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APPENDICES

Appendix A The FTIR spectrum of poly(3-thiophene acetic acid)

Fourier Transform Infrared (FTIR) spectra were obtained using a FTIR spectrometer (Bruker, Equinox 55/FRA 1065) operated in the transmission mode with 32 scans and a resolution of ± 4 cm^{-1}, covering a wavenumber range of 4000-400 cm^{-1} using a deuterated triglycine sulfate detector. Optical grade KBr (Carlo Erba Reagent) was used as the background material. The synthesized poly(3-thiophene acetic acid), PTAA, was intimately mixed with dried KBr at a ratio of PTAA:KBr = 1:20.

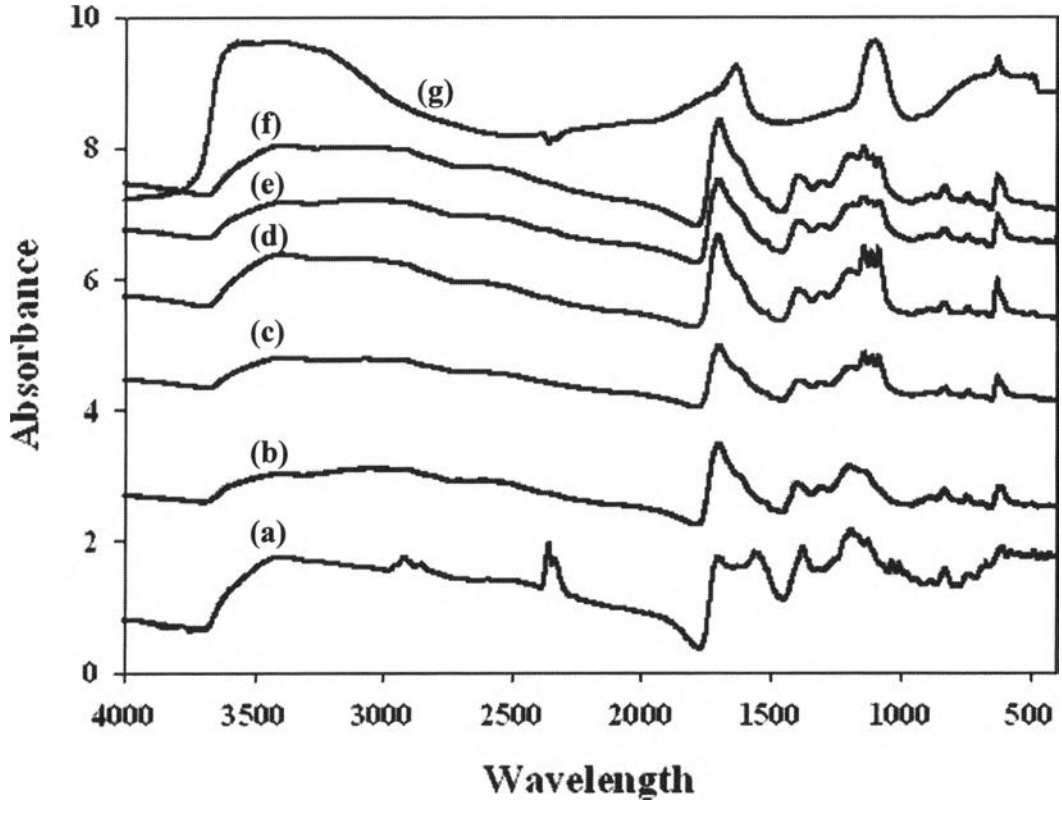

Figure A1 The FTIR spectra of : a) undoped poly(3-thiopheneacetic acid), and HCLO4 doped poly(3-thiopheneacetic acid) as various mole ratio of acid to monomer unit; b) 0.1:1, c) 1:1, d) 50:1, e) 100:1, f) 200:1, g) $HClO_4$.

Figure A1(a) shows the FTIR spectrum of the neutral polymer and the assignments of some peaks are shown in Table A1. The most characteristic feature in this spectrum is the broad OH absorption in the region from 3400 to 2400 cm^{-1}. This peak often obscures the CH stretching vibration that occurs in the same region. It is obvious from the absorption at around 1700 cm^{-1} that the ester groups were not decayed during the polymerization. After the neutral PTAA was doped with perchloric acid, some characteristic peaks of acid appeared on FTIR spectra as shown in Figure A1 (b-f).

Table A1 Assignment of peaks from FTIR spectra of undoped and $HCLO_4$ doped poly(3-thiopheneacetic acid)

Wave Number (cm^{-1})	Assignments
3351	OH, stretching
2915	CH, stretching, aliphatic
1705	C=O, stretching
1400	Thiophene ring, stretching
835	CH, out of plane, thiophene ring

Appendix B The ^{1}H-NMR spectrum of poly(3-thiophene acetic acid)

^{1}H-NMR spectrum in solution state were recorded at 25 ± 1 °C using a 300 MHz Digital NMR spectrometer (Bruker, DPX-300). Deuterated dimethyl sulfoxide was used as the standard solvent. The ^{1}H-NMR spectrum and the assignment of peaks are showed in Figure B1 and Table B1, respectively.

