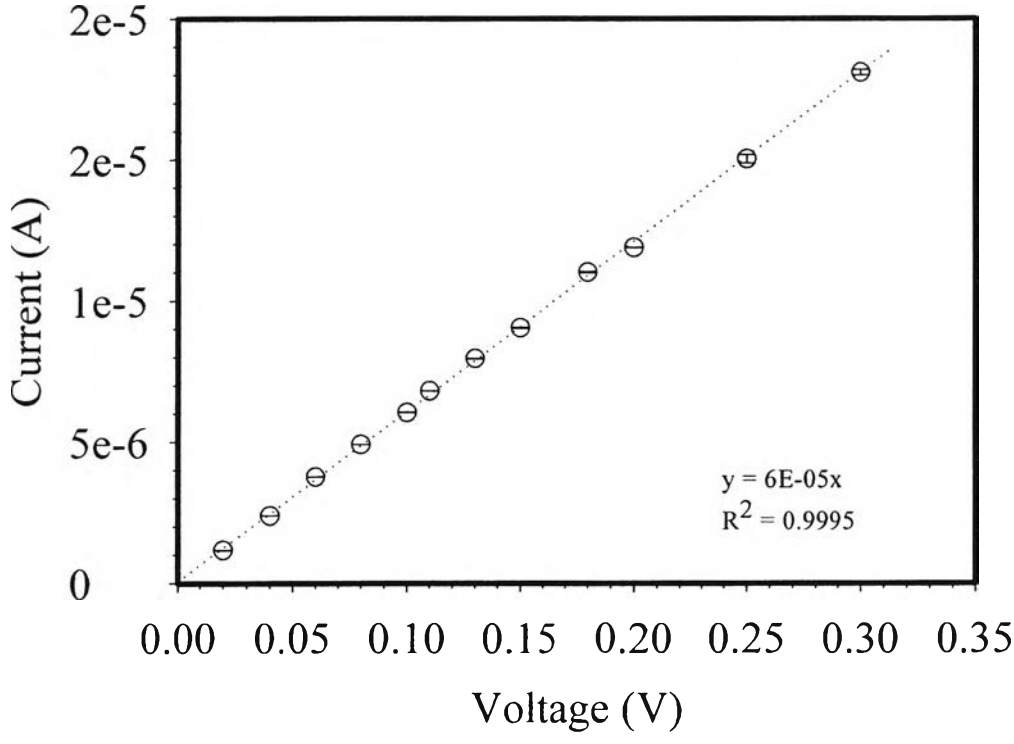


Figure D3 Determine the ohmic regime of doped polypyrrole with 5-sulfosalicylic acid at 1:5 ratio, thickness = 0.054 cm, at 25 °C, R.H. 65%.

Table D5 The raw data of the determination of doped polypyrrole with 5-sulfosalicylic acid at 1:10 ratio, thickness = 0.036 cm, at 25 °C, R.H. 65%

Voltage (V)			**Current (A)**			**Conductivity (S/cm)**		
1	2	3	1	2	3	1	2	3
0.02	0.02	0.02	1.37E-06	1.37E-06	1.38E-06	3.095	3.109	3.124
0.04	0.04	0.04	2.78E-06	2.79E-06	2.79E-06	3.147	3.154	3.160
0.06	0.06	0.06	4.44E-06	4.45E-06	4.46E-06	3.350	3.358	3.366
0.08	0.08	0.08	5.88E-06	5.89E-06	5.90E-06	3.327	3.336	3.343
0.1	0.1	0.1	7.34E-06	7.36E-06	7.37E-06	3.326	3.331	3.336
0.12	0.12	0.12	9.04E-06	9.06E-06	9.07E-06	3.412	3.417	3.424
0.14	0.14	0.14	1.05E-05	1.05E-05	1.05E-05	3.402	3.407	3.410
0.16	0.16	0.16	1.16E-05	1.16E-05	1.17E-05	3.275	3.294	3.307
0.2	0.2	0.2	1.48E-05	1.50E-05	1.50E-05	3.351	3.397	3.392
0.25	0.25	0.25	1.85E-05	1.84E-05	1.86E-05	3.351	3.326	3.360
0.3	0.3	0.3	2.22E-05	2.23E-05	2.23E-05	3.351	3.360	3.363
0.4	0.4	0.4	2.96E-05	2.97E-05	2.98E-05	3.351	3.361	3.372
Average						3.312	3.321	3.330
Average						3.312		
SD						0.093		

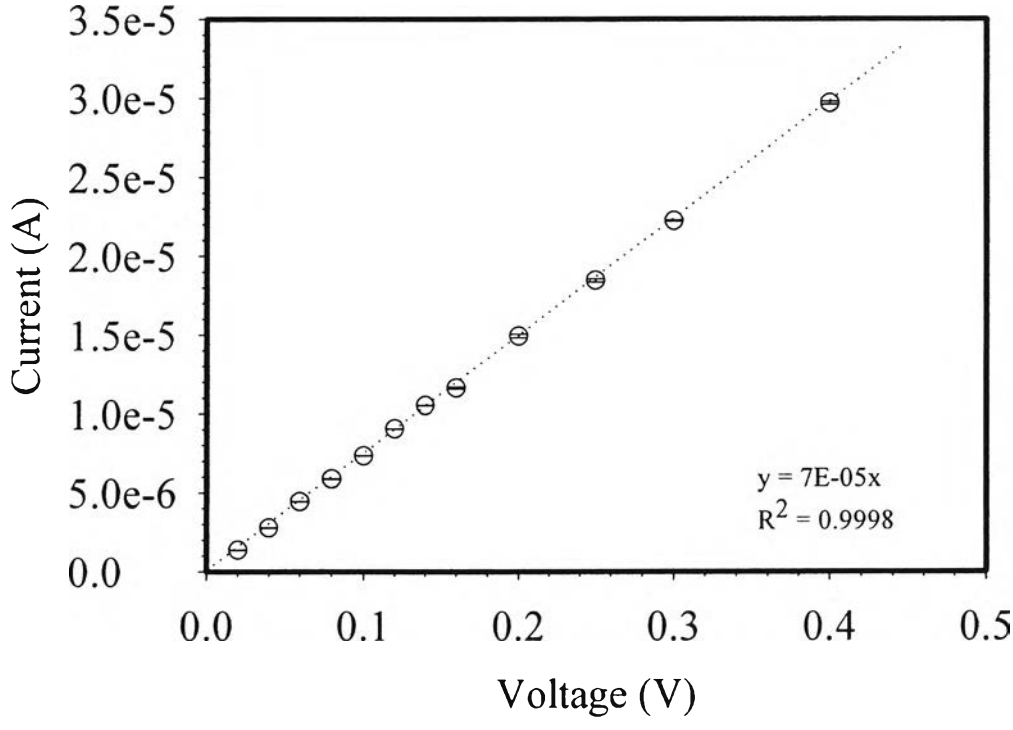


Figure D4 Determine the ohmic regime of doped polypyrrole with 5-sulfosalicylic acid at 1:10 ratio, thickness = 0.036 cm, at 25 °C, R.H. 65%.

Table D6 The raw data of the determination of doped polypyrrole with 5-sulfosalicylic acid at 1:50 ratio, thickness = 0.015 cm, at 25 °C, R.H. 65%

Voltage (V)			Current (A)			Conductivity (S/cm)		
1	2	3	1	2	3	1	2	3
0.02	0.02	0.02	9.39E-06	9.35E-06	9.33E-06	50.348	50.125	50.002
0.04	0.04	0.04	1.86E-05	1.87E-05	1.87E-05	49.921	50.073	50.158
0.06	0.06	0.06	2.96E-05	2.96E-05	2.96E-05	52.893	52.923	52.923
0.08	0.08	0.08	3.90E-05	3.90E-05	3.91E-05	52.238	52.303	52.338
0.1	0.1	0.1	4.85E-05	4.85E-05	4.85E-05	51.943	51.976	52.014
0.12	0.12	0.12	5.94E-05	5.95E-05	5.95E-05	53.087	53.127	53.161
0.14	0.14	0.14	6.42E-05	6.43E-05	6.43E-05	49.162	49.193	49.214
0.16	0.16	0.16	7.37E-05	7.37E-05	7.37E-05	49.366	49.377	49.392
0.18	0.18	0.18	8.94E-05	8.94E-05	8.94E-05	53.257	53.253	53.260
0.2	0.2	0.2	9.89E-05	9.90E-05	9.89E-05	53.001	53.032	53.025
0.23	0.23	0.23	1.15E-04	1.15E-04	1.15E-04	53.420	53.444	53.439
0.25	0.25	0.25	1.24E-04	1.24E-04	1.24E-04	53.227	53.235	53.243
0.28	0.28	0.28	1.40E-04	1.40E-04	1.40E-04	53.581	53.605	53.632
0.3	0.3	0.3	1.50E-04	1.50E-04	1.50E-04	53.450	53.448	53.469
0.35	0.35	0.35	1.75E-04	1.75E-04	1.75E-04	53.541	53.555	53.562
0.4	0.4	0.4	2.00E-04	2.00E-04	2.00E-04	53.625	53.634	53.635
0.5	0.5	0.5	2.51E-04	2.51E-04	2.51E-04	53.758	53.760	53.776
0.6	0.6	0.6	3.01E-04	3.01E-04	3.01E-04	53.819	53.840	53.852
0.8	0.8	0.8	4.02E-04	4.02E-04	4.02E-04	53.903	53.909	53.919
1	1.	1	5.03E-04	5.04E-04	5.04E-04	53.962	53.971	53.980
1.5	1.5	1.5	7.68E-04	7.72E-04	7.70E-04	54.883	55.191	55.020
2	2.	2	1.01E-03	1.01E-03	1.01E-03	54.124	54.166	54.187
3	3	3	1.52E-03	1.52E-03	1.52E-03	54.362	54.390	54.430
4	4	4	2.04E-03	2.04E-03	2.04E-03	54.632	54.688	54.739
5	5	5	2.56E-03	2.57E-03	2.57E-03	54.951	55.044	55.137
10	10	10	5.30E-03	5.36E-03	5.38E-03	56.854	57.424	57.703
Average						51.822	51.838	51.847
Average						51.836		
SD						1.605		

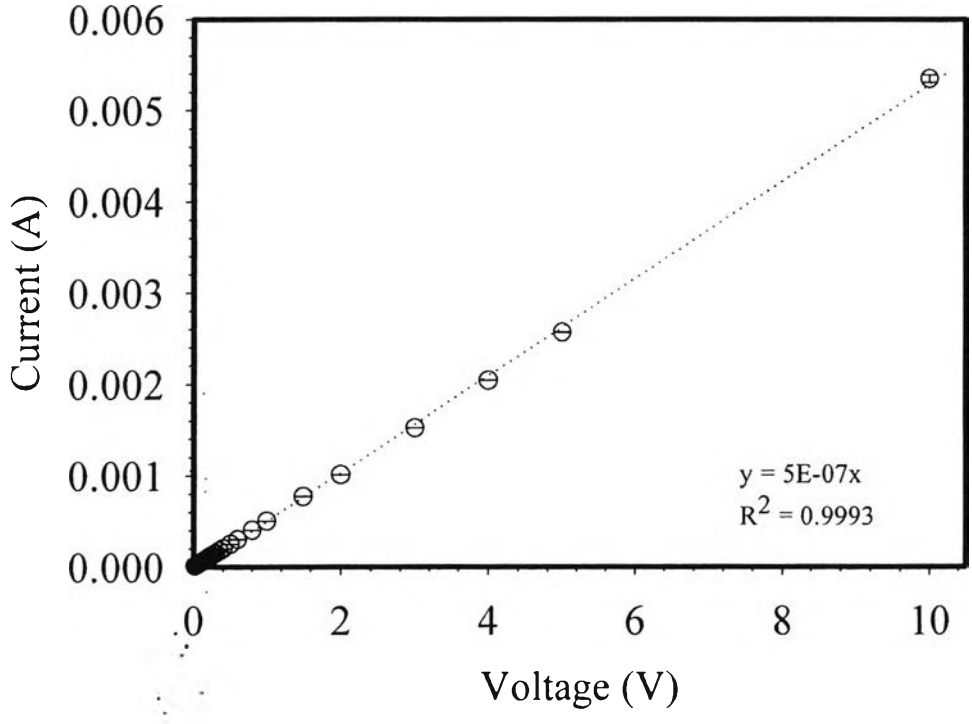


Figure D5 Determine the ohmic regime of doped polypyrrole with 5-sulfosalicylic acid at 1:50 ratio, thickness = 0.015 cm, at 25 °C, R.H. 65%.

Appendix E UV-Visible Spectrum of Sulfosalicylic Acid Model Drug

A UV/Visible spectrophotometer (Shimadzu, UV-2550) was used to determine the maximum spectra of model drug. Model drug in aqueous solution was prepared for scanning the maximum absorption wavelength. The characteristic peak was observed at 298 nm. The absorbance value at the maximum wavelength of model drug was read and the correspondent model drug concentrations were calculated from the calibration curve with various model drug concentration. Figure E1 shows the characteristic peak at the wavelength of 298 nm.

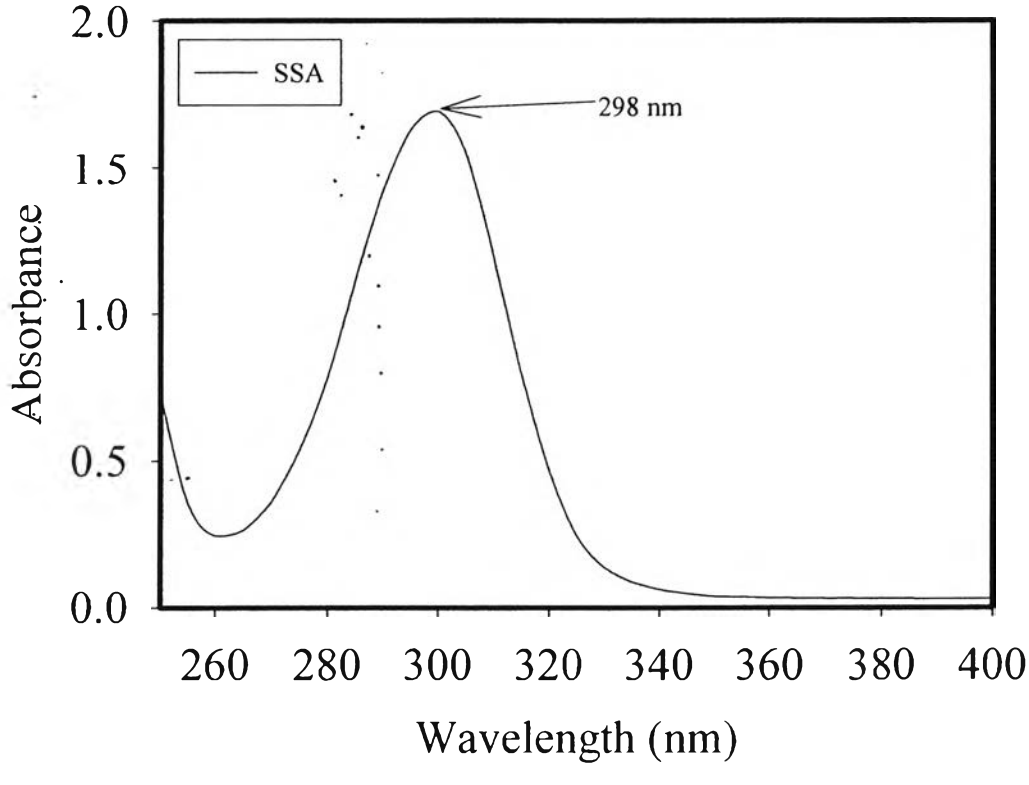


Figure E1 UV-Visible spectrum of 5-sulfosalicylic acid.

Appendix F Identification of Characteristic Peaks of Undoped and Doped Polypyrrole with 5-sulfosalicylic acid from UV-Visible Spectroscopy

The UV-Visible spectra of undoped and doped polypyrrole with 5-sulfosalicylic acid dehydrate by using a UV-Vis absorption spectrometer (Perkin-Elmer, Lambda 10). Scan speed was 240 mm/min, and a slit width of 2.0 nm using a deuterium lamp as the light source. Measurements were taken in the absorbance mode in the wavelength range of 250-500 nm. The samples were prepared by dissolving 0.01 g of each sample in 15 ml of dimethysulfoxide by ultrasonification at room temperature for 1 hour and the solution was carried out for 24 hours. The characteristic peak presented at 298 nm. The contrationtion of sulfosalicylic increased with increasing the doping mole ratio.

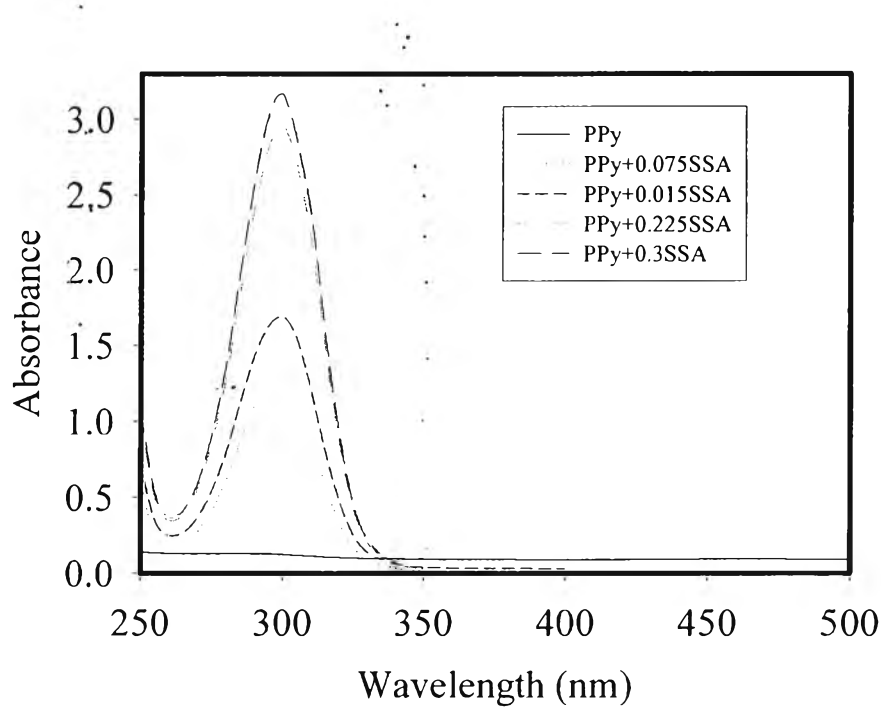


Figure F1 The UV-Visible spectra of: undoped polypyrrole; and polypyrrole doped with 5-sulfosalicylic acid at various mole ratio.

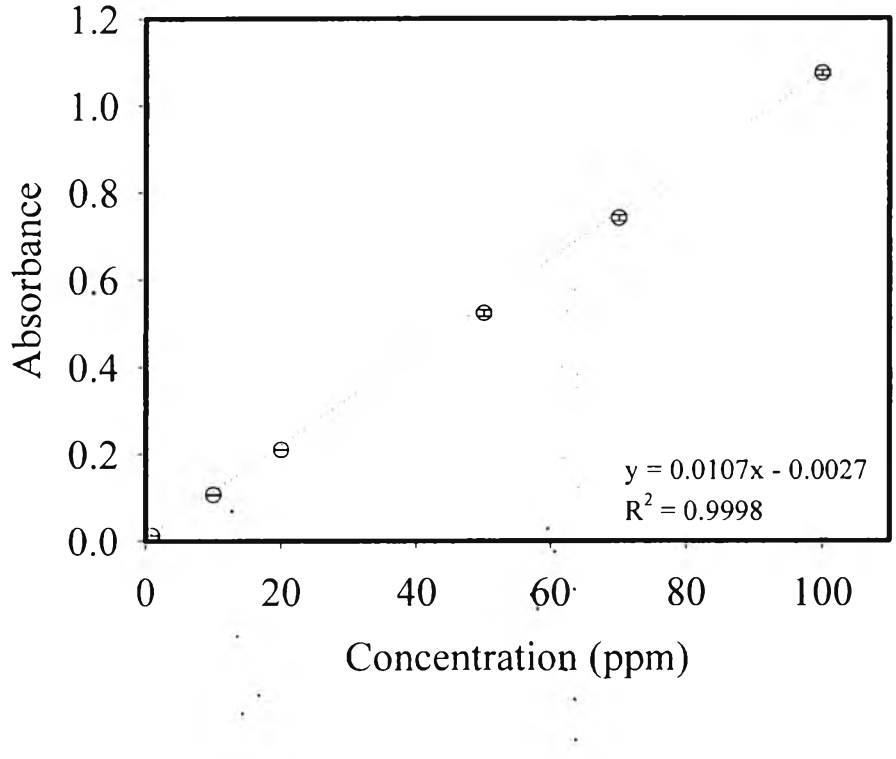


Figure F2 Calibration curve of 5-sulfosalicylic acid in dimethysulfoxide.

The concentration of doped polypyrrole was calculated from the calibration curve of 5-sulfosalicylic acid in dimethysulfoxide.