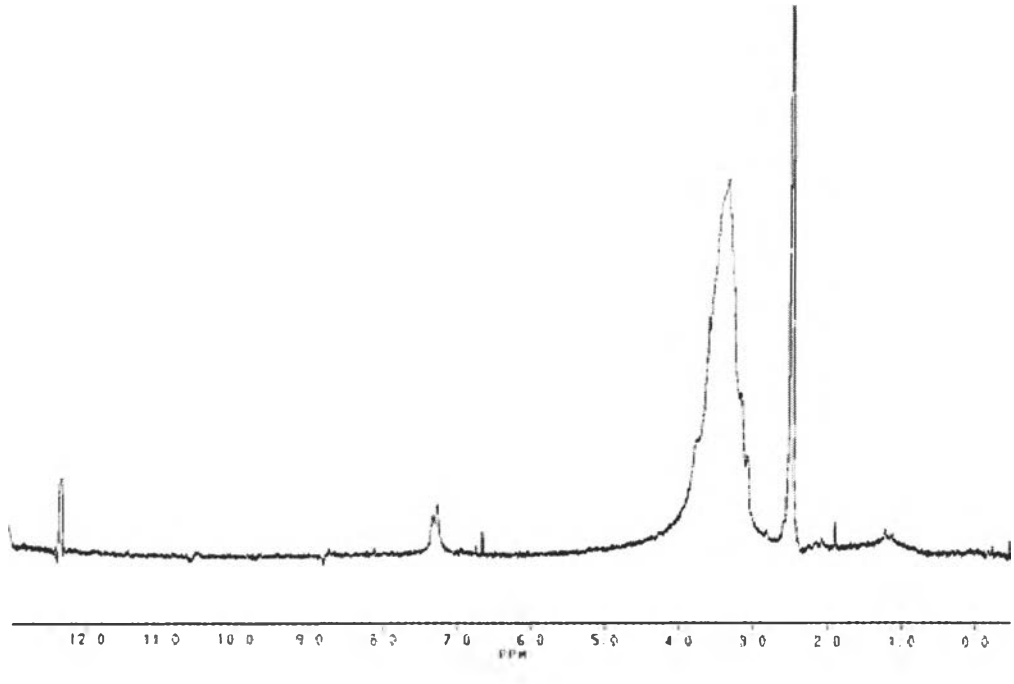

Figure B1 The ^{1}H-NMR spectrum of undoped poly(3-thiopheneacetic acid).

Table B1 Assignment of peaks from ^{1}H-NMR spectrum of undoped poly(3-thiopheneacetic acid)

Chemical Shift (ppm)	Assignments
12.4	Proton of acid group (1H,-COOH)
7.27-7.34	Proton of thiohene ring
3.5-3.8	Proton of $-CH_2$ of thiophene ring (respective head-to-head coupling and head-to-tail coupling defects)

Appendix C The UV-Visible spectra of poly(3-thiophene acetic acid)

The UV-Visible spectra of the synthesized PTAA powder, dissolved in DMSO, was recorded with a UV-Vis spectrometer (Perkins Elmer, Lambda 10), at a scan speed of 240 mm/min, and a slit width of 2.0 nm, using a deuterium lamp as the light source, at wavelengths between 190-800 nm. The UV-Visible absorption spectra and the assignment of peaks of are showed in Figure C1 and Table C1, respectively.

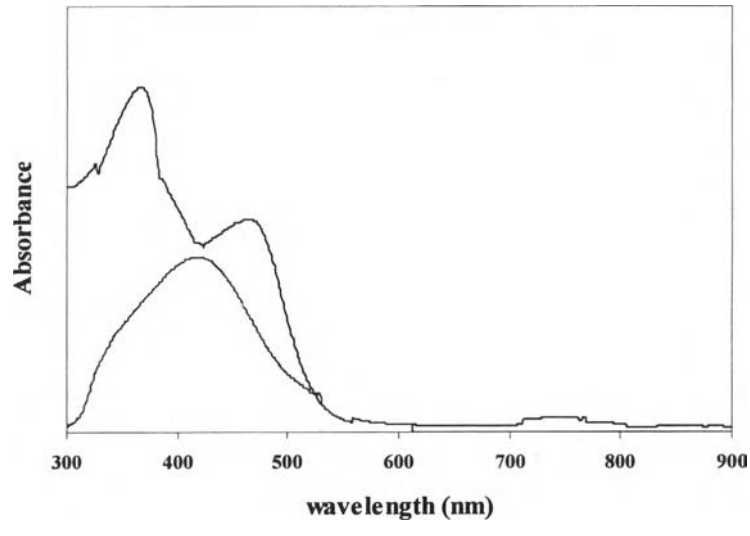

Figure C1 The UV-Visible spectra of undoped and $HClO_4$ doped poly(3-thiopheneacetic acid) with mole ratio of acid to monomer unit equal to 10:1.

Table C1 Assignment of peaks from -Visible spectra of undoped and $HClO_4$ doped poly(3-thiopheneacetic acid)

Wavelength (nm)	Assignments
418	π-π^* transition of undoped PTAA
372, 475	π-π^* transition of the bipolaron state
760	π-π^* transition of the polaron state

Appendix D The thermal analysis

The thermal stability of PTAA was investigated using a thermogravimetric analyzer (Perkin Elmer, TGA7) in the temperature range 25 to 750 °C at a heating rate of 10 °C/min. The thermogravimetric thermograms of undoped and HClO4 doped poly(3-thiopheneacetic acid) are shown in Figure D1 and the information obtained from the thermograms are summarized in Table D1.

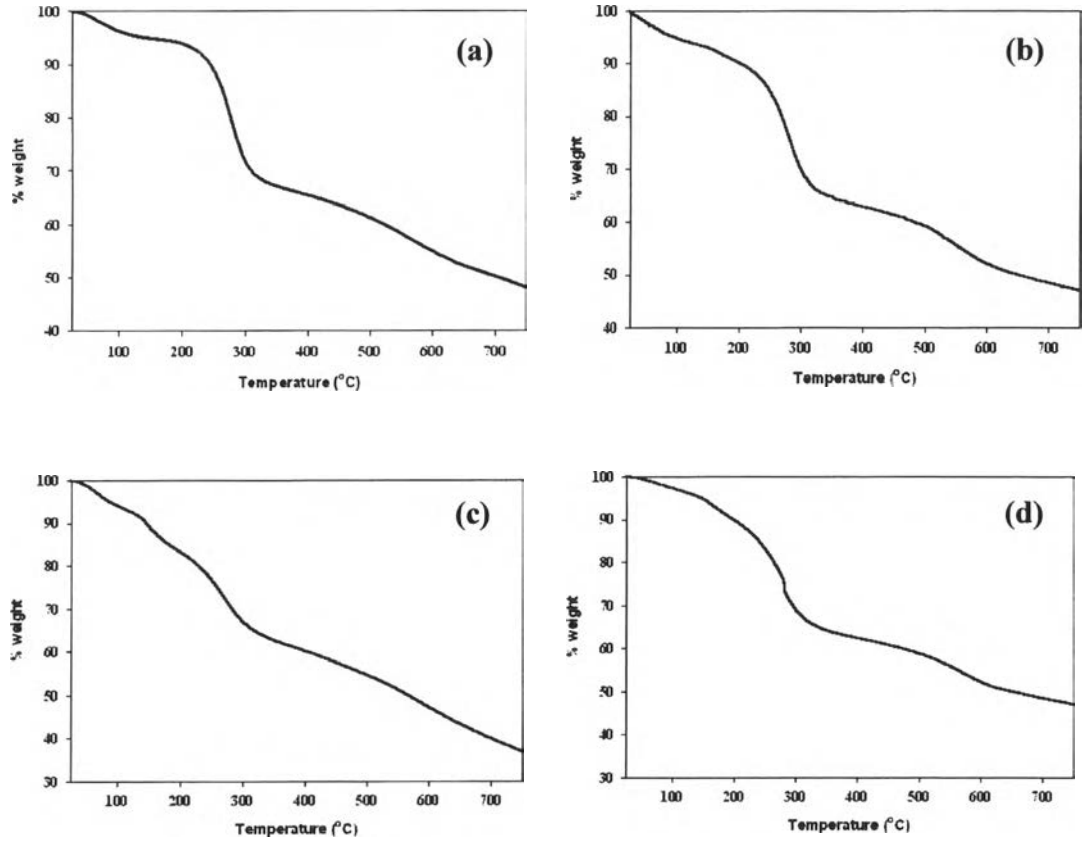

Figure D1 The thermograms of : a) undoped poly(3-thiopheneacetic acid), and $HClO_4$ doped poly(3-thiopheneacetic acid) as various mole ratio of acid to monomer unit; b) 0.1:1, c) 1:1, d) 10:1, e) 100:1, and f) 200:1