Table F1 Assignment peaks of UV-Visible peaks of undoped and doped polypyrrole

Sample	Absorbance	Concentration (ppm)
Ppy+0.075SSA	1.30	121.75
	1.30	121.28
	1.30	121.93
	1.30	121.75
	1.31	122.31
Average	**1.30**	**121.80**
Ppy+0.15SSA	1.70	159.50
	1.70	159.41
	1.70	159.32
	1.71	159.60
	1.71	159.60
Average	**1.70**	**159.49**
Ppy+0.225SSA	2.97	278.01
	2.97	278.01
	2.97	278.01
	2.96	276.89
	2.99	279.22
Average	**2.97**	**278.03**
Ppy+0.3SSA	3.17	296.89
	3.19	298.76
	3.19	298.76
	3.19	298.76
	3.19	298.76
Average	**3.19**	**298.38**

Appendix G Determination of Degree of Swelling and Weight Loss of PAA Hydrogels

The degree of swelling and weight loss of PAA hydrogels were measured in an acetate buffer solution at 37 °C for 5 days according to the following equations (Taepaiboon et al., 2006):

$$\text{Degree of swelling (\%)} = \frac{M - M_d}{M_d} \times 100 \qquad (1)$$

and

$$\text{Weight loss (\%)} = \frac{M_i - M_d}{M_i} \times 100 \qquad (2)$$

where M = the weight of each sample after submersion in the buffer solution.

M_d = the weight of sample after submersion in the buffer solution in its dry state.

M_i = the initial weight of the sample in its dry state.

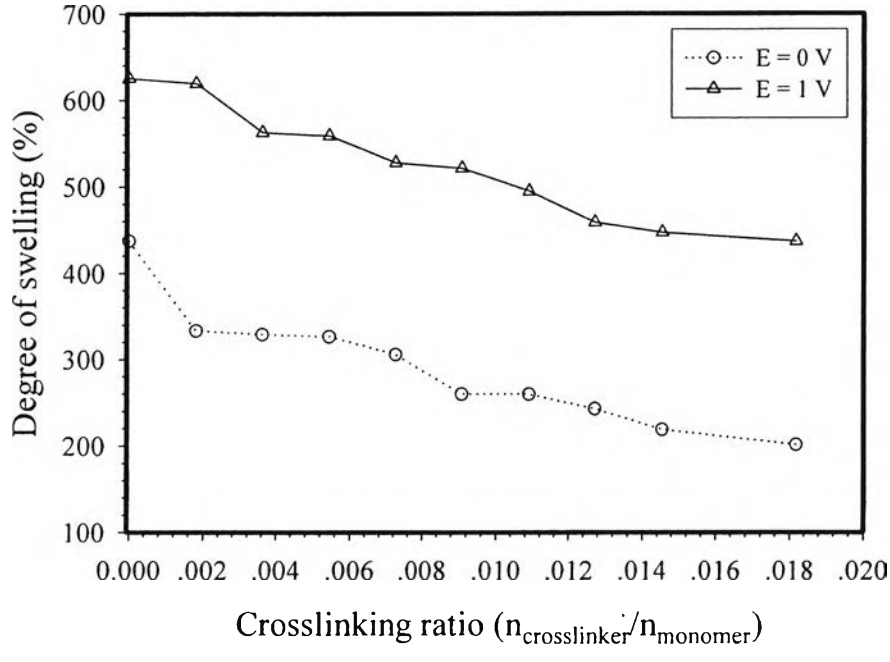


Figure G1 Degree of swelling (%) of poly(acrylic acid) hydrogels at various crosslinking at 37 ^{0}C after 5 day of E = 0 and 1 V.

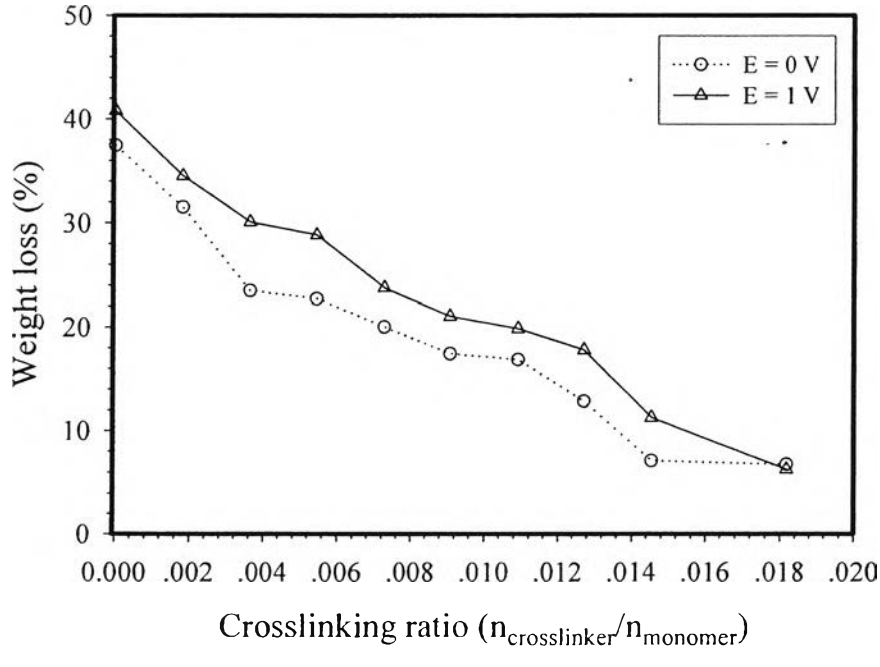


Figure G2 Weight loss (%) of poly(acrylic acid) hydrogels at various crosslinking at 37 ^{0}C after 5 day of E = 0 and 1 V.

Table G1 Values of the degree of swelling (%) and weight loss (%) of poly(acrylic acid) hydrogels at various crosslinking ratios of E = 0 V

Sample	Crosslinking ratios	M_i	M	M_d	Degree of swelling (%)	Weight loss (%)
PAA_0	0	0.92	3.09	0.58	437.20	37.44
PAA_0.25	1.82E-03	0.50	1.50	0.35	333.25	31.49
PAA_0.5	3.64E-03	0.60	1.96	0.46	328.93	23.48
PAA_0.75	5.45E-03	0.84	2.78	0.65	326.46	22.70
PAA_1	7.27E-03	0.69	2.24	0.55	305.86	20.01
PAA_1.25	9.09E-03	0.60	1.78	0.49	260.00	17.44
PAA_1.5	1.09E-02	0.86	2.57	0.71	259.92	16.86
PAA_1.75	1.27E-02	0.62	1.85	0.54	242.87	12.84
PAA_2	1.45E-02	0.55	1.62	0.51	219.05	7.11
PAA_2.5	1.82E-02	0.73	2.05	0.68	201.76	6.75

Table G2 Values of the degree of swelling (%) and weight loss (%) of poly(acrylic acid) hydrogels at various crosslinking ratios of E = 1 V

Sample	Crosslinking ratios	M_i	M	M_d	Degree of swelling (%)	Weight loss (%)
PAA_0	0	0.91	3.93	0.54	625.54	40.78
PAA_0.25	1.82E-03	0.85	4.02	0.56	619.46	34.49
PAA_0.5	3.64E-03	0.88	4.07	0.61	562.71	30.07
PAA_0.75	5.45E-03	0.91	4.26	0.65	559.10	28.84
PAA_1	7.27E-03	0.77	3.70	0.59	527.94	23.75
PAA_1.25	9.09E-03	0.82	4.04	0.65	521.49	21.04
PAA_1.5	1.09E-02	0.72	3.45	0.58	495.10	19.85
PAA_1.75	1.27E-02	0.78	3.60	0.64	458.94	17.80
PAA_2	1.45E-02	0.63	3.06	0.56	447.14	11.25
PAA_2.5	1.82E-02	0.64	3.23	0.60	437.08	6.29

Appendix H Determinaion of The Molecular Weight between Crosslinks, Mesh Size and Crosslinking Density of Poly(acrylic acid) Hydrogel

To determine the molecular weight between crosslinks, $\overline{M}$ c the mesh size, ξ, and the crosslinking density,ρ_x , a sample of PAA film was cut immediately after crosslinking (1 cm^2 square). This sample was weighted in air and heptane. The sample was then placed in distilled water at 37 ^{0}C for 5 days to allow it to swell to equilibrium, and weighted in air and heptane again. Finally, the sample was dried at 25 ^{0}C in vacuum oven for 5 days. Once again, it was weighted in air and heptane. These weights were used to calculate the polymer volume fraction in the relaxed and swellen states, $\upsilon_{2,r}$ and $\upsilon_{2,S}$, respectively (Peppas *et al.*, 1998):

$$\upsilon_{2,r} = \frac{V_d}{V_r} \tag{H.1}$$

$$\upsilon_{2,s} = \frac{V_d}{V_s} \tag{H.2}$$

where V_d = the volumes of the polymer sample in the dry states.

V_r = the volumes of the polymer sample in the relaxed states.

V_s = the volumes of the polymer sample in the swollen states.

The volumes of the polymer sample in the dry, relaxed, and swollen states are calculated using Eq. (H.3) - (H.4) respectively:

$$V_d = \frac{W_{a,d} - W_{h,d}}{\rho_h} \tag{H.3}$$

$$V_r = \frac{W_{a,r} - W_{h,r}}{\rho_h} \tag{H.4}$$

$$V_s = \frac{W_{a,s} - W_{h,s}}{\rho_h} \tag{H.5}$$

where W_d = the weights of the dry polymer in air and heptane.

W_r = the weights of the relaxed polymer in air and heptane.

W_s = the weights of the swollen polymer in air and heptane.

and ρ_h = the density of heptane.

The molecular weight between crosslinks, $\bar{M}_c$, was calculated from the swelling data using Eq (H.6) (Peppas *et al.*, 1998):

$$\frac{1}{\bar{M}_c} = \frac{2}{\bar{M}_n} - \frac{\frac{\bar{\upsilon}}{\bar{V}_1}[\ln(1-\upsilon_{2,S}) + \upsilon_{2,S} + \chi\upsilon_{2,S}^{\,2}]}{\upsilon_{2,r}[(\frac{\upsilon_{2,S}}{\upsilon_{2,r}})^{1/3} - \frac{1}{2}(\frac{\upsilon_{2,S}}{\upsilon_{2,r}})]} \qquad \text{(H.6)}$$

where $\bar{M}_n$ = the number-average molecular weight of the polymer before cross-linking (75000)

$\bar{v}$ = the specific volume of PAA (0.951 cm^3/g)

$\bar{V}_1$ = the molar volume of water (18.1 cm^3/mol)

χ = the Flory interaction parameter of PAA (0.5)

and the dissociation constant is p*K*a = 4.7.

The hydrogel mesh size, ξ, defines the linear distance between consecutive crosslinks. It indicates the diffusional space available for solute transport and can be calculated using Eq (H.7) (Hickey *et al.*, 1995):

$$\xi = \upsilon_{2,s}^{-1/3}\,[C_n(2\bar{M}_c/\bar{M}_r)]^{1/2}\,l \qquad \text{(H.7)}$$

where C_n = the Flory characteristic ratio

l = the carbon-carbon bond length

$\bar{M}_r$ = the molecular weight of the repeating unit of polymer

and $\bar{M}_c$ = the molecular weight between crosslinks.

The crosslinking density of the hydrogel was calculated using Eq (H.8) (Peppas *et al.*, 1996):

$$\rho_x = \frac{1}{\nu \bar{M}_c} \qquad \text{(H.8)}$$

Table H1 shows the molecular weight between crosslinks, mesh size and crosslinking density of each PAA hydrogel at various crosslinking ratios in absence of electric filed. Table H2 show the raw data of the determination of the molecular weight between crosslinks, mesh size and crosslinking density of PAA hydrogels at various crosslinking ratios in absence of electric filed. Table H3 show the molecular weight between crosslinks, mesh size and crosslinking density of PAA hydrogels at various crosslinking ratios and electric filed 1 V and table M4 show the raw data of the determination of the molecular weight between crosslinks, mesh size and crosslinking density of PAA hydrogels at various crosslinking ratios and electric filed 1 V. The molecular weight between crosslinks and mesh size values of PAA hydrogels are larger at lower crosslinking ratio. The mesh sizes of hydrogels vary between 103.92 and 478.90 Å for absent of electric filed strength. For an electric filed strength 1 V, the mesh sizes vary between 126.17 and 490.73 Å.

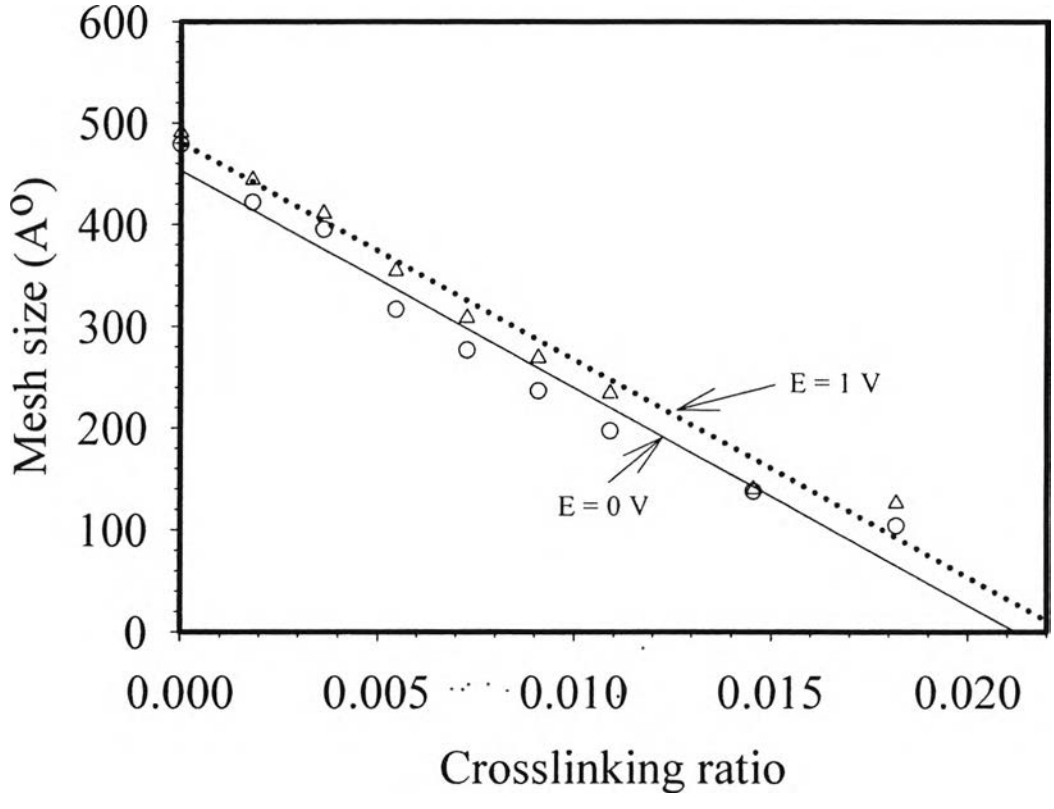


Figure H1 Mesh size of poly(acrylic acid) hydrogels vs. crosslinking ratios at pH 5.5, E = 0 and 1 V and 37 ^{0}C .

Table H1 The molecular weight between crosslinks, mesh size and crosslinking density of PAA hydrogels at various crosslinking ratios and E = 0 V

Sample	Crosslinking ratio, X	Number-average molecular weight between crosslinks, M_c (g/mol)	Mesh size ξ (A^0)	Crosslinking density (mol/cm^3 x 10^4)	a/ξ
PAA_0	0	3.74E+04	478.90	503.58	1.93E-02
PAA_0.25	1.82E-03	3.72E+04	421.73	421.73	2.19E-02
PAA_0.5	3.64E-03	3.69E+04	395.05	395.05	2.34E-02
PAA_0.75	5.45E-03	3.47E+04	316.71	316.71	2.92E-02
PAA_1	7.27E-03	3.16E+04	276.80	291.07	3.34E-02
PAA_1.25	9.09E-03	2.68E+04	236.63	248.83	3.91E-02
PAA_1.5	1.09E-02	2.14E+04	197.21	207.37	4.69E-02
PAA_1.75	1.27E-02	1.63E+04	162.53	170.90	5.69E-02
PAA_2	1.45E-02	1.28E+04	137.85	144.95	6.71E-02
PAA_2.5	1.82E-02	7.83E+03	103.92	109.28	8.90E-02

Table H2 The raw data of the determination of the molecular weight between crosslinks, mesh size and crosslinking density of PAA hydrogels at various crosslinking ratios and E = 0 V

Sample	Crosslinking ratios, X	$W_{a,r}$ (mg)	$W_{h,r}$ (mg)	$W_{a,s}$ (mg)	$W_{h,s}$ (mg)	$W_{a,d}$ (mg)	$W_{h,d}$ (mg)	M_c(g/mol)	ξ(A°)	ρ(mol/cm^3)
PAA_0	0.00E+00	841.80	840.70	2785.00	1805.00	650.70	631.80	37399.34	478.90	5.04E-02
PAA_0.25	1.82E-03	919.40	919.20	3090.00	2990.00	575.20	572.40	37187.03	421.73	4.43E-02
PAA_0.5	3.64E-03	691.20	690.30	4544.00	4229.50	552.90	542.30	36924.49	395.05	4.15E-02
PAA_0.75	5.45E-03	504.00	503.32	1496.00	1380.20	345.30	338.40	34697.36	316.71	3.33E-02
PAA_1	7.27E-03	598.70	596.72	1779.50	1565.10	494.30	477.70	31561.03	276.80	2.91E-02
PAA_1.25	9.09E-03	598.50	597.85	1954.50	1909.00	458.00	453.60	26750.10	236.63	2.49E-02
PAA_1.5	1.09E-02	729.30	726.20	2242.30	2078.00	680.10	660.50	21371.04	197.21	2.07E-02
PAA_1.75	1.27E-02	857.40	856.92	2565.50	2545.78	712.80	710.00	16301.63	162.53	1.71E-02
PAA_2	1.45E-02	547.00	545.10	1621.10	1555.50	508.10	497.50	12782.27	137.85	1.45E-02
PAA_2.5	1.82E-02	618.50	617.50	1648.40	1629.60	539.10	535.70	7831.32	103.92	1.09E-02

Table H3 The molecular weight between crosslinks, mesh size and crosslinking density of PAA hydrogels at various crosslinking ratios and E = 1 V

Sample	Crosslinking ratio, X	Number-average molecular weight between crosslinks, M_c (g/mol)	Mesh size ξ (A^0)	Crosslinking density (mol/cm^3)	a/ξ
PAA_0	0	3.74E+04	490.73	516.02	1.88E-02
PAA_0.25	1.82E-03	3.73E+04	443.85	466.72	2.08E-02
PAA_0.5	3.64E-03	3.72E+04	410.87	432.04	2.25E-02
PAA_0.75	5.45E-03	3.63E+04	354.19	372.44	2.61E-02
PAA_1	7.27E-03	3.40E+04	308.45	324.34	3.00E-02
PAA_1.25	9.09E-03	3.05E+04	269.02	282.88	3.44E-02
PAA_1.5	1.09E-02	2.63E+04	234.24	246.31	3.95E-02
PAA_1.75	1.27E-02	2.32E+04	212.82	223.79	4.35E-02
PAA_2	1.45E-02	1.30E+04	140.02	147.23	6.61E-02
PAA_2.5	1.82E-02	1.09E+04	126.17	132.67	7.33E-02

Table H4 The raw data of the determination of the molecular weight between crosslinks, mesh size and crosslinking density of PAA hydrogels at various crosslinking ratios and E = 1 V

Sample	Crosslinking ratios, X	$W_{a,r}$ (mg)	$W_{h,r}$ (mg)	$W_{a,s}$ (mg)	$W_{h,s}$ (mg)	$W_{a,d}$ (mg)	$W_{h,d}$ (mg)	M_c(g/mol)	ξ(A°)	ρ(mol/cm^3)
PAA_0	0.00E+00	1.83E+02	1.83E+02	5.37E+02	3.87E+02	1.46E+02	1.44E+02	37438.57	490.73	5.16E-02
PAA_0.25	1.82E-03	1.09E+02	1.09E+02	2.71E+02	1.84E+02	5.06E+01	4.85E+01	37338.95	443.85	4.67E-02
PAA_0.5	3.64E-03	1.73E+02	1.73E+02	3.40E+02	2.83E+02	9.09E+01	8.92E+01	37161.97	410.87	4.32E-02
PAA_0.75	5.45E-03	2.24E+02	2.24E+02	5.55E+02	5.00E+02	1.53E+02	1.51E+02	36274.39	354.19	3.72E-02
PAA_1	7.27E-03	2.09E+02	2.09E+02	6.81E+02	6.54E+02	1.49E+02	1.47E+02	33974.84	308.45	3.24E-02
PAA_1.25	9.09E-03	2.15E+02	2.14E+02	4.54E+02	4.27E+02	1.44E+02	1.41E+02	30541.81	269.02	2.83E-02
PAA_1.5	1.09E-02	1.23E+02	1.23E+02	2.53E+02	2.46E+02	7.98E+01	7.91E+01	26305.58	234.24	2.46E-02
PAA_1.75	1.27E-02	1.79E+02	1.79E+02	4.53E+02	4.24E+02	1.17E+02	1.14E+02	23239.57	212.82	2.24E-02
PAA_2	1.45E-02	1.03E+02	1.03E+02	1.96E+02	1.80E+02	5.11E+01	4.85E+01	12968.95	140.02	1.47E-02
PAA_2.5	1.82E-02	1.44E+02	1.43E+02	3.58E+02	3.26E+02	1.07E+02	1.02E+02	10886.31	126.17	1.33E-02

Appendix I Determination of Actual Drug Content

The actual amount of drug in the drug-loaded PAA hydrogel (circular disc about 2.5 cm in diameter) was measured by dissolving the sample in 5 ml of dimethylsulfoxide (DMSO) and then 0.1 ml of the solution was added into 0.4 ml of DMSO. The drug solution was measured for the amount of drug by using the UV/Visible spectrophotometer at a wavelength of 298 nm.