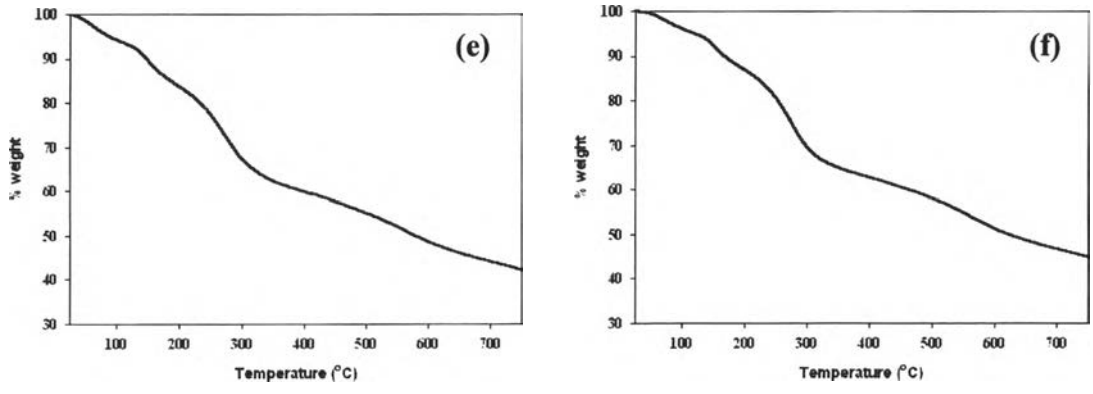

Figure D1 The thermograms of : a) undoped poly(3-thiopheneacetic acid), and $HClO_4$ doped poly(3-thiopheneacetic acid) as various mole ratio of acid to monomer unit; b) 0.1:1, c) 1:1, d) 10:1, e) 100:1, and f) 200:1.

The undoped poly(3-thiopheneacetic acid) shown two degradation steps which are side chain degradation and backbone degradation. After doping with $HClO_4$ acid, the thermograms show the degradation temperature of $HClO_4$ acid dopant at around 148 ^{o}C and the decreasing of thermal stability of main chain as compared to the undoped PTAA was also observed.

Table D1 The percentage of water content and the degradation temperatures of undoped poly(3-thiopheneacetic acid) and $HClO_4$ doped poly(3-thiopheneacetic acid)

N_a/N_m	Water content (%)	Degradation temperature (oC)		% Residue
		Side chain	Backbone	
PTAA	5.207	278.3	574.8	48.04
0.05	6.032	281.4	561.1	47.18
0.1	6.323	281.4	550.6	46.99
0.5	4.129	281.4	554.8	47.04
1.0	4.739	275.1	565.3	44.86
10.0	4.051	282.5	549.5	47.01
50.0	5.241	274.1	586.4	37.07
100.0	5.878	268.1	596.4	30.36
200.0	4.892	275.5	562.5	44.82

Appendix E Morphological Observation

The scanning electron micrographs were carried out to identify the microstructure of the poly(3-thiopheneacetic acid) powder. Figures E1(a) - E1(d) show the micrographs of undoped poly(3-thiopheneacetic acid) and HClO4 doped poly(3-thiopheneacetic acid). These figures illustrate the effect of dopant concentration on the morphology macroscopically.

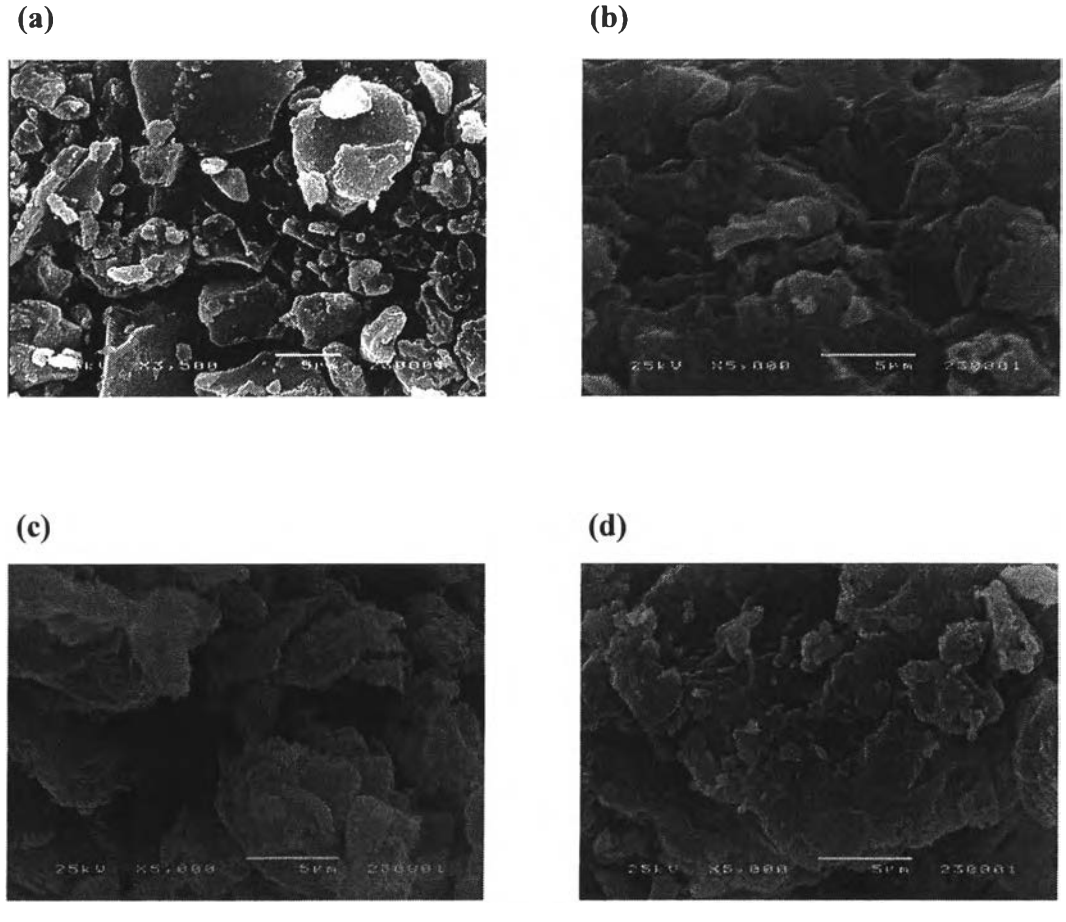

Figure E1 The scanning electron micrographs of : a) undoped poly(3-thiopheneacetic acid), and $HClO_4$ doped poly(3-thiopheneacetic acid) as various mole ratio of acid to monomer unit; b) 10:1, c) 50:1, and d) 100:1.

The undoped poly(3-thiopheneacetic acid) exhibits irregular structure while the $HClO_4$ doped poly(3-thiopheneacetic acid) shows the larger globules than the undoped PTAA. The large globular structure observed from the doped sample might be the aggregated structure of the PTAA. It is believed that these globules contained very small particles because during washing and filtering the doped sample cannot be filtered by using filter paper but had to be centrifuged while the undoped PTAA could be filtered.

Appendix F Four-point probe system for conductivity measurement

Two test structures are generally employed for characterizing sheet conductivity; spreading resistance analysis (two-point probe system), which is designed to confine the measurement current within a region, and four-point probe analysis, which is better suited for use on large area sample. The four point probe is preferable over a two point probe because it provides sheet conductivity or resistivity with relatively high accuracy, precisely, and repeatability.

Probe head assemblies are available in two different arrangements of the probe pins; linear array and square array. Four probe tips are arranged in a linear array as shown in Figure F1. Probe force, probe travel, tip radius and probe material must be selected with consideration for the resistivity, hardness, and thickness of the layer to be measured. It is customary to have the outer two probes carry current and the inner probes measure the resultant voltage.

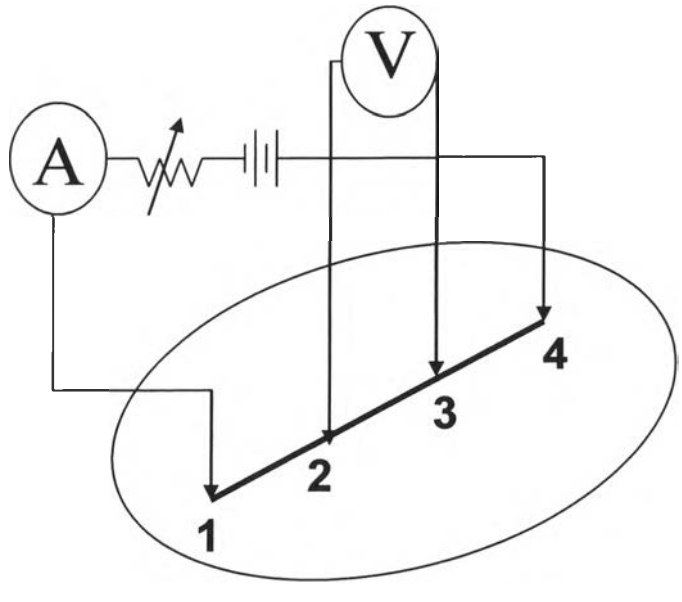

Figure F1 Schematic of the linear array four-point probe meter.

In this diagram, four probes have been attached to the test sample. A constant current is made to flow the length of the sample through probes labeled 1 and 4 in the figure. This can be done using a current source or a power supply as

shown. Many power supplies have a current output readout built into them. If not, an ammeter in series with this circuit can be used to obtain the value of the current.

If the sample has any resistance to the flow of electrical current, then there will be a drop of potential (or voltage) as the current flows along the sample, for example between the two probes labeled 2 and 3 in the figure. The voltage drop between probes 2 and 3 can be measured by a digital voltmeter. The resistance of the sample between probes 2 and 3 is the ratio of the voltage registering on the digital voltmeter to the value of the output current of the power supply. The high impedance of the digital voltmeter minimizes the current flow through the portion of the circuit comprising the voltmeter. Thus, since there is no potential drop across the contact resistance associated with probes 2 and 3, only the resistance associated with the sample between probes 2 and 3 is measured.