The actual amount of drug present in the sample is reported as the percentage of the initial content of drug loaded in PAA solution.

Table I1 The raw data of the determination of actual amount of sulfosalicylic acid in the samples

Sample	Crosslinking ratio, X	Absorbance intensity	Concentration (mg/l)	Actual amount of drug (%)
PAA_0.25	1.82E-03	2.08	188.13	60.95
PAA_0.5	3.64E-03	2.15	194.25	62.94
PAA_0.75	5.45E-03	2.19	198.51	64.32
PAA_1	7.27E-03	2.26	204.71	66.33
PAA_1.25	9.09E-03	2.27	205.67	66.64
PAA_1.5	1.09E-02	2.29	207.40	67.20
PAA_2	1.45E-02	2.38	215.61	69.86
PAA_2.5	1.82E-02	2.66	240.37	77.88

Appendix J Determination of Amounts and Diffusion Coefficient of Sulfosalicylic Acid Released from Sulfosalicylic Acid-Loaded Poly(acrylic acid) Hydrogel at Various Crosslinking Ratios in an Absence of Electric filed

The diffusion studies were carried out using the modified franz diffusion cells for in vivo studies. The modified franz diffusion cell is a vertical diffusion cell, consisting of two half-cells. The first half-cell is the donor half which is exposed to room temperature (25 °C). Another half-cell is the receptor half which is exposed to acetate buffer (pH 5.5) and maintained at 37 °C by a circulating water bath. The drug-loaded PAA hydrogel with various crosslinking ratios was placed over the net mounted on the receptor compartment and pressing the drug with the electric potential into the acetate buffer. 0.3 ml of sample was withdrawn at various time intervals simultaneously replaced with equal volume of fresh buffer solution. An ultraviolet-visible light spectrophotometer is used to measure the absorbance of the samples at 298 nm.

The amounts of sulfosalicylic acid released from sulfosalicylic acid- loaded poly(acrylic acid) hydrogel at time t vs. t at various crosslinking ratios in an absence of electric field during 48 hours is illustrated in Figure J1. The amount of released drug gradually increases with time and then reaches an equilibrium value. But the amount of released drug decreased with increase of crosslinking ratio.

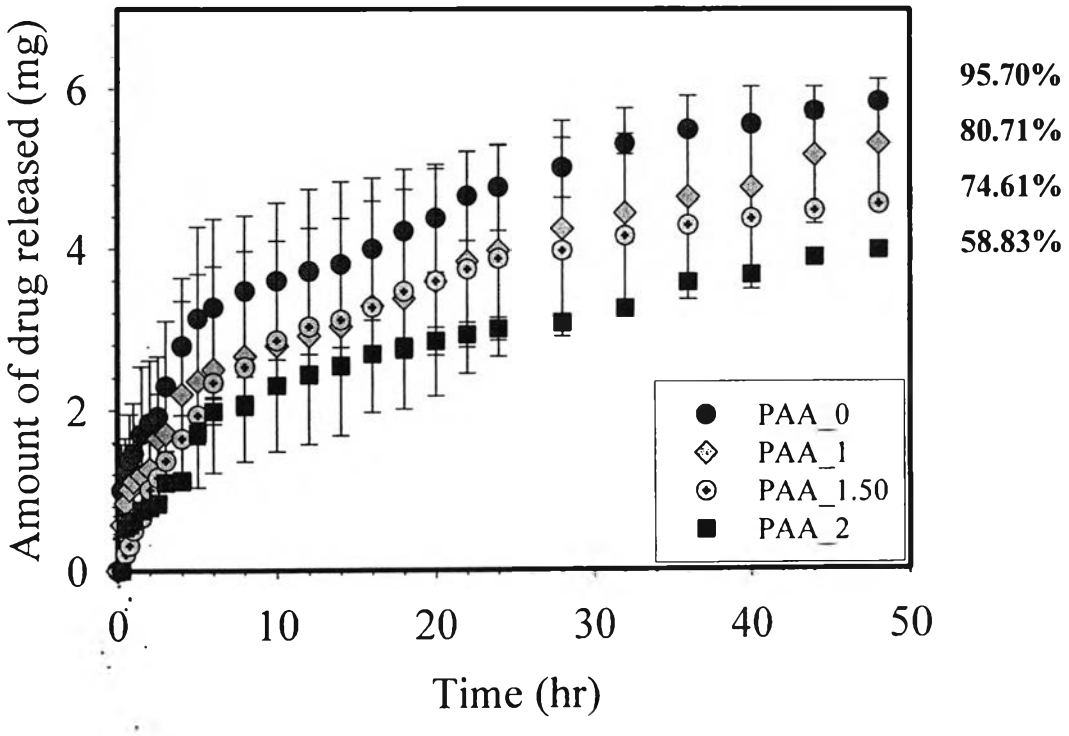


Figure J1 Amount of sulfosalicylic acid released from sulfosalicylic acid-loaded poly(acrylic acid) hydrogel vs. time at various crosslink ratios, E = 0 V, pH 5.5, 37 ^{0}C, n = # samples =2.

Table J1 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.246	0.581	0.592	1.407	0.999	0.576
0.5	0.372	0.615	0.912	1.523	1.217	0.432
0.75	0.387	0.708	0.969	1.781	1.375	0.574
1	0.395	0.741	1.010	1.903	1.456	0.631
1.5	0.425	0.884	1.106	2.292	1.699	0.838
2	0.494	0.901	1.296	2.382	1.839	0.768
2.5	0.523	0.905	1.395	2.443	1.919	0.741
3	0.647	1.058	1.726	2.864	2.295	0.805
4	0.821	1.248	2.185	3.388	2.787	0.850
5	0.857	1.446	2.319	3.939	3.129	1.145
6	0.905	1.458	2.484	4.049	3.266	1.106
8	1.018	1.462	2.809	4.139	3.474	0.940
10	1.035	1.490	2.907	4.290	3.599	0.978
12	1.045	1.519	2.989	4.445	3.717	1.029
14	1.056	1.522	3.074	4.537	3.806	1.035
16	1.153	1.523	3.370	4.625	3.997	0.888
18	1.248	1.546	3.667	4.766	4.216	0.777
20	1.317	1.549	3.903	4.859	4.381	0.676
22	1.435	1.592	4.263	5.050	4.657	0.556
24	1.452	1.596	4.386	5.149	4.767	0.540
28	1.567	1.612	4.747	5.277	5.012	0.375
32	1.725	1.625	5.218	5.399	5.308	0.128
36	1.793	1.624	5.481	5.488	5.484	0.005
40	1.762	1.634	5.505	5.603	5.554	0.069
44	1.783	1.669	5.656	5.781	5.719	0.088
48	1.794	1.677	5.782	5.893	5.838	0.079

Table J2 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.25 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.115	0.175	0.274	0.420	0.347	0.103
0.5	0.162	0.197	0.394	0.483	0.438	0.063
0.75	0.166	0.211	0.413	0.528	0.470	0.082
1	0.310	0.288	0.772	0.725	0.749	0.033
1.5	0.350	0.447	0.886	1.130	1.008	0.172
2	0.421	0.534	1.078	1.367	1.222	0.204
2.5	0.506	0.595	1.308	1.543	1.425	0.166
3	0.536	0.633	1.411	1.669	1.540	0.182
4	0.565	0.667	1.511	1.788	1.649	0.196
5	0.716	0.738	1.910	1.999	1.954	0.063
6	0.733	0.792	1.990	2.171	2.081	0.128
8	1.022	0.925	2.735	2.538	2.637	0.139
10	1.055	1.000	2.872	2.771	2.821	0.071
12	1.090	1.003	3.016	2.836	2.926	0.127
14	1.220	1.006	3.394	2.899	3.146	0.350
16	1.230	1.028	3.487	3.009	3.248	0.338
18	1.424	1.199	4.027	3.483	3.755	0.385
20	1.443	1.243	4.152	3.656	3.904	0.350
22	1.451	1.249	4.254	3.741	3.997	0.363
24	1.461	1.300	4.359	3.935	4.147	0.300
28	1.485	1.532	4.500	4.571	4.536	0.050
32	1.504	1.626	4.629	4.886	4.757	0.182
36	1.515	1.647	4.739	5.028	4.883	0.205
40	1.526	1.659	4.852	5.149	5.001	0.210
44	1.526	1.672	4.938	5.275	5.107	0.239
48	1.532	1.707	5.036	5.452	5.244	0.294

Table J3 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.5 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.053	0.053	0.123	0.123	0.123	0.000
0.5	0.105	0.121	0.251	0.290	0.271	0.028
0.75	0.144	0.253	0.352	0.619	0.485	0.189
1	0.244	0.268	0.604	0.668	0.636	0.045
1.5	0.287	0.342	0.723	0.864	0.794	0.100
2	0.344	0.384	0.876	0.986	0.931	0.078
2.5	0.424	0.527	1.089	1.355	1.222	0.188
3	0.479	0.646	1.246	1.673	1.460	0.302
4	0.495	0.682	1.312	1.797	1.555	0.343
5	0.609	0.748	1.618	1.995	1.806	0.267
6	0.708	0.814	1.892	2.198	2.045	0.216
8	0.910	0.886	2.423	2.419	2.421	0.003
10	0.909	0.889	2.472	2.476	2.474	0.003
12	1.010	1.023	2.768	2.852	2.810	0.059
14	1.044	1.113	2.909	3.127	3.018	0.154
16	1.059	1.441	3.002	3.988	3.495	0.697
18	1.056	1.461	3.055	4.117	3.586	0.751
20	1.063	1.484	3.131	4.255	3.693	0.795
22	1.174	1.609	3.461	4.641	4.051	0.835
24	1.177	1.610	3.534	4.734	4.134	0.849
28	1.259	1.619	3.799	4.847	4.323	0.741
32	1.537	1.629	4.545	4.962	4.754	0.295
36	1.595	1.635	4.773	5.067	4.920	0.208
40	1.637	1.643	4.965	5.179	5.072	0.151
44	1.640	1.642	5.064	5.268	5.166	0.144
48	1.642	1.642	5.160	5.360	5.260	0.142

Table J4 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.75 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.073	0.052	0.171	0.119	0.145	0.037
0.5	0.173	0.068	0.419	0.161	0.290	0.182
0.75	0.218	0.174	0.538	0.423	0.481	0.081
1	0.284	0.206	0.710	0.510	0.610	0.141
1.5	0.327	0.356	0.830	0.886	0.858	0.040
2	0.432	0.457	1.105	1.152	1.128	0.034
2.5	0.493	0.557	1.276	1.421	1.349	0.103
3	0.610	0.564	1.589	1.469	1.529	0.085
4	0.613	0.570	1.630	1.515	1.573	0.081
5	0.665	0.675	1.790	1.802	1.796	0.008
6	0.813	0.775	2.189	2.084	2.136	0.075
8	0.924	0.876	2.502	2.373	2.437	0.092
10	0.896	0.895	2.487	2.467	2.477	0.014
12	0.997	0.926	2.784	2.592	2.688	0.136
14	1.075	0.987	3.029	2.793	2.911	0.167
16	1.086	1.000	3.114	2.881	2.998	0.165
18	1.106	1.151	3.225	3.303	3.264	0.055
20	1.121	1.161	3.323	3.393	3.358	0.050
22	1.167	1.164	3.496	3.464	3.480	0.023
24	1.258	1.289	3.785	3.834	3.810	0.035
28	1.531	1.544	4.519	4.525	4.522	0.005
32	1.578	1.548	4.718	4.623	4.670	0.067
36	1.595	1.550	4.849	4.715	4.782	0.095
40	1.608	1.565	4.971	4.837	4.904	0.095
44	1.609	1.566	5.061	4.927	4.994	0.095
48	1.617	1.566	5.173	5.016	5.094	0.111

Table J5 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.270	0.206	0.651	0.493	0.572	0.111
0.5	0.343	0.343	0.843	0.839	0.841	0.003
0.75	0.417	0.391	1.042	0.976	1.009	0.047
1	0.440	0.436	1.120	1.106	1.113	0.010
1.5	0.445	0.471	1.157	1.216	1.186	0.042
2	0.460	0.498	1.220	1.307	1.264	0.062
2.5	0.466	0.787	1.259	2.039	1.649	0.552
3	0.477	0.795	1.311	2.101	1.706	0.559
4	0.494	1.150	1.379	3.010	2.195	1.153
5	0.500	1.241	1.423	3.296	2.360	1.325
6	0.560	1.258	1.595	3.406	2.501	1.281
8	0.606	1.303	1.740	3.586	2.663	1.306
10	0.644	1.327	1.866	3.718	2.792	1.310
12	0.670	1.357	1.964	3.865	2.915	1.344
14	0.700	1.375	2.076	3.985	3.030	1.350
16	0.799	1.436	2.355	4.211	3.283	1.312
18	0.804	1.457	2.412	4.341	3.377	1.364
20	0.858	1.525	2.588	4.589	3.589	1.415
22	0.950	1.584	2.860	4.817	3.838	1.384
24	1.004	1.585	3.044	4.909	3.976	1.318
28	1.087	1.672	3.302	5.210	4.256	1.349
32	1.155	1.701	3.529	5.374	4.452	1.305
36	1.217	1.731	3.745	5.542	4.644	1.271
40	1.240	1.737	3.869	5.655	4.762	1.263
44	1.498	1.747	4.566	5.775	5.171	0.855
48	1.548	1.751	4.771	5.882	5.327	0.786

Table J6 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1.25 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.124	0.070	0.295	0.165	0.230	0.092
0.5	0.340	0.174	0.826	0.421	0.624	0.286
0.75	0.350	0.251	0.870	0.618	0.744	0.179
1	0.387	0.292	0.980	0.732	0.856	0.175
1.5	0.532	0.502	1.353	1.258	1.306	0.068
2	0.557	0.550	1.446	1.403	1.424	0.030
2.5	0.582	0.624	1.536	1.613	1.575	0.055
3	0.610	0.678	1.636	1.779	1.708	0.101
4	0.627	0.753	1.714	2.000	1.857	0.203
5	0.769	0.809	2.093	2.179	2.136	0.061
6	0.788	0.946	2.182	2.556	2.369	0.264
8	0.853	0.990	2.384	2.717	2.551	0.236
10	0.904	1.058	2.557	2.937	2.747	0.269
12	0.911	1.123	2.625	3.154	2.889	0.374
14	0.953	1.197	2.777	3.397	3.087	0.438
16	0.990	1.264	2.921	3.627	3.274	0.500
18	0.995	1.268	2.988	3.708	3.348	0.509
20	1.132	1.316	3.377	3.897	3.637	0.367
22	1.137	1.378	3.452	4.121	3.787	0.473
24	1.150	1.417	3.547	4.293	3.920	0.528
28	1.169	1.483	3.658	4.533	4.096	0.619
32	1.456	1.492	4.422	4.639	4.530	0.153
36	1.546	1.495	4.723	4.729	4.726	0.004
40	1.599	1.507	4.939	4.842	4.890	0.069
44	1.615	1.557	5.066	5.047	5.056	0.014
48	1.653	1.558	5.249	5.137	5.193	0.079

Table J7 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1.5 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.108	0.109	0.257	0.258	0.257	0.000
0.5	0.148	0.150	0.359	0.364	0.362	0.003
0.75	0.224	0.231	0.553	0.568	0.561	0.011
1	0.285	0.305	0.712	0.762	0.737	0.035
1.5	0.422	0.402	1.061	1.014	1.038	0.033
2	0.434	0.404	1.115	1.043	1.079	0.051
2.5	0.530	0.505	1.372	1.312	1.342	0.043
3	0.630	0.564	1.646	1.483	1.564	0.115
4	0.755	0.615	1.985	1.638	1.812	0.246
5	0.906	0.733	2.393	1.959	2.176	0.307
6	0.908	0.741	2.449	2.020	2.234	0.304
8	1.055	0.933	2.859	2.527	2.693	0.235
10	1.102	0.940	3.030	2.598	2.814	0.306
12	1.111	1.014	3.115	2.830	2.972	0.202
14	1.150	1.087	3.271	3.064	3.168	0.146
16	1.225	1.204	3.519	3.409	3.464	0.078
18	1.250	1.301	3.648	3.713	3.680	0.046
20	1.282	1.313	3.797	3.815	3.806	0.013
22	1.308	1.348	3.930	3.974	3.952	0.031
24	1.322	1.432	4.040	4.254	4.147	0.152
28	1.367	1.514	4.221	4.533	4.377	0.221
32	1.380	1.592	4.331	4.808	4.569	0.337
36	1.382	1.608	4.413	4.935	4.674	0.369
40	1.383	1.611	4.493	5.033	4.763	0.381
44	1.384	1.614	4.572	5.130	4.851	0.395
48	1.403	1.660	4.695	5.332	5.014	0.450

Table J8 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_2 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.207	0.244	0.496	0.587	0.542	0.064
0.5	0.212	0.259	0.520	0.637	0.579	0.083
0.75	0.222	0.276	0.557	0.693	0.625	0.096
1	0.296	0.296	0.748	0.757	0.752	0.006
1.5	0.302	0.305	0.780	0.795	0.788	0.010
2	0.318	0.315	0.835	0.836	0.835	0.001
2.5	0.421	0.411	1.103	1.088	1.095	0.011
3	0.451	0.381	1.199	1.037	1.118	0.115
4	0.612	0.690	1.616	1.811	1.714	0.138
5	0.702	0.791	1.871	2.095	1.983	0.158
6	0.728	0.794	1.973	2.146	2.059	0.123
8	0.832	0.857	2.267	2.344	2.306	0.054
10	0.885	0.872	2.441	2.428	2.435	0.009
12	0.899	0.907	2.527	2.563	2.545	0.026
14	0.973	0.909	2.755	2.618	2.686	0.097
16	0.989	0.910	2.850	2.671	2.760	0.126
18	1.016	0.911	2.969	2.723	2.846	0.174
20	1.020	0.928	3.037	2.817	2.927	0.155
22	1.023	0.940	3.102	2.898	3.000	0.144
24	1.024	0.961	3.160	3.001	3.080	0.113
28	1.059	1.028	3.303	3.219	3.261	0.059
32	1.164	1.141	3.619	3.552	3.585	0.047
36	1.166	1.162	3.687	3.666	3.677	0.014
40	1.247	1.206	3.951	3.839	3.895	0.080
44	1.257	1.217	4.044	3.931	3.988	0.080
48	1.289	1.234	4.194	4.043	4.118	0.107

Table J9 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_2.5 at time t, pH 5.5 at 37 ^{0}C, in an absence of electric field

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.036	0.036	0.081	0.081	0.081	0.000
0.5	0.047	0.044	0.109	0.102	0.105	0.005
0.75	0.080	0.059	0.191	0.140	0.166	0.036
1	0.105	0.071	0.257	0.174	0.215	0.059
1.5	0.160	0.087	0.397	0.215	0.306	0.128
2	0.174	0.108	0.439	0.271	0.355	0.119
2.5	0.208	0.139	0.533	0.354	0.443	0.127
3	0.238	0.186	0.617	0.476	0.546	0.100
4	0.265	0.323	0.694	0.818	0.756	0.088
5	0.299	0.360	0.792	0.926	0.859	0.095
6	0.308	0.398	0.832	1.040	0.936	0.147
8	0.336	0.439	0.917	1.162	1.039	0.174
10	0.379	0.474	1.040	1.271	1.156	0.163
12	0.396	0.507	1.103	1.378	1.240	0.194
14	0.408	0.542	1.154	1.491	1.322	0.238
16	0.419	0.570	1.204	1.589	1.396	0.272
18	0.448	0.599	1.298	1.691	1.494	0.278
20	0.474	0.622	1.385	1.782	1.584	0.281
22	0.471	0.643	1.404	1.866	1.635	0.327
24	0.514	0.668	1.536	1.963	1.750	0.302
28	0.630	0.694	1.845	2.065	1.955	0.155
32	0.643	0.753	1.912	2.246	2.079	0.236
36	0.682	0.801	2.044	2.406	2.225	0.256
40	0.733	0.880	2.207	2.643	2.425	0.308
44	0.723	0.903	2.224	2.747	2.485	0.370
48	0.740	0.940	2.304	2.888	2.596	0.413

Release Kinetics of Model Drug from Drug-Loaded PAA Hydrogel

The study of sulfosalicylic acid transport mechanism from the PAA hydrogels, Fickian diffusion models are considered to fit the experimental data.

The power law model is described by the Ritger-Peppas equation (Venkatesh *et al.*, 1992):

$$\frac{M_t}{M_\infty} = k_1 t^n \qquad \text{(J.1)}$$

where M_t/M_∞ = the fractional drug release

k = a kinetic constant

t = the release time

and n = the scaling exponent that can be related to the drug transport mechanism.

For a thin hydrogel film, when n = 0.5, the drug release mechanism is observed by the Fickian diffusion:

$$\frac{M_t}{M_\infty} = k_H t^{1/2} \qquad \text{(J.2)}$$

where M_t/M_∞ = the fractional drug release

k_H = a kinetic constant

and t = the release time.

The diffusion coefficients of sulfosalicylic acid from the PAA hydrogels are calculated from the slopes of plots of drug accumulation *vs.* square root of time according to Higuchi's equation (A-sasutjarit *et al.*, 2005):

$$Q = 2C_0 (Dt/\pi)^{1/2} \qquad \text{(J.3)}$$

where Q = the amount of material flowing through a unit cross-section of barrier in unit time

C_0 = the initial drug concentration in the hydrogel

and D = the diffusion coefficient of a drug.

The diffusion coefficients of each system were calculated from the slopes of the plot of the amounts of sulfosalicylic acid released from sulfosalicylic acid-loaded poly(acrylic acid) hydrogel at time t vs. $t^{1/2}$ at various crosslinking ratios in an absence of electric field during 48 hours using the Higuchi's equation (see figure J2).

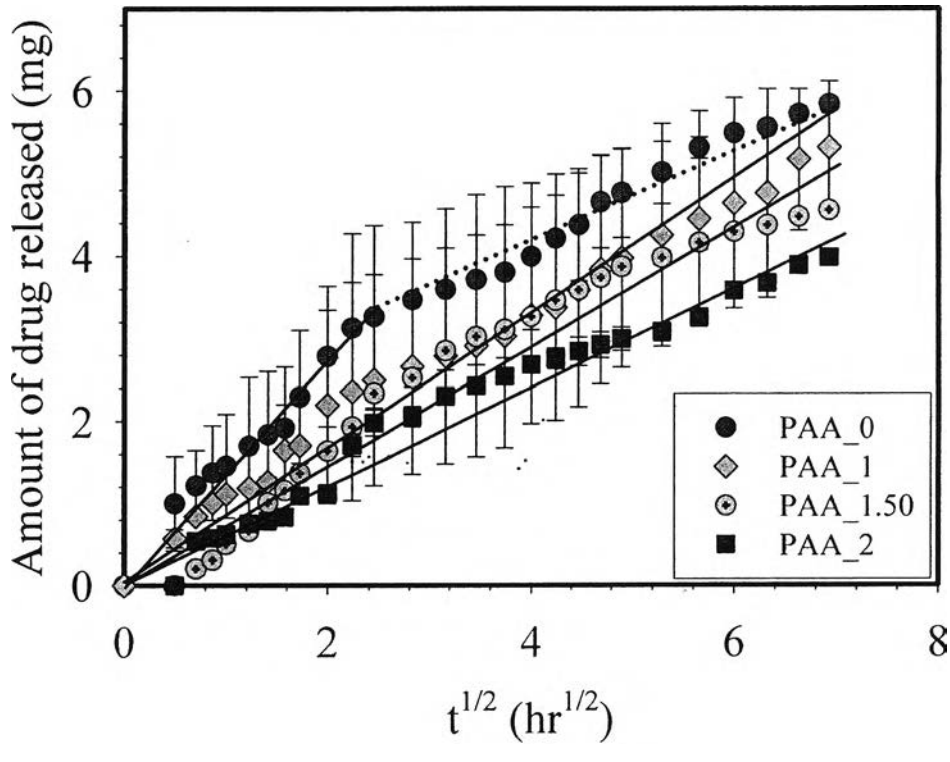


Figure J2 Amount of sulfosalicylic acid released from sulfosalicylic acid-loaded poly(acrylic acid) hydrogel vs. $t^{1/2}$ at various crosslink ratios, E = 0 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Figure J3 shows the diffusion coefficients of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. crosslinking ratios without electric field at 37 ^{0}C.

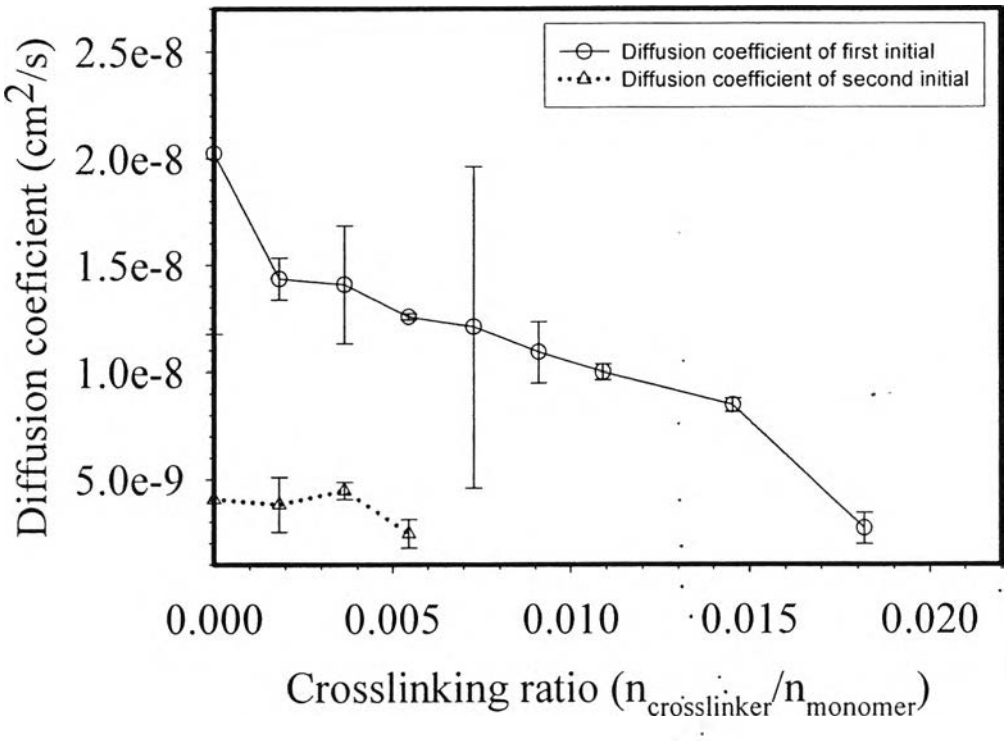


Figure J3 Diffusion coefficient of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. crosslinking ratios without electric field , pH 5.5, 37 ^{0}C, n = # samples = 2.

Figure J4 shows the diffusion coefficients of sulfosalicylic acid from poly(acrylic aid) hydrogels vs. mesh size without electric field at 37 ^{0}C.

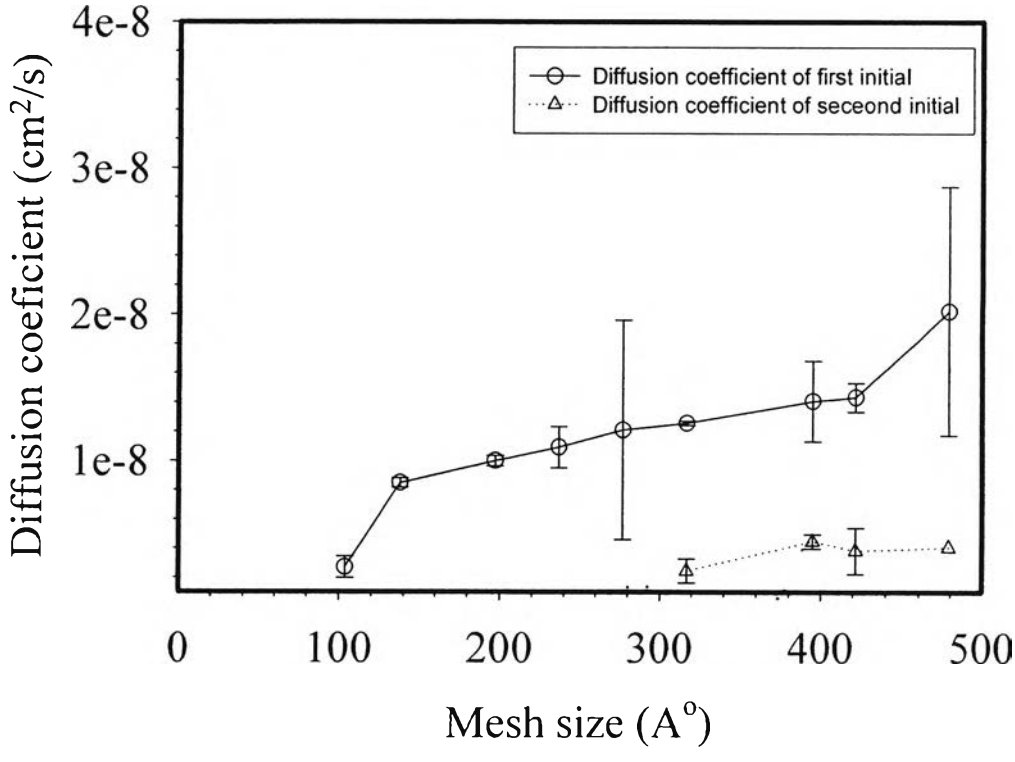


Figure J4 Diffusion coefficient of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. mesh size without electric field , pH 5.5, 37 ^{0}C, n = # samples = 2.

Table J10 Raw data of the determination of the diffusion coefficient of sulfosalicylic acid released from various crosslinked PAA hydrogel, pH 5.5 at 37 ^{0}C, without electric field

Sample	Crosslinking ratio, X	Slope of first initial		Slope of second initial		Diffusion Coefficient of first initial(cm^2/s)				Diffusion Coefficient of second initial(cm^2/s)			
		1	2	1	2	1	2	Average	SD	1	2	Average	SD
PAA_0	0.00	0.841	1.141	-	0.449	1.42E-08	2.62E-08	2.02E-08	8.48E-09	-	4.06E-09	2.03E-09	2.87E-09
PAA_0.25	1.82E-03	0.864	0.823	0.558	0.472	1.51E-08	1.37E-08	1.44E-08	9.86E-10	6.27E-09	4.49E-09	5.38E-09	1.26E-09
PAA_0.5	3.64E-03	0.776	0.892	0.330	0.554	1.21E-08	1.60E-08	1.41E-08	2.76E-09	2.20E-09	6.18E-09	4.19E-09	2.81E-09
PAA_0.75	5.45E-03	0.786	0.793	0.452	0.473	1.25E-08	1.27E-08	1.26E-08	1.49E-10	4.12E-09	4.52E-09	4.32E-09	2.82E-10
PAA_1	7.27E-03	0.930	0.580	-	-	1.74E-08	6.79E-09	1.21E-08	7.52E-09	-	-	-	-
PAA_1.25	9.09E-03	0.702	0.769	-	-	9.92E-09	1.19E-08	1.09E-08	1.42E-09	-	-	-	-
PAA_1.5	1.09E-02	0.696	0.713	-	-	9.75E-09	1.03E-08	1.00E-08	3.55E-10	-	-	-	-
PAA_2	1.45E-02	0.657	0.640	-	-	8.70E-09	8.25E-09	8.47E-09	3.18E-10	-	-	-	-
PAA_2.5	1.82E-02	0.329	0.400	-	-	2.18E-09	3.22E-09	2.70E-09	7.38E-10	-	-	-	-

Appendix K Determination of Amounts and Diffusion Coefficient of Sulfosalicylic Acid Released from Sulfosalicylic Acid-Loaded Poly(acrylic acid) Hydrogel at Various Crosslinking Ratios with Electric Field (E = 1 V)

The amounts of sulfosalicylic acid released from sulfosalicylic acid- loaded poly(acrylic acid) hydrogel at time t vs. time at various crosslinking ratios at electric field strength 1 V during 48 hours is illustrated in Figure K1. The amount of released drug gradually increases with time and then reaches an equilibrium value. But the amount of released drug decreased with increase of crosslinking ratio.

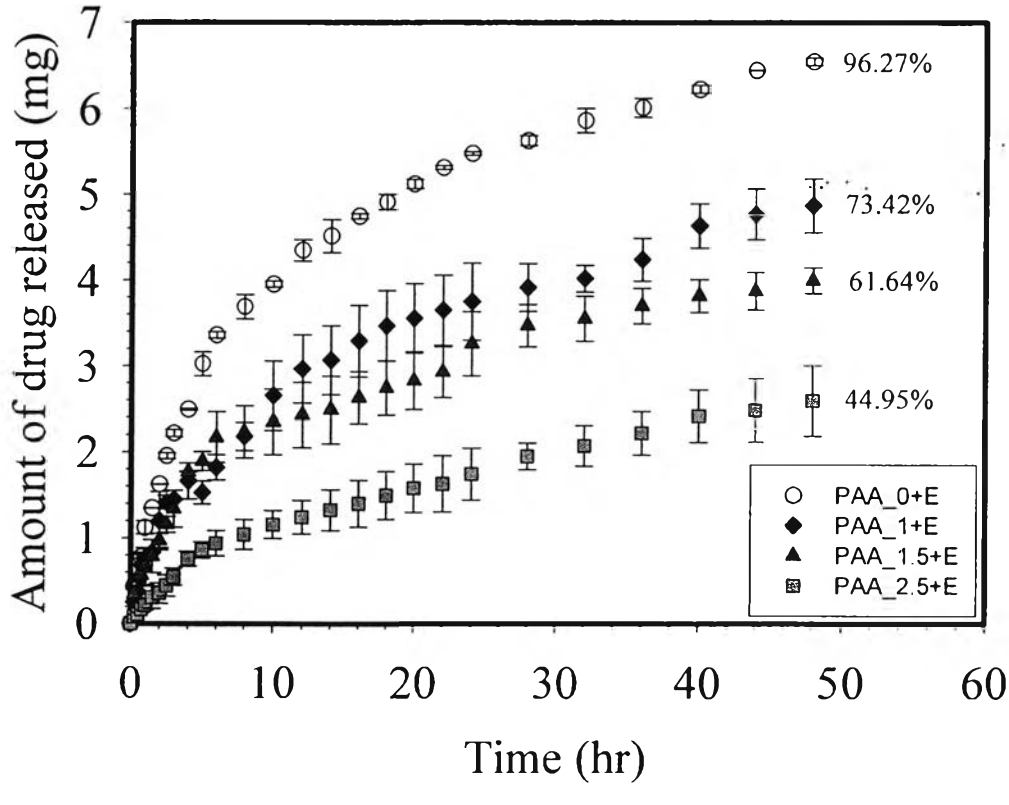


Figure K1 Amounts of sulfosalicylic acid release from sulfosalicylic acid-loaded poly(acrylic acid) hydrogel vs. time at various crosslink ratios, E = 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Table K1 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.181	0.182	0.434	0.437	0.435	0.002
0.5	0.198	0.205	0.485	0.502	0.494	0.012
0.75	0.321	0.307	0.794	0.763	0.778	0.022
1	0.424	0.469	1.064	1.174	1.119	0.078
1.5	0.529	0.530	1.344	1.347	1.345	0.002
2	0.633	0.630	1.625	1.620	1.622	0.004
2.5	0.743	0.763	1.929	1.979	1.954	0.035
3	0.858	0.832	2.249	2.189	2.219	0.043
4	0.941	0.933	2.498	2.482	2.490	0.011
5	1.175	1.094	3.121	2.924	3.023	0.139
6	1.256	1.236	3.385	3.332	3.359	0.037
8	1.311	1.396	3.589	3.790	3.689	0.142
10	1.420	1.440	3.926	3.977	3.952	0.035
12	1.524	1.595	4.260	4.434	4.347	0.124
14	1.537	1.647	4.376	4.648	4.512	0.193
16	1.644	1.656	4.722	4.763	4.743	0.030
18	1.657	1.704	4.847	4.973	4.910	0.089
20	1.717	1.741	5.085	5.159	5.122	0.053
22	1.765	1.772	5.299	5.333	5.316	0.024
24	1.804	1.786	5.493	5.465	5.479	0.020
28	1.836	1.795	5.670	5.588	5.629	0.058
32	1.914	1.826	5.964	5.763	5.864	0.142
36	1.922	1.855	6.090	5.936	6.013	0.109
40	1.946	1.918	6.258	6.194	6.226	0.045
44	1.979	1.977	6.445	6.443	6.444	0.001
48	1.987	1.961	6.576	6.516	6.546	0.042

Table K2 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.25+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.127	0.122	0.302	0.290	0.296	0.009
0.5	0.132	0.127	0.322	0.309	0.315	0.009
0.75	0.142	0.135	0.352	0.335	0.344	0.012
1	0.149	0.149	0.377	0.377	0.377	0.001
1.5	0.153	0.164	0.397	0.422	0.409	0.018
2	0.265	0.199	0.677	0.517	0.597	0.113
2.5	0.307	0.218	0.793	0.573	0.683	0.156
3	0.407	0.289	1.055	0.757	0.906	0.211
4	0.509	0.395	1.325	1.032	1.179	0.207
5	0.609	0.496	1.597	1.300	1.448	0.211
6	0.710	0.612	1.875	1.610	1.743	0.187
8	0.830	0.719	2.208	1.904	2.056	0.215
10	0.914	0.863	2.458	2.295	2.376	0.116
12	1.082	0.922	2.919	2.486	2.703	0.307
14	1.184	1.144	3.227	3.078	3.152	0.106
16	1.195	1.171	3.321	3.208	3.264	0.080
18	1.227	1.523	3.464	4.129	3.796	0.471
20	1.323	1.530	3.768	4.232	4.000	0.328
22	1.324	1.575	3.843	4.428	4.136	0.413
24	1.374	1.666	4.039	4.736	4.387	0.493
28	1.400	1.820	4.178	5.204	4.691	0.725
32	1.499	1.848	4.499	5.375	4.937	0.620
36	1.560	1.920	4.731	5.654	5.193	0.652
40	1.677	1.924	5.103	5.770	5.436	0.472
44	1.779	1.925	5.446	5.882	5.664	0.308
48	1.800	1.940	5.596	6.025	5.810	0.303

Table K3 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.5+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.052	0.053	0.120	0.122	0.121	0.001
0.5	0.053	0.056	0.125	0.132	0.128	0.005
0.75	0.055	0.077	0.132	0.187	0.160	0.039
1	0.064	0.106	0.157	0.262	0.210	0.074
1.5	0.094	0.153	0.234	0.382	0.308	0.104
2	0.118	0.214	0.298	0.537	0.418	0.169
2.5	0.153	0.319	0.389	0.806	0.597	0.294
3	0.186	0.413	0.479	1.051	0.765	0.405
4	0.309	0.554	0.786	1.419	1.103	0.447
5	0.592	0.629	1.493	1.632	1.562	0.098
6	0.795	0.733	2.020	1.920	1.970	0.070
8	0.961	0.840	2.467	2.220	2.344	0.174
10	1.296	0.943	3.338	2.519	2.928	0.579
12	1.405	1.047	3.675	2.823	3.249	0.602
14	1.526	1.150	4.047	3.134	3.591	0.646
16	1.565	1.182	4.227	3.274	3.751	0.674
18	1.581	1.285	4.354	3.592	3.973	0.539
20	1.585	1.290	4.453	3.675	4.064	0.550
22	1.614	1.316	4.613	3.812	4.212	0.566
24	1.654	1.325	4.800	3.907	4.353	0.631
28	1.731	1.436	5.081	4.252	4.667	0.586
32	1.751	1.545	5.225	4.596	4.911	0.445
36	1.828	1.570	5.511	4.745	5.128	0.541
40	1.884	1.578	5.750	4.852	5.301	0.635
44	1.890	1.596	5.869	4.983	5.426	0.627
48	1.900	1.600	6.000	5.083	5.541	0.648

Table K4 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.75+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.378	0.464	0.912	1.122	1.017	0.149
0.5	0.419	0.496	1.033	1.227	1.130	0.137
0.75	0.477	0.502	1.198	1.269	1.233	0.050
1	0.524	0.533	1.339	1.371	1.355	0.022
1.5	0.548	0.547	1.427	1.434	1.430	0.005
2	0.611	0.557	1.610	1.489	1.549	0.086
2.5	0.638	0.576	1.710	1.567	1.638	0.101
3	0.657	0.623	1.793	1.715	1.754	0.055
4	0.669	0.630	1.858	1.767	1.812	0.065
5	0.681	0.740	1.925	2.068	1.997	0.101
6	0.699	0.783	2.007	2.215	2.111	0.147
8	0.708	0.833	2.068	2.380	2.224	0.221
10	0.759	1.069	2.232	3.000	2.616	0.543
12	0.789	1.069	2.348	3.060	2.704	0.503
14	0.887	1.169	2.630	3.363	2.997	0.518
16	0.915	1.169	2.747	3.430	3.089	0.482
18	0.977	1.271	2.949	3.743	3.346	0.561
20	1.011	1.278	3.085	3.831	3.458	0.528
22	1.116	1.378	3.399	4.147	3.773	0.529
24	1.157	1.380	3.561	4.227	3.894	0.471
28	1.263	1.406	3.882	4.368	4.125	0.344
32	1.271	1.442	3.974	4.536	4.255	0.397
36	1.297	1.442	4.108	4.617	4.362	0.360
40	1.310	1.509	4.212	4.859	4.535	0.457
44	1.340	1.524	4.359	4.979	4.669	0.439
48	1.370	1.553	4.506	5.135	4.821	0.445