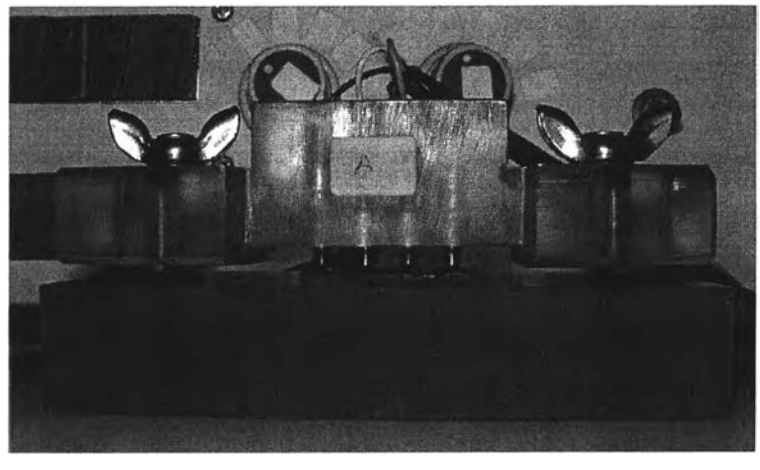

Figure F2 The linear array four-point probe meter.

Appendix G Determination of ohmic's law regime

Ohmic regime or linear regime is the regime in which applied voltage is linearly dependent on current according to ohmic's law in Equation G.1.

$$V_a = IR \qquad \text{(G.1)}$$

Where V_a = applied voltage (mV)
I = current (mA)
R = resistance (Ω)

Since the specific conductivity given by xxx, the acceptable current which is used in the experiments should be in the ohmic's regime. Figure G1 and G2 illustrate the plot of applied voltage, V_a, and current, I, using silicon wafer and polythiophene pellet as a standard materials, respectively. The ohmic's regime experiment has been done at 25 ± 1 °C, 1 atm, and 46% relative humidity.

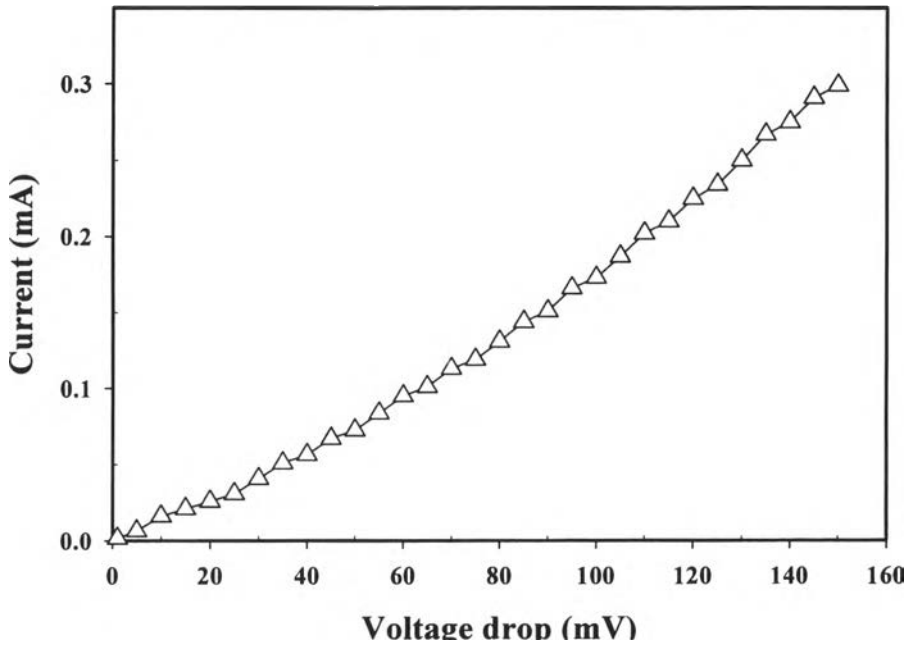

Figure G1 The ohmic's law region of the current and the applied voltage by using the silicon wafer (Si10-28A) as a standard sheet.