Table K5 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.105	0.105	0.249	0.248	0.249	0.105
0.5	0.152	0.154	0.370	0.373	0.372	0.152
0.75	0.278	0.274	0.684	0.675	0.679	0.278
1	0.306	0.300	0.767	0.753	0.760	0.306
1.5	0.326	0.325	0.833	0.830	0.831	0.326
2	0.369	0.567	0.956	1.436	1.196	0.369
2.5	0.525	0.567	1.356	1.468	1.412	0.525
3	0.553	0.541	1.452	1.437	1.445	0.553
4	0.565	0.682	1.513	1.394	1.453	0.565
5	0.596	0.511	1.621	1.837	1.729	0.596
6	0.621	0.701	1.714	1.924	1.819	0.621
8	0.751	0.839	2.065	2.297	2.181	0.751
10	0.858	1.083	2.367	2.937	2.652	0.858
12	0.968	1.185	2.684	3.247	2.965	0.968
14	0.985	1.199	2.780	3.349	3.064	0.985
16	1.051	1.268	2.994	3.583	3.289	1.051
18	1.102	1.311	3.177	3.757	3.467	1.102
20	1.117	1.317	3.276	3.846	3.561	1.117
22	1.130	1.327	3.369	3.945	3.657	1.130
24	1.133	1.350	3.440	4.074	3.757	1.133
28	1.224	1.337	3.725	4.118	3.922	1.224
32	1.274	1.312	3.915	4.134	4.024	1.274
36	1.308	1.400	4.070	4.420	4.245	1.308
40	1.437	1.531	4.456	4.818	4.637	1.437
44	1.446	1.560	4.559	4.974	4.767	1.446
48	1.449	1.571	4.646	5.087	4.867	1.449

Table K6 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1.25+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.042	0.071	0.096	0.165	0.131	0.049
0.5	0.055	0.113	0.129	0.273	0.201	0.101
0.75	0.071	0.123	0.171	0.302	0.236	0.093
1	0.176	0.152	0.431	0.380	0.406	0.036
1.5	0.198	0.255	0.493	0.640	0.566	0.103
2	0.246	0.389	0.623	0.978	0.800	0.251
2.5	0.352	0.437	0.894	1.117	1.005	0.158
3	0.462	0.543	1.181	1.399	1.290	0.154
4	0.512	0.625	1.328	1.630	1.479	0.213
5	0.624	0.727	1.629	1.914	1.771	0.201
6	0.728	0.829	1.916	2.200	2.058	0.201
8	0.832	0.932	2.211	2.499	2.355	0.203
10	0.985	1.102	2.628	2.964	2.796	0.237
12	1.044	1.157	2.828	3.160	2.994	0.234
14	1.049	1.169	2.899	3.253	3.076	0.250
16	1.158	1.180	3.222	3.345	3.283	0.087
18	1.168	1.251	3.312	3.584	3.448	0.192
20	1.175	1.287	3.393	3.741	3.567	0.246
22	1.188	1.337	3.491	3.935	3.713	0.314
24	1.223	1.315	3.642	3.958	3.800	0.223
28	1.298	1.351	3.894	4.119	4.006	0.160
32	1.361	1.394	4.120	4.299	4.210	0.127
36	1.423	1.402	4.346	4.397	4.371	0.036
40	1.444	1.407	4.478	4.487	4.482	0.007
44	1.475	1.454	4.633	4.680	4.656	0.034
48	1.478	1.489	4.724	4.847	4.785	0.087

Table K7 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1.5+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.412	0.206	0.292
0.25	0.119	0.172	0.282	0.412	0.347	0.092
0.5	0.147	0.300	0.359	0.732	0.545	0.264
0.75	0.150	0.301	0.373	0.752	0.562	0.268
1	0.205	0.322	0.516	0.820	0.668	0.215
1.5	0.255	0.357	0.649	0.922	0.785	0.193
2	0.356	0.391	0.908	1.024	0.966	0.082
2.5	0.477	0.409	1.221	1.090	1.156	0.092
3	0.576	0.439	1.490	1.186	1.338	0.215
4	0.677	0.670	1.767	1.772	1.769	0.004
5	0.681	0.736	1.814	1.971	1.892	0.111
6	0.726	0.886	1.962	2.377	2.170	0.293
8	0.732	0.893	2.017	2.445	2.231	0.302
10	0.740	0.943	2.078	2.615	2.347	0.380
12	0.758	0.955	2.162	2.696	2.429	0.378
14	0.760	0.961	2.211	2.766	2.488	0.392
16	0.827	0.971	2.416	2.844	2.630	0.303
18	0.851	1.000	2.520	2.969	2.744	0.317
20	0.864	1.021	2.600	3.075	2.837	0.336
22	0.898	1.027	2.730	3.148	2.939	0.296
24	0.990	1.161	3.004	3.531	3.267	0.373
28	1.091	1.185	3.306	3.654	3.480	0.246
32	1.094	1.195	3.375	3.745	3.560	0.261
36	1.146	1.211	3.561	3.851	3.706	0.205
40	1.172	1.227	3.689	3.957	3.823	0.190
44	1.158	1.229	3.722	4.030	3.876	0.218
48	1.201	1.230	3.892	4.103	3.997	0.150

Table K8 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_2+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.207	0.244	0.496	0.587	0.542	0.064
0.5	0.212	0.259	0.520	0.637	0.579	0.083
0.75	0.222	0.276	0.557	0.693	0.625	0.096
1	0.296	0.296	0.748	0.757	0.752	0.006
1.5	0.302	0.305	0.780	0.795	0.788	0.010
2	0.318	0.315	0.835	0.836	0.835	0.001
2.5	0.421	0.411	1.103	1.088	1.095	0.011
3	0.451	0.381	1.199	1.037	1.118	0.115
4	0.612	0.690	1.616	1.811	1.714	0.138
5	0.702	0.791	1.871	2.095	1.983	0.158
6	0.728	0.794	1.973	2.146	2.059	0.123
8	0.832	0.857	2.267	2.344	2.306	0.054
10	0.885	0.872	2.441	2.428	2.435	0.009
12	0.899	0.907	2.527	2.563	2.545	0.026
14	0.973	0.909	2.755	2.618	2.686	0.097
16	0.989	0.910	2.850	2.671	2.760	0.126
18	1.016	0.911	2.969	2.723	2.846	0.174
20	1.020	0.928	3.037	2.817	2.927	0.155
22	1.023	0.940	3.102	2.898	3.000	0.144
24	1.024	0.961	3.160	3.001	3.080	0.113
28	1.059	1.028	3.303	3.219	3.261	0.059
32	1.164	1.141	3.619	3.552	3.585	0.047
36	1.166	1.162	3.687	3.666	3.677	0.014
40	1.247	1.206	3.951	3.839	3.895	0.080
44	1.257	1.217	4.044	3.931	3.988	0.080
48	1.289	1.234	4.194	4.043	4.118	0.107

Table K9 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_2.5+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.345	0.137	0.832	0.327	0.579	0.358
0.5	0.346	0.143	0.854	0.349	0.601	0.357
0.75	0.352	0.159	0.889	0.395	0.642	0.349
1	0.367	0.228	0.944	0.571	0.758	0.264
1.5	0.417	0.228	1.086	0.584	0.835	0.354
2	0.438	0.417	1.160	1.056	1.108	0.073
2.5	0.444	0.480	1.201	1.235	1.218	0.024
3	0.487	0.672	1.328	1.728	1.528	0.283
4	0.532	0.683	1.466	1.793	1.629	0.231
5	0.559	0.731	1.560	1.946	1.753	0.273
6	0.589	0.738	1.665	2.004	1.834	0.239
8	0.592	0.742	1.706	2.055	1.881	0.247
10	0.691	0.762	1.979	2.147	2.063	0.118
12	0.695	0.767	2.028	2.201	2.114	0.123
14	0.707	0.770	2.095	2.250	2.172	0.110
16	0.713	0.774	2.149	2.304	2.226	0.109
18	0.757	0.775	2.296	2.350	2.323	0.038
20	0.769	0.787	2.369	2.423	2.396	0.038
22	0.785	0.796	2.449	2.489	2.469	0.028
24	0.799	0.799	2.529	2.540	2.534	0.008
28	0.804	0.799	2.584	2.585	2.584	0.000
32	0.816	0.813	2.660	2.662	2.661	0.002
36	0.825	0.813	2.727	2.710	2.718	0.012
40	0.833	0.815	2.793	2.759	2.776	0.024
44	0.908	0.847	3.020	2.883	2.952	0.097
48	0.918	0.881	3.097	3.014	3.055	0.059

Release Kinetics of Model Drug from Drug-Loaded PAA Hydrogel

The study of sulfosalicylic acid transport mechanism from the PAA hydrogels, Fickian diffusion models are considered to fit the experimental data.

The power law model is described by the Ritger-Peppas equation (Venkatesh *et al.*, 1992):

$$\frac{M_t}{M_\infty} = k_1 t^n \qquad \text{(K.1)}$$

where M_t/M_∞ = the fractional drug release

k = a kinetic constant

t = the release time

and n = the scaling exponent that can be related to the drug transport mechanism.

For a thin hydrogel film, when n = 0.5, the drug release mechanism is observed by the Fickian diffusion:

$$\frac{M_t}{M_\infty} = k_H t^{1/2} \qquad \text{(K.2)}$$

where M_t/M_∞ = the fractional drug release

k_H = a kinetic constant

and t = the release time.

The diffusion coefficients of sulfosalicylic acid from the drug-loaded PAA hydrogels are calculated from the slopes of plots of drug accumulation *vs.* square root of time according to Higuchi's equation (A-sasutjarit *et al.*, 2005):

$$Q = 2C_0 (Dt/\pi)^{1/2} \qquad \text{(K.3)}$$

where Q = the amount of material flowing through a unit cross-section of barrier in unit time

C_0 = the initial drug concentration in the hydrogel

and D = the diffusion coefficient of a drug.

The diffusion coefficients of each system are calculated from the slopes of the plot of the amounts of sulfosalicylic acid released from sulfosalicylic acid-loaded poly(acrylic acid) hydrogel at time t vs. $t^{1/2}$ at various crosslinking ratios (with the electric field 1 V during 48 hours using the Higuchi's equation (see figure K2).

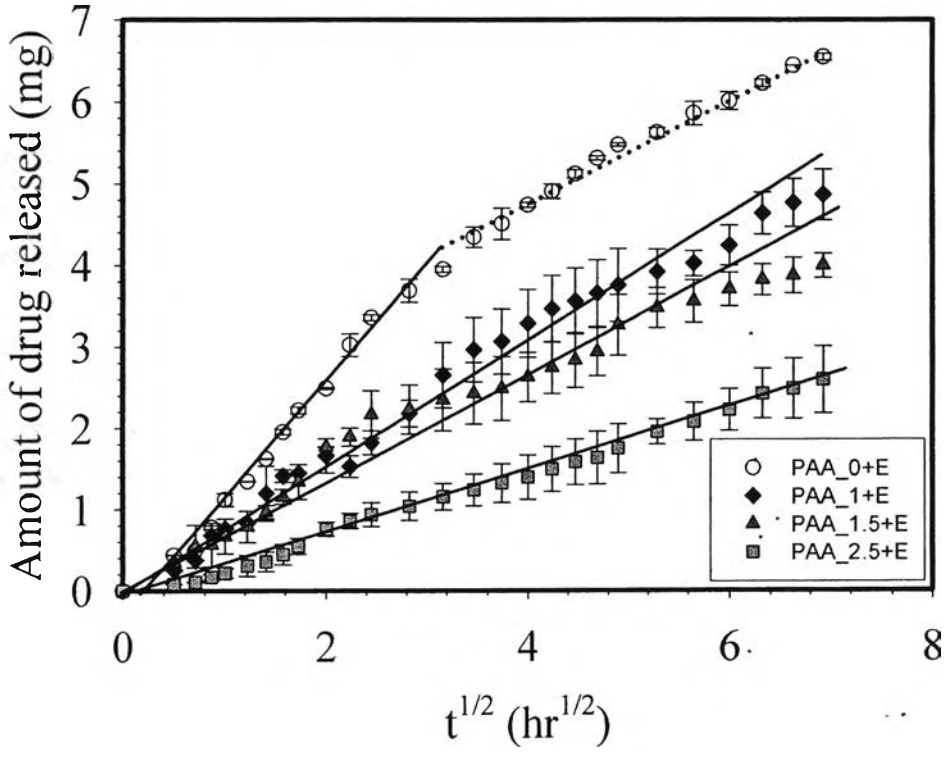


Figure K2 Amounts of sulfosalicylic acid release from sulfosalicylic acid-loaded poly(crylic acid) hydrogel vs. $t^{1/2}$ at various crosslink ratios, E = 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

The diffusion coefficients of each system were calculated from the slopes of these plots using the Higuchi's equation (see figure K2). Figure K3 shows the diffusion coefficients of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. crosslinking ratios and mesh size at electric field strength 1 V at 37 ^{0}C. Figure K4 present the diffusion coefficients of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. crosslinking ratios and mesh size at electric field strength of 0 and 1 V at 37 ^{0}C.

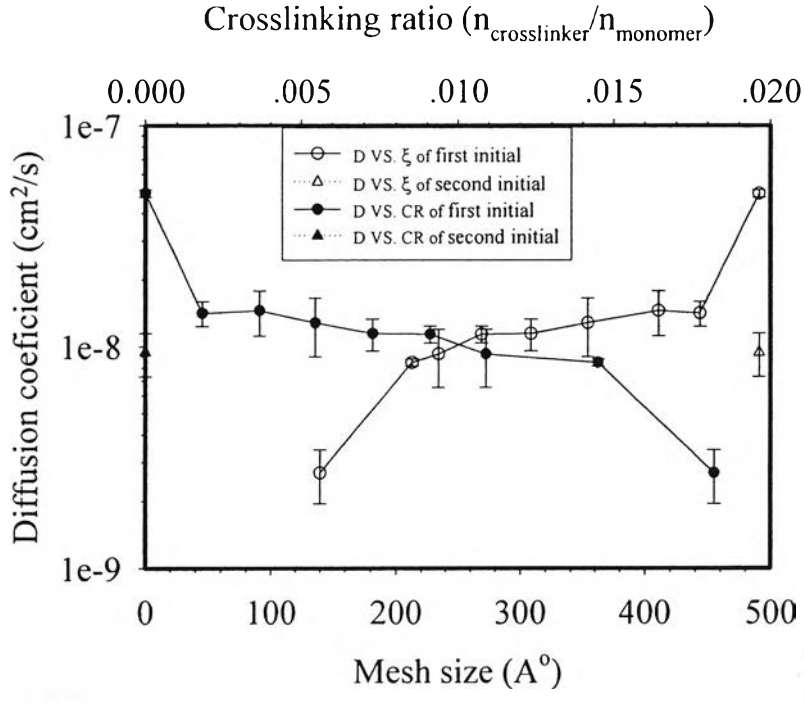


Figure K3 Diffusion coefficient of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. crosslinking ratios and Mesh size at electric field strength 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

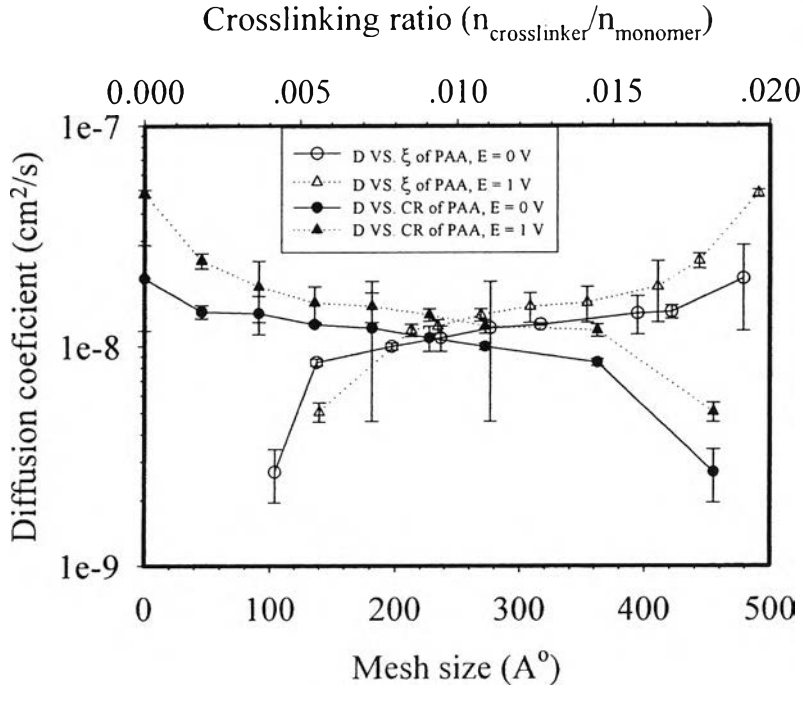


Figure K4 Diffusion coefficient of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. crosslinking ratios and Mesh size at electric field strength of 0 and 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Table K10 The raw data of the determination of the diffusion coefficient of sulfosalicylic acid released from various crosslinked PAA hydrogel, pH 5.5, at 37 ^{0}C, E = 1 V

Sample	Crosslinking ratio, X	Slope of first initial		Slope of second initial		Diffusion Coefficient of first initial (cm^2/s)				Diffusion Coefficient of second initial (cm^2/s)			
		1	2	1	2	1	2	Average	SD	1	2	Average	SD
PAA_0	0.00	1.584	1.541	0.735	0.628	1.584	1.541	4.92E-08	1.94E-09	1.09E-08	7.94E-09	9.41E-09	2.09E-09
PAA_0.25	1.82E-03	0.799	0.875	-	-	1.069	1.130	2.44E-08	1.89E-09	-	-	-	-
PAA_0.5	3.64E-03	0.915	0.777	-	-	1.059	0.849	1.86E-08	5.71E-09	-	-	-	-
PAA_0.75	5.45E-03	0.709	0.876	-	-	0.824	0.939	1.57E-08	2.88E-09	-	-	-	-
PAA_1	7.27E-03	0.708	0.796	-	-	0.819	0.913	1.51E-08	2.32E-09	-	-	-	-
PAA_1.25	9.09E-03	0.728	0.774	-	-	0.810	0.802	1.31E-08	1.98E-10	-	-	-	-
PAA_1.5	1.09E-02	0.604	0.745	-	-	0.762	0.745	1.14E-08	3.65E-10	-	-	-	-
PAA_2	1.45E-02	0.657	0.640	-	-	0.784	0.749	1.18E-08	7.69E-10	-	-	-	-
PAA_2.5	1.82E-02	0.329	0.400	-	-	0.483	0.518	5.06E-09	5.07E-10	-	-	-	-

Figure K5 shows the log-log plot of diffusion coefficients of sulfosalicylic acid from poly(acrylic) hydrogels vs. drug size/mesh size of hydrogel at electric field strength of 0 and 1 V at 37 ^{0}C. From these results, the scaling exponents m were determined from the following equation:

$$D = D_0(a/\xi)^{-m} \tag{K.4}$$

where D = the diffusion coefficient of a drug

D_0 = the initial diffusion coefficient

a = the size of drug

ξ = the mesh size of hydrogel

and m = the scaling exponent.

The scaling exponent m value of the system for the sulfosalicylic acid to diffuse through the poly(acrylic acid) matrix skin under electric field strength of 0 and 1 V are 0.48 and 0.49, respectively. D_0 values are 2.33 x 10^{-9} and 2.09 x 10^{-9} cm^2/s, respectively.

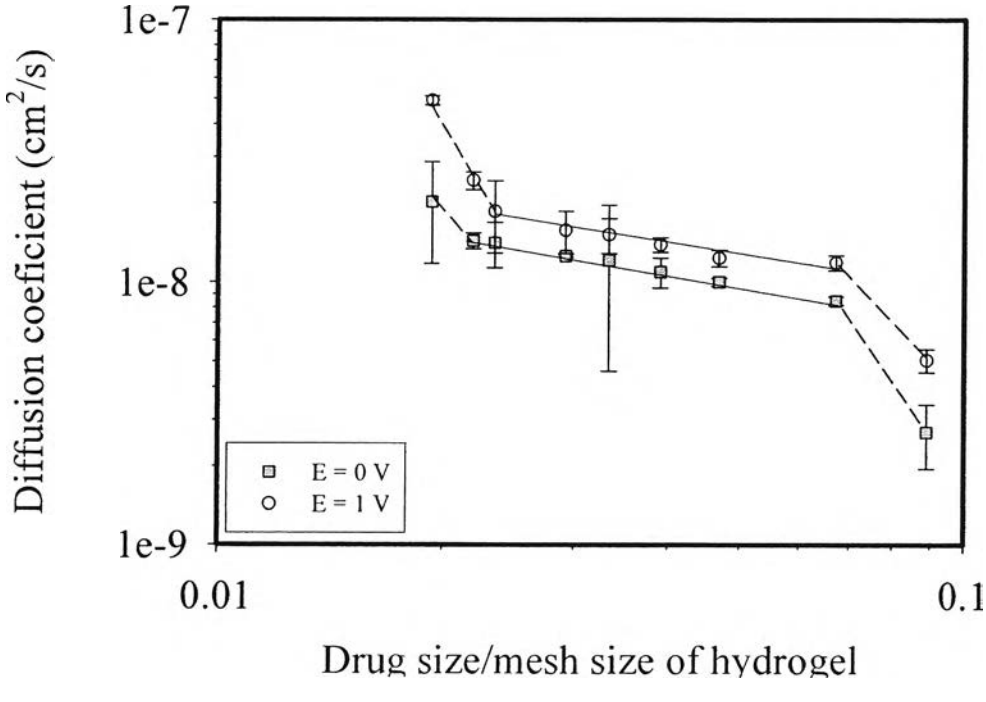


Figure K5 Diffusion coefficient of sulfosalicylic acid from poly(acrylic acid) hydrogels vs. drug size/mesh size of hydrogel at electric field strength of 0 and 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Appendix L Determination of Amounts and Diffusion Coefficient of Sulfosalicylic Acid Released from Sulfosalicylic Acid-Loaded Polypyrrole/Poly(acrylic acid) Blend Film at Various Crosslinking Ratios with Electric Field Strength (E = 1 V)

The amounts of sulfosalicylic acid released from sulfosalicylic acid- loaded polypyrrole/poly(acrylic acid) blend film at time t vs. time at various crosslinking ratios with electric field strength 1 V during 48 hours is illustrated in Figure L1. The amount of released drug was increases with time and then reaches an equilibrium value. Moreover the amount of released drug decreased with increase of crosslinking ratio.

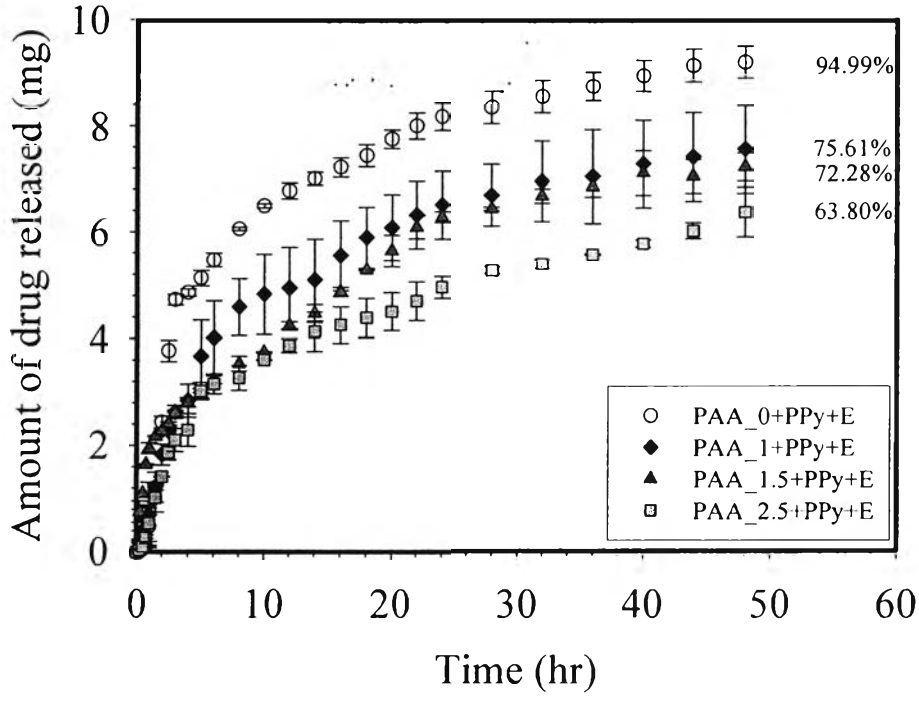


Figure L1 Amounts of sulfosalicylic acid release from sulfosalicylic acid-loaded polypyrrole/poly(acrylic acid) hydrogel vs. time at various crosslink ratios, E = 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Table L1 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.5	0.042	0.000	0.095	0.000	0.047	0.067
0.75	0.090	0.017	0.214	0.034	0.124	0.127
1	0.297	0.095	0.723	0.225	0.474	0.352
1.5	0.502	0.480	1.238	1.167	1.202	0.051
2	0.952	1.022	2.360	2.512	2.436	0.107
2.5	1.567	1.457	3.911	3.627	3.769	0.201
3	1.894	1.845	4.793	4.653	4.723	0.099
4	1.896	1.867	4.904	4.810	4.857	0.067
5	1.986	1.913	5.230	5.025	5.127	0.145
6	2.074	2.013	5.555	5.375	5.465	0.127
8	2.240	2.234	6.075	6.028	6.051	0.033
10	2.369	2.360	6.513	6.459	6.486	0.039
12	2.374	2.478	6.659	6.877	6.768	0.154
14	2.425	2.508	6.915	7.090	7.002	0.123
16	2.440	2.555	7.088	7.344	7.216	0.181
18	2.466	2.593	7.289	7.582	7.435	0.207
20	2.546	2.650	7.621	7.866	7.743	0.173
22	2.568	2.713	7.819	8.166	7.993	0.246
24	2.577	2.726	7.983	8.350	8.167	0.260
28	2.582	2.754	8.140	8.571	8.355	0.305
32	2.606	2.771	8.344	8.767	8.555	0.299
36	2.633	2.774	8.555	8.929	8.742	0.265
40	2.646	2.800	8.735	9.149	8.942	0.292
44	2.659	2.820	8.916	9.354	9.135	0.310
48	2.792	2.861	9.386	9.613	9.499	0.160

Table L2 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.25+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.5	0.087	0.198	0.205	0.474	0.340	0.190
0.75	0.323	0.228	0.785	0.558	0.671	0.160
1	0.744	0.744	1.826	1.828	1.827	0.001
1.5	0.803	0.770	2.010	1.932	1.971	0.055
2	1.275	1.284	3.203	3.225	3.214	0.015
2.5	1.366	1.351	3.497	3.460	3.479	0.026
3	1.467	1.393	3.819	3.638	3.728	0.128
4	1.500	1.609	3.982	4.240	4.111	0.182
5	1.717	1.692	4.592	4.532	4.562	0.042
6	1.943	1.903	5.240	5.141	5.190	0.070
8	2.099	1.959	5.728	5.383	5.556	0.244
10	2.248	2.145	6.207	5.946	6.077	0.185
12	2.287	2.281	6.428	6.398	6.413	0.021
14	2.342	2.382	6.690	6.771	6.731	0.057
16	2.347	2.395	6.833	6.936	6.885	0.073
18	2.375	2.415	7.035	7.119	7.077	0.059
20	2.381	2.432	7.181	7.296	7.238	0.082
22	2.490	2.463	7.579	7.508	7.543	0.051
24	2.494	2.543	7.728	7.839	7.784	0.078
28	2.503	2.640	7.892	8.218	8.055	0.230
32	2.558	2.656	8.164	8.406	8.285	0.171
36	2.634	2.681	8.493	8.616	8.554	0.087
40	2.651	2.780	8.683	9.006	8.845	0.228
44	2.705	2.811	8.964	9.237	9.100	0.193
48	2.838	2.891	9.437	9.590	9.513	0.108

Table L3 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.5+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.5	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.029	0.000	0.063	0.031	0.044
1	0.052	0.041	0.118	0.094	0.106	0.017
1.5	0.104	0.139	0.250	0.334	0.292	0.060
2	0.697	0.427	1.696	1.043	1.369	0.462
2.5	0.967	0.987	2.392	2.428	2.410	0.025
3	1.599	1.334	3.985	3.327	3.656	0.465
4	1.731	1.665	4.395	4.208	4.301	0.132
5	1.877	1.725	4.847	4.448	4.648	0.282
6	1.883	1.828	4.967	4.796	4.881	0.121
8	1.921	1.835	5.164	4.913	5.038	0.177
10	1.936	1.853	5.309	5.061	5.185	0.176
12	1.950	1.886	5.452	5.245	5.348	0.147
14	1.952	1.887	5.565	5.352	5.459	0.151
16	1.989	1.834	5.765	5.329	5.547	0.308
18	1.996	1.872	5.895	5.525	5.710	0.261
20	2.017	1.882	6.056	5.655	5.856	0.283
22	2.146	1.973	6.482	5.982	6.232	0.354
24	2.354	2.058	7.109	6.298	6.703	0.573
28	2.384	2.138	7.314	6.609	6.961	0.499
32	2.406	2.245	7.502	6.988	7.245	0.363
36	2.432	2.315	7.700	7.284	7.492	0.295
40	2.480	2.468	7.953	7.786	7.870	0.118
44	2.501	2.453	8.143	7.889	8.016	0.179
48	2.482	2.482	8.237	8.096	8.167	0.099

Table L4 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_0.75+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.177	0.200	0.425	0.479	0.452	0.039
0.5	0.202	0.223	0.494	0.547	0.520	0.038
0.75	0.216	0.255	0.539	0.637	0.588	0.069
1	0.229	0.269	0.584	0.685	0.634	0.072
1.5	0.284	0.333	0.730	0.857	0.794	0.090
2	0.381	0.353	0.983	0.922	0.953	0.043
2.5	0.480	0.679	1.245	1.735	1.490	0.347
3	0.645	0.894	1.672	2.296	1.984	0.441
4	1.028	1.047	2.639	2.718	2.679	0.056
5	1.336	1.385	3.446	3.600	3.523	0.109
6	1.608	1.718	4.183	4.487	4.335	0.215
8	1.846	1.872	4.852	4.957	4.905	0.074
10	1.927	1.971	5.151	5.303	5.227	0.108
12	1.963	2.013	5.347	5.516	5.432	0.120
14	1.992	2.022	5.528	5.651	5.589	0.087
16	2.004	2.113	5.670	5.985	5.828	0.223
18	2.003	2.174	5.779	6.252	6.016	0.334
20	2.056	2.231	6.019	6.513	6.266	0.349
22	2.111	2.242	6.269	6.666	6.467	0.281
24	2.117	2.313	6.403	6.963	6.683	0.396
28	2.122	2.347	6.533	7.176	6.854	0.455
32	2.126	2.359	6.662	7.338	7.000	0.478
36	2.159	2.362	6.862	7.477	7.170	0.435
40	2.160	2.424	6.984	7.760	7.372	0.549
44	2.189	2.431	7.177	7.913	7.545	0.521
48	2.204	2.462	7.336	8.125	7.731	0.558

Table L5 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.095	0.076	0.226	0.177	0.202	0.034
0.5	0.218	0.109	0.529	0.263	0.396	0.188
0.75	0.320	0.185	0.789	0.454	0.621	0.237
1	0.452	0.101	1.129	0.258	0.693	0.615
1.5	0.558	0.409	1.411	1.013	1.212	0.281
2	0.775	0.677	1.970	1.688	1.829	0.199
2.5	0.904	0.880	2.326	2.220	2.273	0.075
3	1.044	0.990	2.719	2.538	2.629	0.128
4	1.159	1.002	3.058	2.621	2.839	0.309
5	1.580	1.210	4.145	3.185	3.665	0.679
6	1.689	1.321	4.500	3.521	4.011	0.692
8	1.840	1.572	4.962	4.206	4.584	0.535
10	1.959	1.572	5.355	4.294	4.824	0.750
12	1.966	1.579	5.480	4.398	4.939	0.765
14	1.984	1.603	5.635	4.547	5.091	0.769
16	2.093	1.787	6.010	5.084	5.547	0.655
18	2.160	1.907	6.291	5.475	5.883	0.577
20	2.200	1.928	6.510	5.633	6.072	0.620
22	2.254	1.978	6.763	5.863	6.313	0.637
24	2.281	2.008	6.957	6.046	6.502	0.644
28	2.293	2.062	7.114	6.290	6.702	0.583
32	2.398	2.070	7.498	6.425	6.962	0.759
36	2.417	2.021	7.677	6.422	7.049	0.888
40	2.440	2.088	7.870	6.698	7.284	0.829
44	2.442	2.092	8.012	6.826	7.419	0.839
48	2.442	2.105	8.147	6.974	7.560	0.830

Table L6 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1.25+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.5	0.000	0.152	0.000	0.362	0.181	0.256
0.75	0.112	0.486	0.266	1.184	0.725	0.649
1	0.342	0.597	0.832	1.481	1.156	0.459
1.5	0.448	0.660	1.108	1.668	1.388	0.396
2	0.633	0.691	1.583	1.779	1.681	0.138
2.5	0.764	0.828	1.936	2.152	2.044	0.153
3	0.824	0.948	2.126	2.490	2.308	0.257
4	1.160	1.165	2.988	3.072	3.030	0.059
5	1.319	1.270	3.440	3.392	3.416	0.034
6	1.462	1.412	3.863	3.808	3.836	0.039
8	1.776	1.481	4.708	4.056	4.382	0.461
10	1.786	1.652	4.831	4.554	4.692	0.196
12	1.990	1.853	5.429	5.135	5.282	0.207
14	1.990	1.861	5.540	5.258	5.399	0.200
16	1.994	1.866	5.661	5.375	5.518	0.203
18	1.995	1.894	5.774	5.548	5.661	0.160
20	1.999	1.947	5.896	5.783	5.840	0.080
22	2.013	2.066	6.043	6.180	6.112	0.097
24	2.114	2.106	6.402	6.394	6.398	0.006
28	2.218	2.174	6.774	6.679	6.726	0.067
32	2.222	2.090	6.907	6.596	6.752	0.220
36	2.228	2.091	7.047	6.714	6.881	0.235
40	2.231	2.099	7.178	6.851	7.015	0.231
44	2.233	2.134	7.308	7.056	7.182	0.179
48	2.230	2.162	7.426	7.243	7.335	0.130

Table L7 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_1.5+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.371	0.254	0.897	0.612	0.755	0.201
0.5	0.446	0.445	1.100	1.089	1.094	0.008
0.75	0.662	0.656	1.650	1.628	1.639	0.016
1	0.798	0.742	2.017	1.873	1.945	0.102
1.5	0.839	0.851	2.162	2.180	2.171	0.013
2	0.870	0.866	2.285	2.266	2.275	0.014
2.5	0.910	0.898	2.429	2.390	2.410	0.028
3	0.946	0.982	2.568	2.646	2.607	0.055
4	0.996	1.051	2.744	2.869	2.806	0.089
5	1.041	1.097	2.909	3.038	2.974	0.091
6	1.171	1.127	3.282	3.174	3.228	0.076
8	1.286	1.206	3.628	3.430	3.529	0.141
10	1.298	1.309	3.729	3.748	3.738	0.013
12	1.496	1.453	4.284	4.170	4.227	0.080
14	1.584	1.492	4.582	4.346	4.464	0.167
16	1.690	1.646	4.928	4.804	4.866	0.088
18	1.798	1.800	5.286	5.271	5.278	0.010
20	1.987	1.823	5.845	5.429	5.637	0.294
22	2.099	1.985	6.229	5.926	6.077	0.215
24	2.099	2.054	6.347	6.203	6.275	0.102
28	2.100	2.095	6.467	6.418	6.442	0.035
32	2.102	2.195	6.589	6.779	6.684	0.134
36	2.106	2.232	6.718	6.992	6.855	0.194
40	2.099	2.352	6.819	7.410	7.115	0.418
44	2.053	2.241	6.824	7.271	7.048	0.316
48	2.095	2.248	7.042	7.414	7.228	0.263

Table L8 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_2+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.070	0.069	0.163	0.160	0.162	0.002
0.5	0.099	0.080	0.238	0.193	0.215	0.032
0.75	0.164	0.139	0.402	0.340	0.371	0.043
1	0.201	0.194	0.500	0.481	0.490	0.014
1.5	0.335	0.325	0.838	0.811	0.825	0.019
2	0.567	0.561	1.419	1.404	1.412	0.011
2.5	0.667	0.742	1.694	1.873	1.784	0.127
3	0.891	0.971	2.277	2.473	2.375	0.139
4	1.144	1.173	2.944	3.019	2.981	0.053
5	1.281	1.219	3.341	3.195	3.268	0.103
6	1.490	1.451	3.921	3.828	3.875	0.066
8	1.516	1.790	4.067	4.735	4.401	0.473
10	1.629	1.801	4.427	4.861	4.644	0.307
12	1.753	1.865	4.820	5.117	4.969	0.210
14	1.759	1.913	4.933	5.339	5.136	0.287
16	1.873	2.009	5.308	5.679	5.494	0.263
18	1.927	2.106	5.546	6.030	5.788	0.342
20	1.949	2.131	5.705	6.208	5.956	0.355
22	1.985	2.136	5.904	6.339	6.121	0.308
24	1.992	2.174	6.030	6.551	6.291	0.368
28	2.006	2.181	6.178	6.689	6.434	0.361
32	2.008	2.182	6.293	6.815	6.554	0.369
36	2.016	2.186	6.424	6.946	6.685	0.369
40	2.035	2.189	6.586	7.077	6.832	0.347
44	2.049	2.192	6.734	7.207	6.971	0.334
48	2.091	2.196	6.951	7.339	7.145	0.274

Table L9 The raw data of the determination of amounts of sulfosalicylic acid released from PAA_2.5+PPy+E at time t, pH 5.5 at 37 ^{0}C, with the electric field 1 V

Time	Absorbance intensity		Drug Accumulation (mg)			
Hour	1	2	1	2	Average	SD
0	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.012	0.024	0.023	0.053	0.038	0.021
0.5	0.032	0.063	0.071	0.148	0.110	0.054
0.75	0.090	0.124	0.215	0.301	0.258	0.061
1	0.122	0.319	0.296	0.781	0.539	0.343
1.5	0.336	0.486	0.825	1.204	1.015	0.268
2	0.572	0.558	1.417	1.406	1.412	0.008
2.5	0.701	0.773	1.764	1.961	1.862	0.139
3	0.760	0.876	1.947	2.254	2.100	0.217
4	0.795	0.959	2.074	2.506	2.290	0.305
5	1.118	1.194	2.903	3.131	3.017	0.161
6	1.140	1.229	3.019	3.283	3.151	0.187
8	1.147	1.261	3.101	3.429	3.265	0.232
10	1.327	1.299	3.602	3.594	3.598	0.006
12	1.442	1.344	3.957	3.775	3.866	0.128
14	1.583	1.349	4.380	3.863	4.121	0.366
16	1.592	1.378	4.491	4.009	4.250	0.340
18	1.617	1.394	4.641	4.126	4.384	0.365
20	1.624	1.411	4.749	4.245	4.497	0.356
22	1.668	1.457	4.947	4.436	4.692	0.362
24	1.692	1.576	5.099	4.806	4.953	0.207
28	1.708	1.753	5.231	5.326	5.278	0.067
32	1.711	1.766	5.336	5.456	5.396	0.084
36	1.766	1.779	5.565	5.584	5.575	0.014
40	1.834	1.798	5.831	5.732	5.781	0.070
44	1.915	1.833	6.130	5.917	6.024	0.151
48	2.111	1.844	6.712	6.047	6.380	0.470

Release Kinetics of Model Drug from Drug-Loaded PPy/PAA Blend Film

The study of sulfosalicylic acid transport mechanism from the PPy/PAA blend films, Fickian diffusion models are considered to fit the experimental data.

The power law model is described by the Ritger-Peppas equation (Venkatesh *et al.*, 1992):

$$\frac{M_t}{M_\infty} = k_1 t^n \qquad \text{(L.1)}$$

where M_t/M_∞ = the fractional drug release

k = a kinetic constant

t = the release time

and n = the scaling exponent that can be related to the drug transport mechanism.

For a thin hydrogel film, when n = 0.5, the drug release mechanism is observed by the Fickian diffusion:

$$\frac{M_t}{M_\infty} = k_H t^{1/2} \qquad \text{(L.2)}$$

where M_t/M_∞ = the fractional drug release

k_H = a kinetic constant

and t = the release time.

The diffusion coefficients of sulfosalicylic acid from the PPy/PAA blend films are calculated from the slopes of plots of drug accumulation *vs.* square root of time according to Higuchi's equation (A-sasutjarit *et al.*, 2005):

$$Q = 2C_0(Dt/\pi)^{1/2} \qquad \text{(L.3)}$$

where Q = the amount of material flowing through a unit cross-section of barrier in unit time

C_0 = the initial drug concentration in the hydrogel

and D = the diffusion coefficient of a drug.

The diffusion coefficients of each system are calculated from the slopes of the plot of the amounts of sulfosalicylic acid released from sulfosalicylic acid-loaded polypyrrole/poly(acrylic acid) blend film at time t vs. $t^{1/2}$ at various crosslinking ratios with the electric field 1 V during 48 hours using the Higuchi's equation (see figure L2).

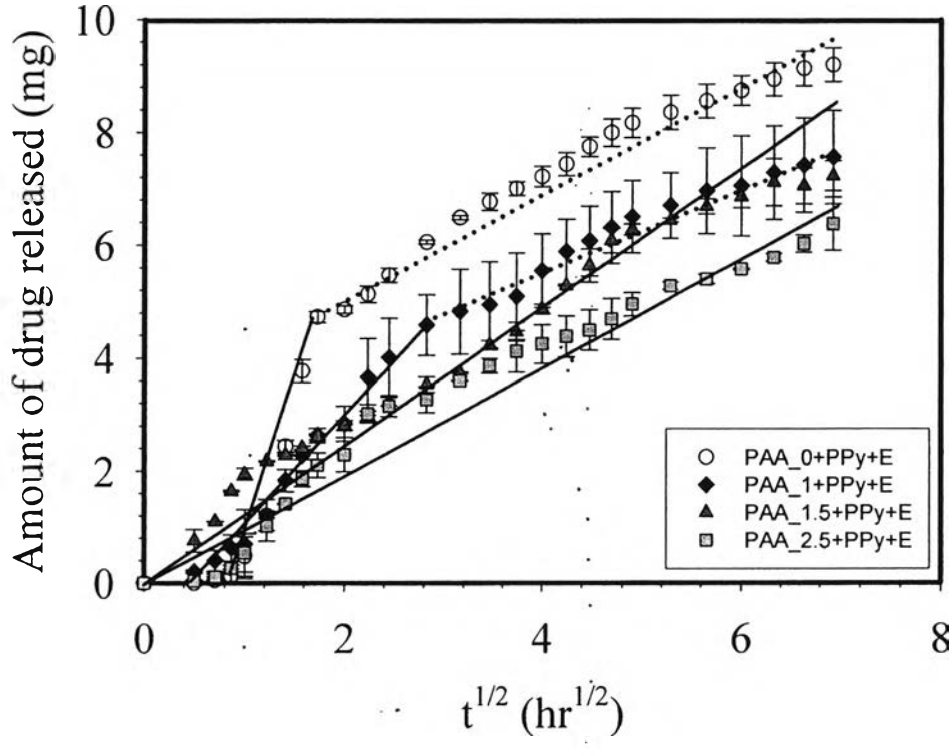


Figure L2 Amounts of sulfosalicylic acid release from sulfosalicylic acid-loaded polypyrrole/poly(acrylic acid) blend films vs. $t^{1/2}$ at various crosslink ratios, E = 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Figure L3 shows the amounts of sulfosalicylic acid released from sulfosalicylic acid- loaded poly(acrylic acid) and polypyrrole/poly(acrylic acid) blend film at time t vs. $t^{1/2}$ at crosslinking ratios 9.09×10^{-3} with the electric field 1 V during 48 hours.