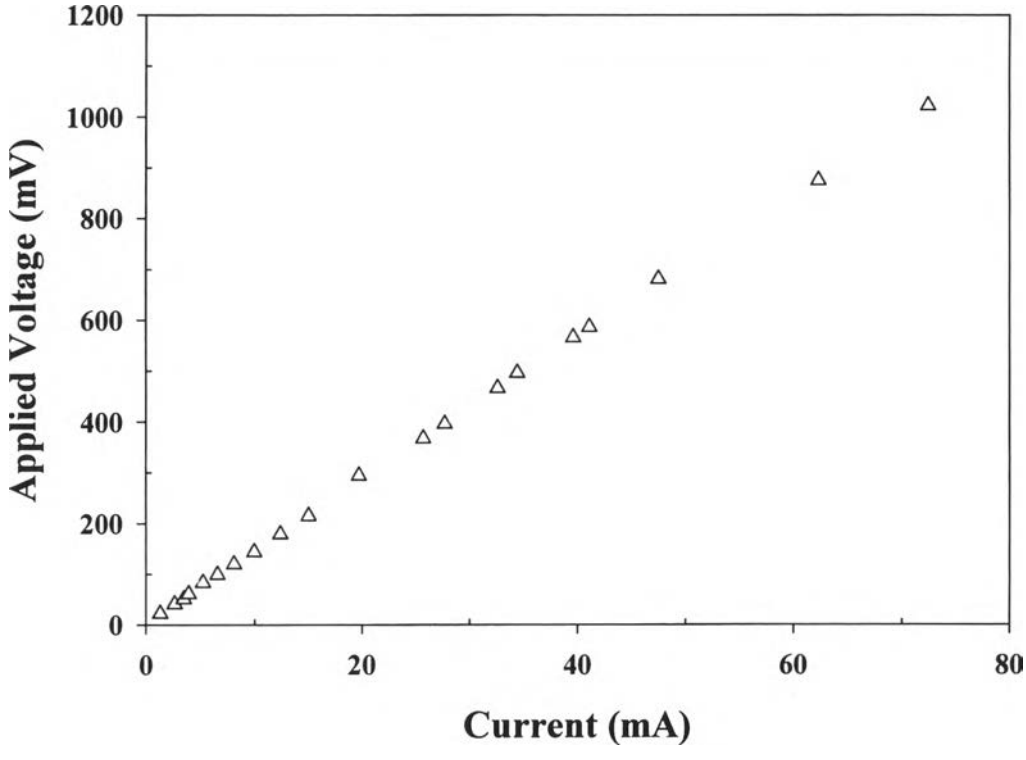

Figure G.2 The ohmic's law region of the current and the applied voltage by using the polythiophene pellet as a standard sheet.

Appendix H Determination of the geometric correction factor (K)

As in the case of microelectronic structures, four point-probe sheet resistance measurements are susceptible to geometric error (K) which can be calculated by using Equation H.1.

$$K = w / l \qquad \text{(H.1)}$$

where K = correction factor
w = probe width (cm)
l = probe length (cm)

In this measurement, the constant K value was determined using a standard silicon wafer sheet with a known resistivity value. K value was calculated by Equation H.2.

$$K = \frac{\rho}{R \times t} = \frac{I \times \rho}{V \times t} \qquad \text{(H.2)}$$

where K = geometric correction factor
ρ = resistivity of standard material sheet (Ω cm)
t = film thickness (cm)
R = film resistivity (Ω)
I = current (A)
V = voltage drop (V)

The sheet resistivity (ρ) and thickness of standard silicone wafer are shown in Table H1.

Table H1 The sheet resistivity and thickness of the standard silicon wafer sheets

Standard No.	Material	Sheet Resistivity, ρ (Ω cm)	Thickness (cm)
11	Si 10-28A	3.50E+01	5.22E-02
22	SiO_B	9.23E-03	7.16E-02

Table H2 Determination of K factor of the custom built four-point probe meter

Conditions: Temperature 26 ± 1 oC
Relative humidity 46–47 %
Pressure 1 atm

Standard No. 11			Standard No. 22		
I (mA)	V (mV)	K	I (mA)	V (mV)	K
7.70E-4	1.03	4.97E-1	5.8	2.0	3.74E-1
1.66E-3	2.29	4.63E-1	6.5	2.0	4.19E-1
1.58E-3	2.99	3.52E-1	6.8	2.1	4.17E-1
1.99E-3	4.11	3.22E-1	7.9	2.4	4.24E-1
2.13E-3	3.65	3.88E-1	8.8	2.5	4.54E-1
2.43E-3	5.00	3.23E-1	9.1	2.6	4.51E-1
2.81E-3	5.30	3.53E-1	10.1	2.5	5.21E-1
4.21E-3	6.08	4.61E-1	10.8	3.2	4.51E-1
5.02E-3	6.35	5.26E-1	12.0	3.3	4.80E-1
6.66E-3	8.29	5.35E-1	12.5	3.4	4.74E-1
Average		4.22E-1	Average		4.74E-1
SD		0.084	SD		0.041
			K Value		**4.35E-1**

Appendix I Specific conductivity measurement

To determine the electrical conductivity, $HClO_4$ doped polythiophene disks (25 mm diameter and ~0.2 mm thickness) were prepared by molding with a hydraulic press. Electrical conductivity was measured using a custom-built four-point probe. The specific conductivity, σ (S/cm), was obtained, by measuring the resistance, R and using the following relation:

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

where t is the film thickness and K is the geometric correction factor. The K value of the probe is 0.454. The thickness of polythiophene pellets were measured by a digital thickness gauge (Peacock, PDN 12N). The measurements were performed in the linear Ohmic regime i.e. the specific conductivity values were independent of the applied DC current. The measurements were carried out at 27± 1 °C, 1 atm, and 46% relative humidity and repeated at least two times. The specific conductivity of HClO4 doped PTAA pellet as a function of mole ratio of acid to monomer unit is shown in Figure I1 and the raw data of conductivity measurement are tabulated in Table I1.