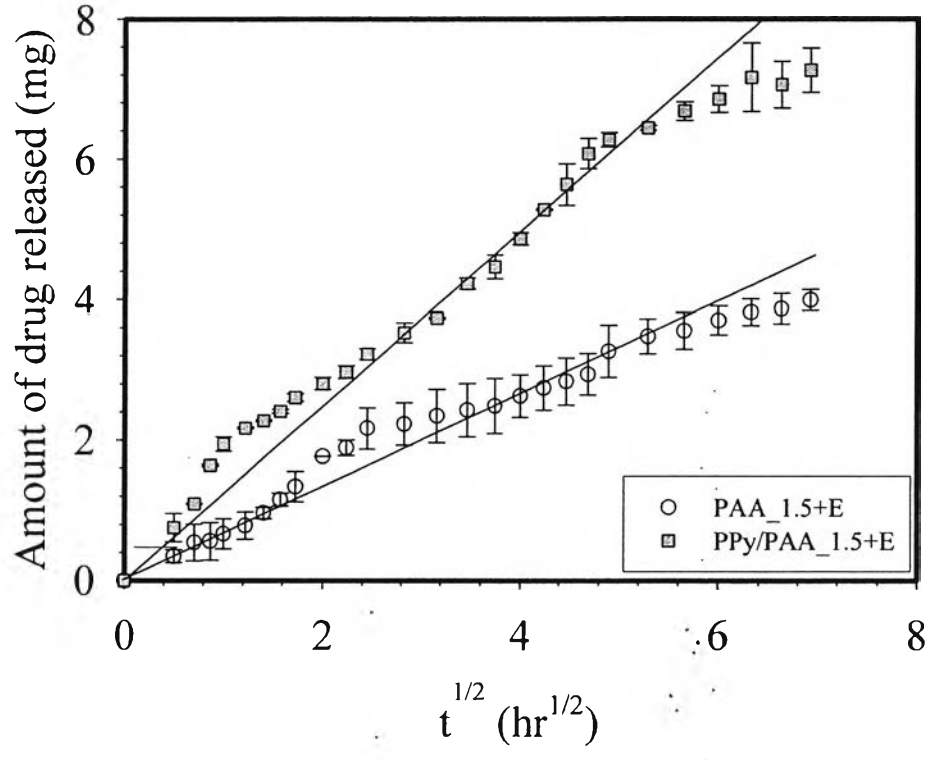


Figure L3 The amounts of sulfosalicylic acid released from sulfosalicylic acid- loaded poly(acrylic acid) and polypyrrole/poly(acrylic acid) blend film at time t vs. $t^{1/2}$ at crosslinking ratios 9.09×10^{-3} with the electric field 1 V during 48 hours.

The diffusion coefficients were calculated from the slopes of these plots using the Higuchi's equation (see figure L2). Figure L4 shows the diffusion coefficients of sulfosalicylic acid from polypyrrole/poly(acrylic acid) blend films of first and second initial period vs. crosslinking ratios and mesh size at electric field strength 1 V at 37 ^{0}C.

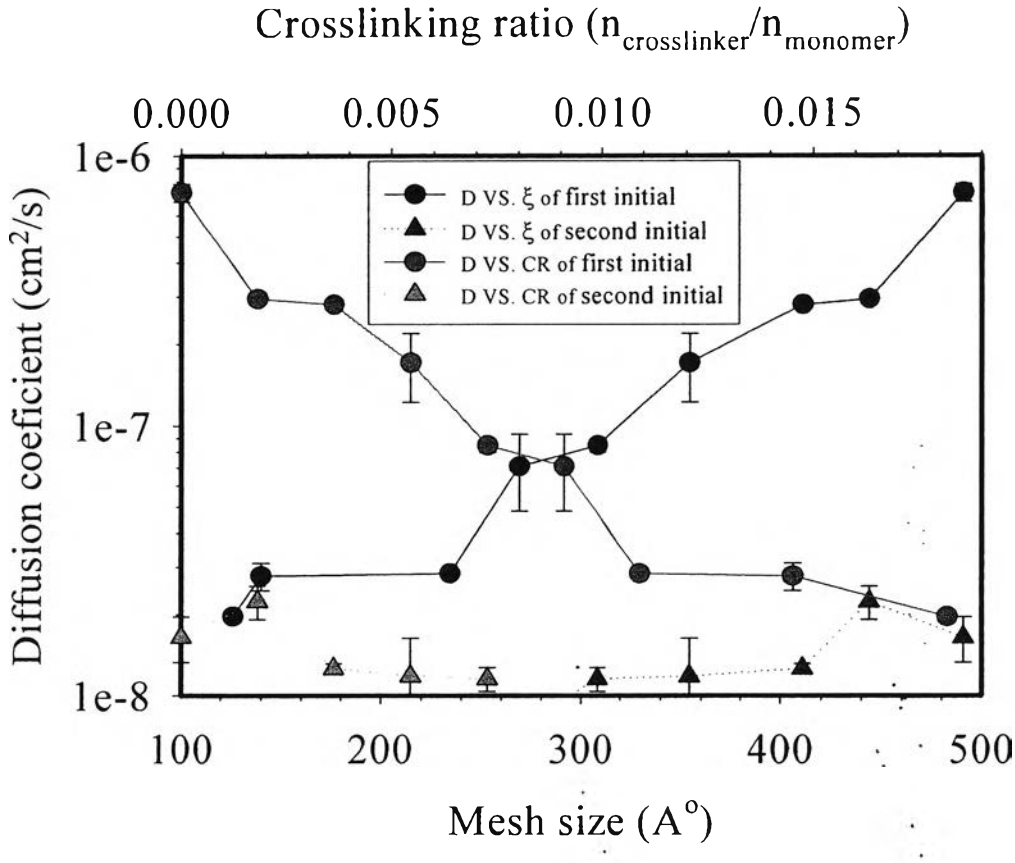
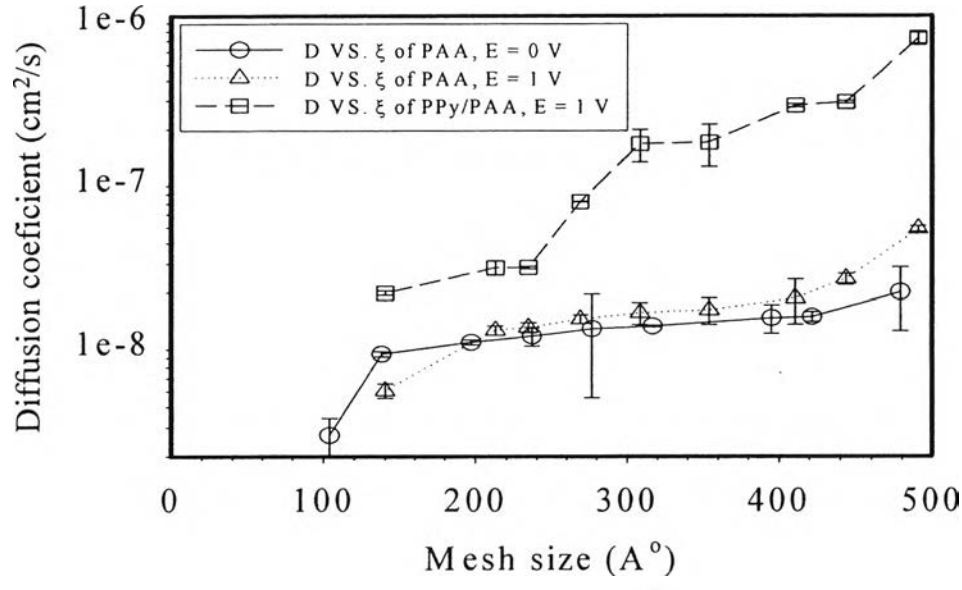
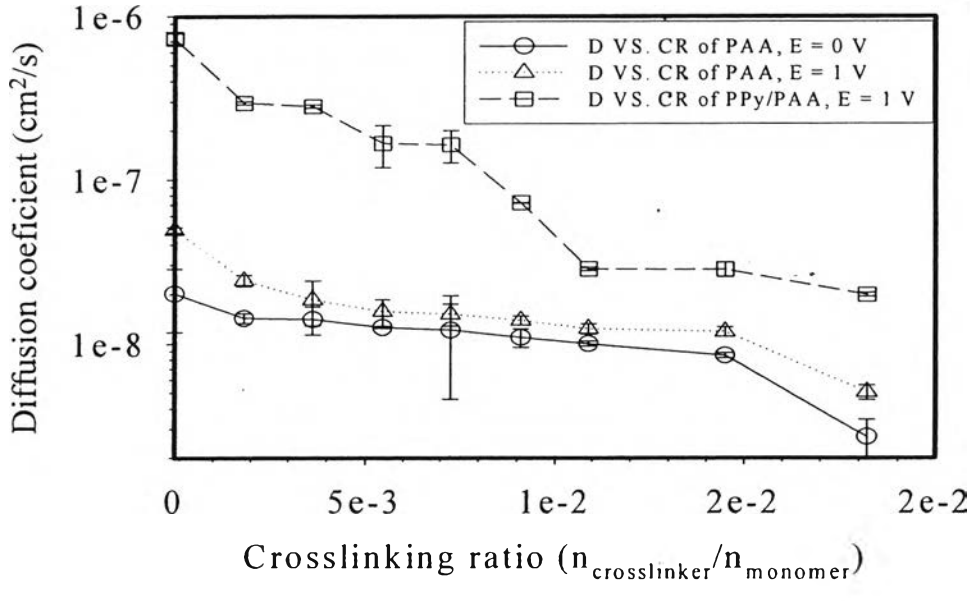


Figure L4 Diffusion coefficient of sulfosalicylic acid from polypyrrole/poly(acrylic acid) blend films vs. crosslinking ratios and Mesh size at electric field strength 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Figure L5 (a) and (b) show the diffusion coefficients of sulfosalicylic acid from poly(acrylic acid) hydrogel and polypyrrole/poly(acrylic acid) blend films vs. crosslinking ratios and mesh size at electric field strength of 0 and 1 V at 37 ^{0}C, respectively.



(a)



(b)

Figure L5 Diffusion coefficient of sulfosalicylic acid from poly(acrylic acid) hydrogels and polypyrrole/poly(acrylic acid) blend films vs. (a) crosslinking ratios and (b) mesh size (Å), at electric field strength of 0 and 1 V, pH 5.5, 37 ^{0}C, n = # samples = 2.

Table L10 Raw data of the determination of the diffusion coefficient of sulfosalicylic acid released from various crosslinked PPy/PAA blend films, pH 5.5, at 37 ^{0}C, E = 1 V

Sample	Crosslinking ratio, X	Slope of first initial		Slope of second initial		Diffusion Coefficient of first initial(cm^2/s)				Diffusion Coefficient of second initial(cm^2/s)			
		1	2	1	2	1	2	Average	SD	1	2	Average	SD
PAA_0+Ppy+E	0.00	5.853	6.176	0.841	0.963	6.91E-07	7.69E-07	7.30E-07	5.53E-08	1.42E-08	1.87E-08	1.65E-08	3.14E-09
PAA_0.25+Ppy+E	1.82E-03	3.798	3.850	1.000	1.105	2.91E-07	2.99E-07	2.95E-07	5.75E-09	2.02E-08	2.46E-08	2.24E-08	3.16E-09
PAA_0.5+Ppy+E	3.64E-03	3.702	3.763	0.803	0.780	2.76E-07	2.85E-07	2.81E-07	6.44E-09	1.30E-08	1.23E-08	1.26E-08	5.14E-10
PAA_0.75+Ppy+E	5.45E-03	2.604	3.195	0.653	0.863	1.37E-07	2.06E-07	1.71E-07	4.88E-08	8.60E-09	1.50E-08	1.18E-08	4.54E-09
PAA_1Ppy+E	7.27E-03	2.090	2.009	0.783	0.730	8.81E-08	8.13E-08	8.47E-08	4.75E-09	1.24E-08	1.07E-08	1.15E-08	1.16E-09
PAA_1.25+Ppy+E	9.09E-03	2.072	1.651	0.631	0.617	8.66E-08	5.50E-08	7.08E-08	2.23E-08	8.02E-09	7.67E-09	7.84E-09	2.53E-10
PAA_1.5Ppy+E	1.09E-02	1.181	1.194	-	-	2.81E-08	2.88E-08	2.84E-08	4.64E-10	-	-	-	-
PAA_2+Ppy+E	1.45E-02	1.124	1.222	-	-	2.55E-08	3.01E-08	2.78E-08	3.28E-09	-	-	-	-
PAA_2.5+Ppy+E	1.82E-02	1.005	0.971	-	-	2.03E-08	1.90E-08	1.97E-08	9.38E-10	-	-	-	-

Table L11 Raw data of the determination of the diffusion coefficient of sulfosalicylic acid released from various crosslinked poly(acrylic acid) hydrogels and polypyrrole/poly(acrylic acid) blend films, pH 5.5, at 37 ^{0}C, E = 0 and 1 V.

Sample	Crosslinking ratio, X	Electric field strength (V)	Current (μA)	Slope		Diffusion Coefficient (cm^2/s)	
				1	2	Average	SD
PAA 0	0	0	-	0.841	1.141	2.02E-08	8.48E-09
PAA 0.25	1.82E-03	0	-	0.864	0.823	1.44E-08	9.86E-10
PAA 0.5	3.64E-03	0	-	0.776	0.892	1.41E-08	2.76E-09
PAA 0.75	5.45E-03	0	-	0.786	0.793	1.26E-08	1.49E-10
PAA 1	7.27E-03	0	-	0.93	0.58	1.21E-08	7.52E-09
PAA 1.25	9.09E-03	0	-	0.702	0.769	1.09E-08	1.42E-09
PAA 1.5	1.09E-02	0	-	0.696	0.713	1.00E-08	3.55E-10
PAA 2	1.45E-02	0	-	0.657	0.64	8.47E-09	3.18E-10
PAA 2.5	1.82E-02	0	-	0.329	0.4	2.70E-09	7.38E-10
PAA 0+E	0	1	1	1.584	1.541	4.92E-08	1.94E-09
PAA 0.25+E	1.82E-03	1	2	1.069	1.130	2.44E-08	1.89E-09
PAA 0.5+E	3.64E-03	1	2	1.059	0.849	1.86E-08	5.71E-09
PAA 0.75+E	5.45E-03	1	2.5	0.824	0.939	1.57E-08	2.88E-09
PAA 1+E	7.27E-03	1	3.5	0.819	0.913	1.51E-08	2.32E-09
PAA 1.25+E	9.09E-03	1	2.5	0.810	0.802	1.31E-08	1.98E-10
PAA 1.5+E	1.09E-02	1	1	0.762	0.745	1.14E-08	3.65E-10
PAA 2+E	1.45E-02	1	3	0.784	0.749	1.18E-08	7.69E-10
PAA 2.5+E	1.82E-02	1	3.5	0.483	0.518	5.06E-09	5.07E-10
PAA 0+Ppy+E	0	1	3.5	5.853	6.176	7.30E-07	5.53E-08
PAA 0.25+Ppy+E	1.82E-03	1	3.5	3.798	3.85	2.95E-07	5.75E-09
PAA 0.5+Ppy+E	3.64E-03	1	2.5	3.702	3.763	2.81E-07	6.44E-09
PAA 0.75+Ppy+E	5.45E-03	1	2.5	2.604	3.195	1.71E-07	4.88E-08
PAA 1Ppy+E	7.27E-03	1	3.5	2.09	2.009	8.47E-08	4.75E-09
PAA 1.25+Ppy+E	9.09E-03	1	2.5	2.072	1.651	7.08E-08	2.23E-08
PAA 1.5Ppy+E	1.09E-02	1	1	1.181	1.194	2.84E-08	4.64E-10
PAA 2+Ppy+E	1.45E-02	1	1	1.124	1.222	2.78E-08	3.28E-09
PAA 2.5+Ppy+E	1.82E-02	1	1	1.005	0.971	1.97E-08	9.38E-10

Figure L6 (a) and (b) show the log-log plot between the diffusion coefficients of SSA from PAA hydrogels and PPy/PAA blend films of first and second initial period vs. drug size/mesh size of hydrogel at electric field strengths of 0 and 1 V at 37 ^{0}C, respectively.

From these results, the scaling exponents' m was determined from the following equation:

$$D = D_0(a/\xi)^{-m} \tag{4}$$

where D = the diffusion coefficient of a drug

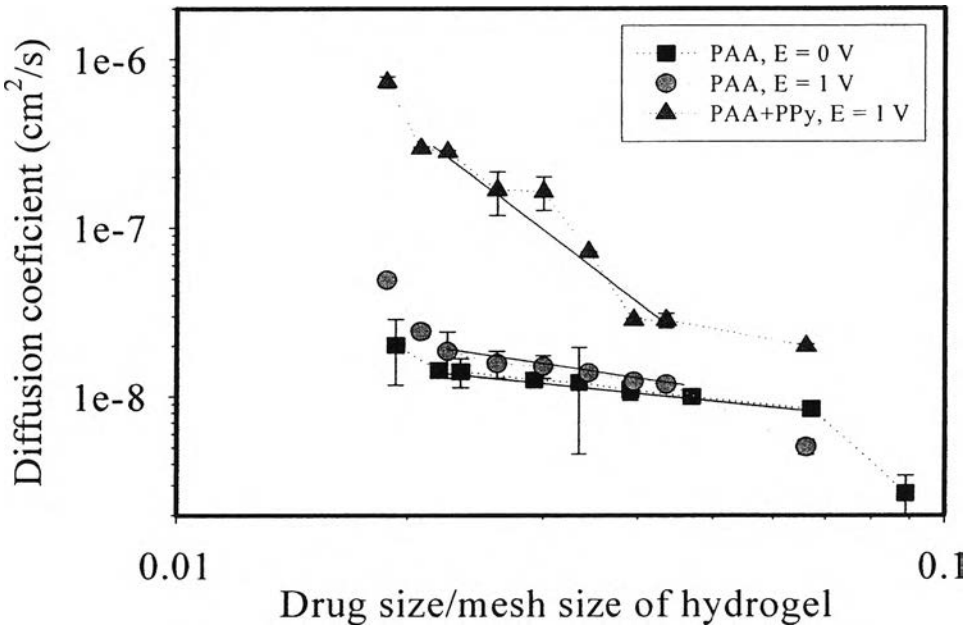
D_0 = the initial diffusion coefficient

a = the size of drug

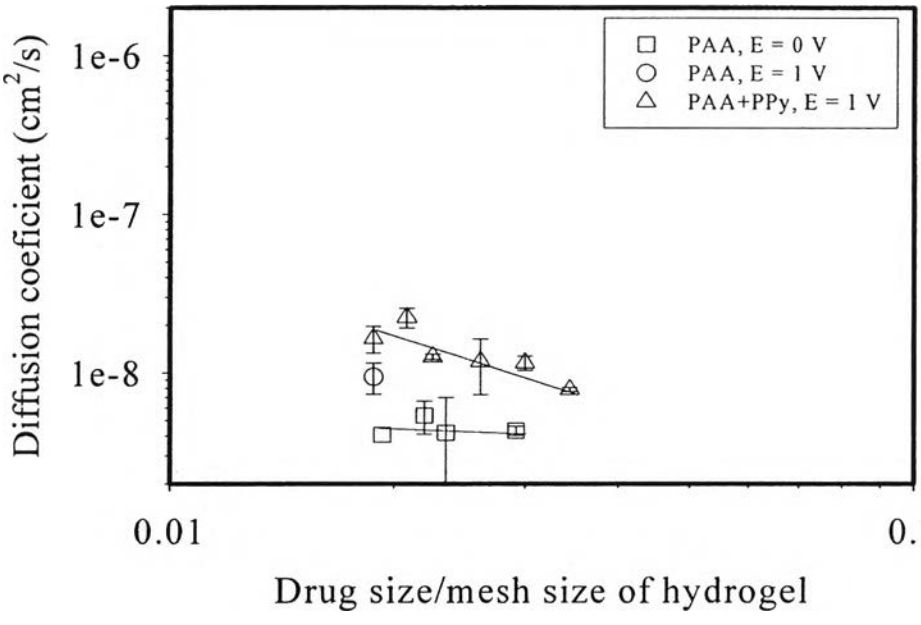
ξ = the mesh size of hydrogel

and m = the scaling exponent.

The scaling exponent m value for the SSA to diffuse through the PAA hydrogel under electric field strength of 0 and 1 V and the SSA to diffuse through the PPy/PAA blend film under electric field strength of 1 V are 0.48, 0.49 and 3.61, respectively. D_0 values are 2.33 x 10^{-9}, 2.09 x 10^{-9} and 2.97 x 10^{-13} cm^2/s, respectively.



(a)



(b)

Figure L6 The log-log plot between the diffusion coefficients of SSA from PAA hydrogels and PPy/PAA blend films of (a) first and (b) second initial period vs. drug size/mesh size of hydrogel at electric field strengths of 0 and 1 V at 37 ^{0}C, n = # samples = 2.

From a plot of $\ln(M_t/M_\infty)$ versus ln(t), the scaling exponents n were determined from equation L1 as shown in table L12. The n value of uncrosslinked PAA hydrogel without electric field is near the Fickian exponent value of n = 0.5. Thus, sulfosalicylic acid release is controlled by Fickian diffusion mechanism and the change in their structure had effect on the mechanism of release.

Table L12 Release kinetic parameters and linear regression values obtained from fitting drug release experimental data to the Ritger-Peppas model

Sample	Crosslinking ratio, X	Electric field strength (V)	Current (μA)	Diffusional exponent (n)	Kinetic constant (K)(hr^{-n})	r^2
PAA 0	0.00	0	-	0.352	0.311	0.989
PAA 0.25	1.82E-03	0	-	0.539	0.150	0.984
PAA 0.5	3.64E-03	0	-	0.644	0.109	0.966
PAA 0.75	5.45E-03	0	-	0.609	0.117	0.962
PAA 1	7.27E-03	0	-	0.408	0.218	0.991
PAA 1.25	9.09E-03	0	-	0.495	0.170	0.957
PAA 1.5	1.09E-02	0	-	0.568	0.137	0.943
PAA 2	1.45E-02	0	-	0.438	0.159	0.969
PAA 2.5	1.82E-02	0	-	0.662	0.045	0.982
PAA 0+E	0.00	1	1.00	0.505	0.226	0.969
PAA 0.25+E	1.82E-03	1	2.00	0.613	0.140	0.987
PAA 0.5+E	3.64E-03	1	2.00	0.775	0.076	0.967
PAA 0.75+E	5.45E-03	1	2.50	0.369	0.240	0.978
PAA 1+E	7.27E-03	1	3.50	0.543	0.145	0.970
PAA 1.25+E	9.09E-03	1	2.50	0.708	0.088	0.961
PAA 1.5+E	1.09E-02	1	1.00	0.477	0.154	0.971
PAA 2+E	1.45E-02	1	3.00	0.598	0.118	0.960
PAA 2.5+E	1.82E-02	1	3.50	0.557	0.089	0.937
PAA 0+Ppy+E	0.00	1	3.50	0.412	0.316	0.804
PAA 0.25+Ppy+E	1.82E-03	1	3.50	0.393	0.320	0.952
PAA 0.5+Ppy+E	3.64E-03	1	2.50	0.308	0.355	0.901
PAA 0.75+Ppy+E	5.45E-03	1	2.50	0.615	0.134	0.925
PAA 1Ppy+E	7.27E-03	1	3.50	0.644	0.124	0.928
PAA 1.25+Ppy+E	9.09E-03	1	2.50	0.511	0.178	0.948
PAA 1.5Ppy+E	1.09E-02	1	1.00	0.383	0.244	0.986
PAA 2+Ppy+E	1.45E-02	1	1.00	0.710	0.099	0.917
PAA 2.5+Ppy+E	1.82E-02	1	1.00	0.801	0.064	0.855

Appendix M The Thermogravimetric Thermogram of Polypyrrole, doped Polypyrrole, Sulfosalicylic, Poly(acrylic acid) Hydrogel, Sulfosalicylic Acid-Loaded Poly(acrylic acid) Hydrogels and Polypyrrole/Poly(acrylic acid) Blend Films

The thermogravimetric analyzer (DuPont, model TGA 2950) was used to determine the thermal behavior of polymers. The experiment was carried out by weighting powder sample of 7-13 mg and placed it in a platinum pan, and then heated it under nitrogen flow with the heating rate 10 °C/min from room temperature to 600 °C.

There are three transitions for undoped and doped polypyrrole. The first transition (45-65°C) refers to the losses of organic solvent and water. The second transition (100-130°C) refers to the PPy side chain degradation, and the third transition (215-235°C) refers to the PPy backbone degradation. The TGA results of PPy and doped PPy showed that doped PPy has higher thermal stability, because after doping the degradation temperature of sulfuric acid doped PPy is higher than that of undoped PPy.

For pure PAA, pure SSA, drug-load PAA hydrogel and drug-load PPy/PAA blend film, there are three transitions. The first transition is occurred in the temperature range of about 50-90 °C corresponding to the evaporation of water, while the second transitions cover the temperature range of 150-290 °C was due to the decomposition of sulfonic functional groups of SSA, and the dehydration and decarboxylation of PAA which lead to the formation of inter- and intra-molecular anhydride (Tanodekaew S. et al., 2004). The third decomposition stage in range of 240-370 °C has been described to the degradation of residual polymer. The TGA results demonstrated that new structure were from in drug-load PAA hydrogel and doped PPy.

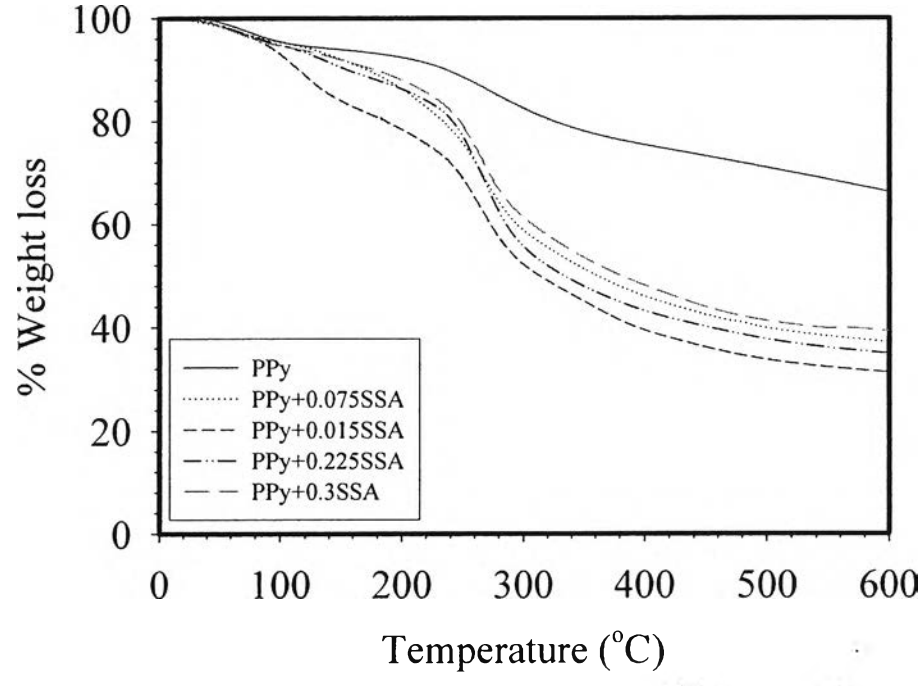


Figure M1 TGA thermogram of PPy and doped PPy at various doping level.

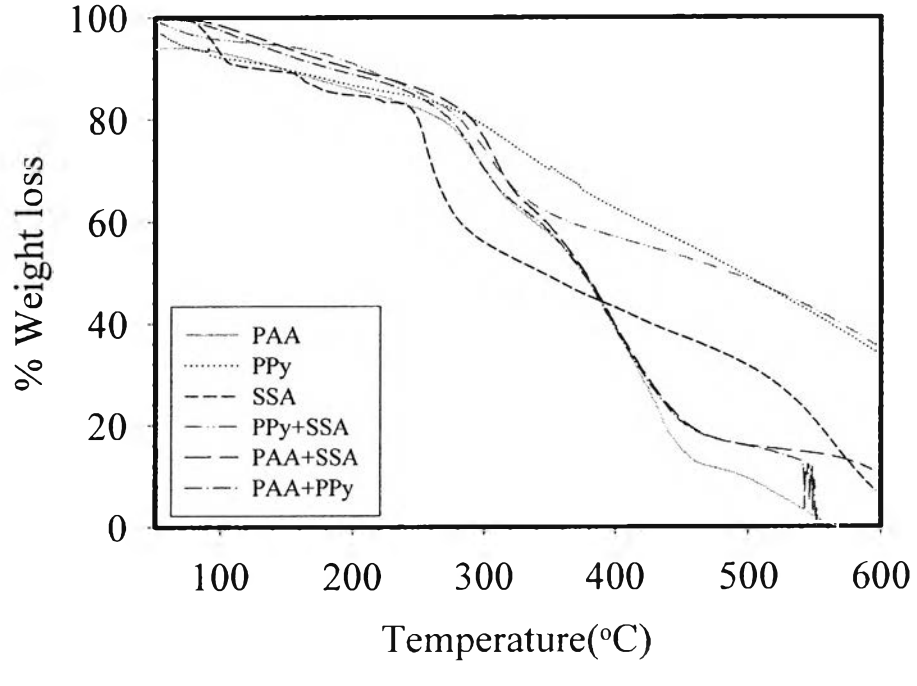


Figure M2 The TGA thermograms of pure PAA hydrogel, drug-loaded PAA hydrogel, drug-loaded PPy/PAA blend film, pure model drug, PPy and drug-loaded PPy.

Table M1 The summary of the degradation temperature, percent weight loss and percent resdidue in the TGA thermogram of PPy and doped PPy at various doping level

Sample	T_d (°C)	% Weigth loss	% Residue
Ppy	50.71	5.73	65.94
	101.47	7.34	
	219.87	21.02	
Ppy+0.075SSA	45.92	3.92	28.42
	121.45	4.85	
	216.57	59.2	
Ppy+0.015SSA	64.22	16.67	33.53
	127.75	5.71	
	235.93	50.33	
Ppy+0.225SSA	55.73	4.61	31.67
	118.86	6.60	
	238.61	52.61	
Ppy+0.3SSA	55.18	4.88	35.97
	124.72	3.89	
	235.00	50.72	

Table M2 The summary of the degradation temperature, percent weight loss and percent resdidue in the TGA thermogram of SSA, PAA, drug-load PAA hydrogel, drug-load PPy/PAA blend films, PPy and doped PPy at various doping level

Sample	T_d (°C)	% Weigth loss	% Residue
PAA	52.10	8.33	12.85
	269.22	23.30	
	367.87	48.90	
PPy	30.81	6.62	33.56
	134.66	6.69	
	256.36	19.90	
SSA	80.52	9.17	6.16
	150.11	4.85	
	241.31	27.44	
PAA+SSA	64.22	13.53	11.17
	127.75	20.44	
	235.93	47.10	
PPy+SSA	32.04	4.43	34.77
	146.41	8.41	
	274.92	25.28	
PAA+Ppy	73.41	11.04	11.32
	265.27	24.00	
	365.86	40.19	

Appendix N DSC Thermograms of Polypyrrole, doped Polypyrrole, Sulfosalicylic, Poly(acrylic acid) Hydrogel, Sulfosalicylic Acid-Loaded Poly(acrylic acid) Hydrogels and Polypyrrole/Poly(acrylic acid) Blend Films

The thermal behavior of the PAA hydrogel, PPy powder, the drug, drug-loaded PAA hydrogel and the drug-loaded PPy/PAA blend film were determined by a differential scanning calorimeter (DSC; Mettler Toledo 822e/400). The DSC thermogram (equilibrated with an indium standard; each sample weighed 3–5 mg) was obtained during heating from 25 to 350 °C at a heating rate of 10 °C/min under nitrogen purge (60 ml/min).

Figure N1 shows DSC thermograms for pure PAA, pure PPy, the drug, dopped PPy,drug-loaded PAA hydrogel and the drug-loaded PPy/PAA blend film. Endothermic ransitions at 151.5, 138.3, 156.0, 142.1 and 153.2 °C can be related to the evaporation of the water trapped inside the polymer or bonded to the polymer backbone for pure PAA, pure PPy, dopped PPy, drug-loaded PAA hydrogel and the drug-loaded PPy/PAA blend film, respectively (Nateghi and Borhani, 2008). The DSC thermogram for pure PAA and drug exhibit a melting temperature at 312.1 and 165.5 °C, respectively. For pure PPy exhibited a board transition around 286.3 °C. The melting temperatures (T_m) of dopped PPy, drug-loaded PAA hydrogel and the drug-loaded PPy/PAA blend film shift to about 274.3, 306.5 and 294 °C, respectively. The possible reason for the peak shift is the interaction between polymer and drug molecule since SSA had a potential to form H-bonding with the hydroxyl group of PAA (Taepaiboon et al., 2006) and the ionic bonding between hydroxyl group of SSA and amine group PPy (Xue and Yin, 2006).

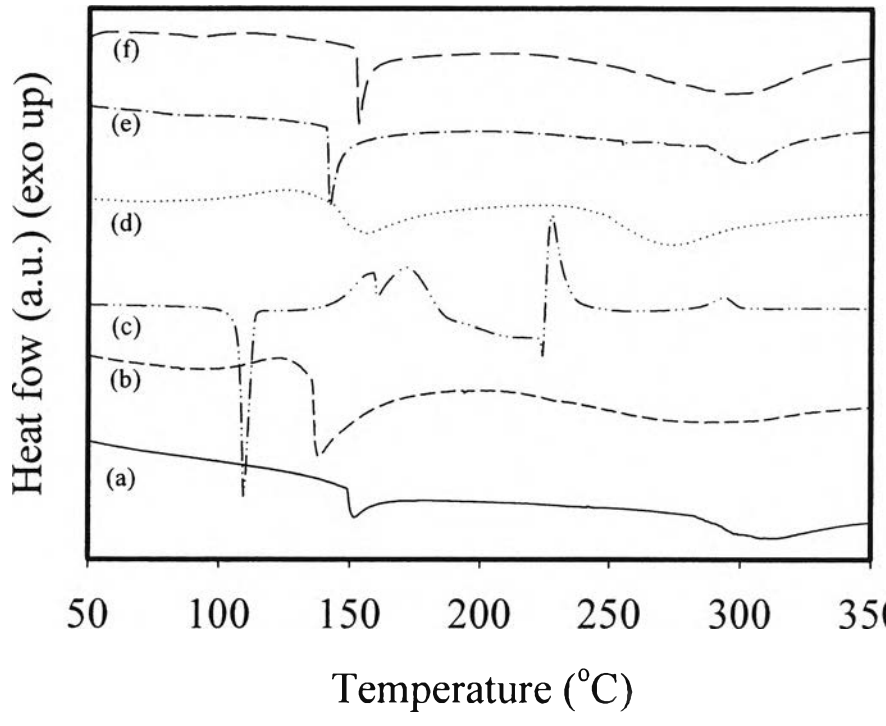


Figure N1 The DSC thermograms of (a) pure PAA hydrogel, (b) pure PPy, (c) model drug, (d) drug-loaded PPy, (e) drug-loaded PAA hydrogel and (f) drug-loaded PPy/PAA blend film.

Appendix O Determination of Particle Sizes of Doped and Undoped Polypyrrole

Table O1 Summarized the particles diameter of PPy and doped PPy with 5-sulfosalicylic acid at 1:10 ratio

Samples	Particle diameter (μm)				
	1	2	3	Avg.	STD
Undoped PPy	18.83	18.25	18.63	18.57	0.29
Doped PPy (PPy:SSA=1:10)	19.76	19.68	19.70	19.71	0.04

Table O2 The raw data from particle size analysis of undoped PPy

Particle size diameter (μm)		undoped Ppy					
		1		2		3	
Size low	Size high	In %	Under %	In %	Under %	In %	Under %
0.2	0.48	0.05	0.05	0.06	0.06	0.06	0.06
0.48	0.59	0.26	0.31	0.33	0.38	0.33	0.39
0.59	0.71	0.44	0.75	0.55	0.93	0.55	0.94
0.71	0.86	0.56	1.31	0.71	1.63	0.71	1.65
0.86	1.04	0.65	1.96	0.83	2.46	0.84	2.48
1.04	1.26	0.78	2.73	0.98	3.44	0.98	3.47
1.26	1.52	0.99	3.73	1.22	4.66	1.22	4.69
1.52	1.84	1.36	5.09	1.61	6.27	1.62	6.31
1.84	2.23	1.90	6.99	2.17	8.44	2.17	8.47
2.23	2.70	2.51	9.50	2.77	11.21	2.75	11.23
2.7	3.27	3.08	12.58	3.28	14.48	3.25	14.48
3.27	3.95	3.63	16.21	3.74	18.22	3.69	18.17
3.95	4.79	4.12	20.34	4.11	22.33	4.05	22.23
4.79	5.79	4.52	24.86	4.40	26.72	4.33	26.55
5.79	7.01	4.83	29.70	4.62	31.35	3.56	31.11
7.01	8.48	5.10	34.80	4.85	36.20	4.79	35.90
8.48	10.27	5.46	40.26	5.23	41.43	5.19	41.09
10.27	12.43	5.96	46.22	5.79	47.22	5.76	46.85
12.43	15.05	6.56	52.78	6.49	53.71	6.45	53.30
15.05	18.21	7.13	59.91	7.16	60.87	7.09	60.39
18.21	22.04	7.51	67.41	7.58	68.45	7.49	67.87
22.04	26.68	7.53	74.94	7.57	76.01	7.46	75.33
26.68	32.29	7.08	82.02	7.00	83.01	6.95	82.27
32.29	39.08	6.11	88.13	5.91	88.92	5.95	88.23
39.08	47.30	4.76	92.88	4.50	93.42	4.64	92.86
47.3	57.25	3.32	96.21	3.09	96.51	3.26	96.12
57.25	69.30	2.08	98.29	1.92	98.43	2.06	98.18
69.3	83.87	1.14	99.43	1.07	99.50	1.17	99.35
83.87	101.52	0.50	99.42	0.47	99.97	0.54	99.89
101.52	122.87	0.08	100.00	0.03	100.00	0.11	100.00
122.87	148.72	0.00	100.00	0.00	100.00	0.00	100.00
148.72	180.00	0.00	100.00	0.00	100.00	0.00	100.00

Table O3 The raw data from particle size analysis of doped PPy with 5-sulfosalicylic acid at 1:10 ratio

Particle size diameter (μm)		doped Ppy (PPy:SSA=1:10)					
		1		2		3	
Size low	Size high	In %	Under %	In %	Under %	In %	Under %
0.2	0.48	0.00	0.00	0.00	0.00	0.00	0.00
0.48	0.59	0.00	0.00	0.00	0.00	0.00	0.00
0.59	0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.86	0.00	0.00	0.00	0.00	0.00	0.00
0.86	1.04	0.21	0.21	0.34	0.34	0.38	0.38
1.04	1.26	0.54	0.75	0.64	0.98	0.67	1.05
1.26	1.52	0.72	1.47	0.81	1.79	0.83	1.88
1.52	1.84	0.86	2.33	0.96	2.75	0.96	2.84
1.84	2.23	1.16	3.50	1.28	4.03	1.29	4.13
2.23	2.70	1.64	5.14	1.76	5.79	1.78	5.91
2.7	3.27	2.05	7.18	2.16	7.95	2.17	8.08
3.27	3.95	2.68	9.86	2.76	10.71	2.77	10.85
3.95	4.79	3.27	13.13	3.31	14.02	3.32	14.17
4.79	5.79	3.92	17.05	3.91	17.93	3.92	18.09
5.79	7.01	4.55	21.60	4.50	22.44	4.50	22.59
7.01	8.48	5.23	26.83	5.15	27.59	5.14	27.73
8.48	10.27	6.06	32.89	5.98	33.57	5.96	33.70
10.27	12.43	7.07	39.96	7.00	40.58	6.99	40.69
12.43	15.05	8.15	48.11	8.09	48.67	8.09	48.77
15.05	18.21	9.03	57.15	8.96	57.62	8.97	57.74
18.21	22.04	9.38	66.53	9.27	66.89	9.30	67.04
22.04	26.68	8.94	75.46	8.79	75.69	8.81	75.85
26.68	32.29	7.74	83.20	7.59	83.27	7.57	83.41
32.29	39.08	6.08	89.28	5.95	89.23	5.89	89.31
39.08	47.30	4.36	93.64	4.28	93.50	4.21	93.52
47.3	57.25	2.84	96.48	2.80	96.30	2.74	96.26
57.25	69.30	1.72	98.21	1.74	98.05	1.70	97.96
69.3	83.87	0.98	99.18	1.04	99.09	1.02	98.98
83.87	101.52	0.50	99.68	0.57	99.66	0.57	99.55
101.52	122.87	0.23	99.91	0.27	99.93	0.30	99.85
122.87	148.72	0.09	100.00	0.07	100.00	0.15	100.00
148.72	180.00	0.00	100.00	0.00	100.00	0.00	100.00

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Presentation:

1. Chansai P., Sirivat A., Chotpattananont D., and Viravaidya K., (2008 April) Controlled Transdermal iontophoresis of Sulfosalicylic Acid from Polypyrrole/Poly(acrylic acid) Hydrogel. Poster Presentation at The 14th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.
2. Chansai P., Sirivat A., Chotpattananont D., and Viravaidya K., (2008 April) Controlled Transdermal iontophoresis of Sulfosalicylic Acid from Polypyrrole/Poly(acrylic acid) Hydrogel. Poster Presentation at Smart materials Smart/Intelligent Materials and Nanotechnology international Conference, Chiang Mai, Thailand.