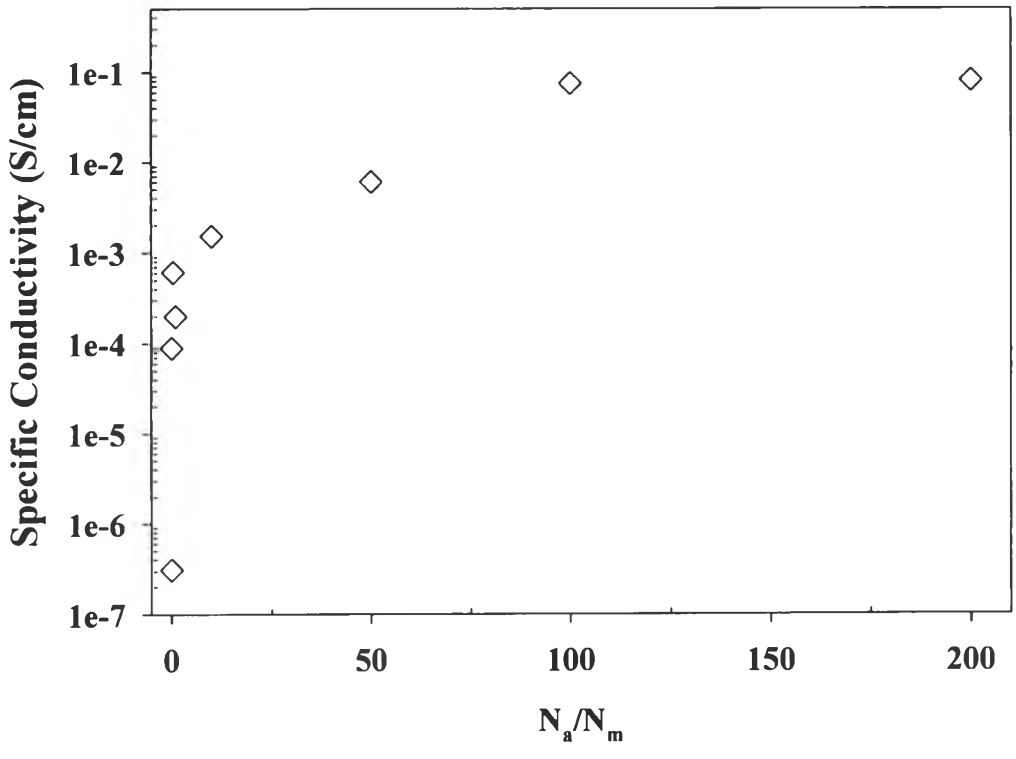

Figure I1 The specific conductivity of HClO4 doped poly(3-thiopheneacetic acid) as a function of mole ratio of acid to monomer unit.

Table I1 The raw data of conductivity measurement of undoped poly(3-thiopeheneacetic acid)

Thickness (cm)	Current (mA)		Volt drop (mV)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0170	1.44E-08	1.44E-08	5	10	4.47E-07	2.24E-07
0.0161	1.47E-08	5.70E-08	10	20	2.28E-07	4.42E-07
0.0129	1.50E-08	8.45E-08	15	30	1.55E-07	4.37E-07
0.0137	1.52E-08	7.52E-08	20	40	1.18E-07	2.92E-07
0.0152	1.54E-08	7.54E-08	25	50	9.56E-08	2.34E-07
0.0117	1.55E-08	1.55E-07	30	60	8.02E-08	4.01E-07
0.0143	1.57E-07	1.57E-07	35	70	6.96E-07	3.48E-07
0.0180	1.19E-07	1.19E-07	40	80	4.62E-07	2.31E-07
0.0144	1.26E-07	2.36E-07	45	90	4.35E-07	4.07E-07
	1.06E-07	1.46E-07	50	100	3.30E-07	2.27E-07
	1.07E-07	1.57E-07	55	110	3.01E-07	2.21E-07
	1.07E-07	2.67E-07	60	120	2.76E-07	3.45E-07
	1.07E-07	2.54E-07	65	130	2.56E-07	3.03E-07
	1.71E-07	2.37E-07	70	135	3.79E-07	2.73E-07
	1.21E-07	2.62E-07	75	140	2.51E-07	2.91E-07
	1.52E-07	2.45E-07	80	145	2.95E-07	2.62E-07
	2.25E-07	2.25E-07	85	150	4.10E-07	2.32E-07
	2.36E-07	2.36E-07	90	155	4.07E-07	2.36E-07
	2.90E-07	2.90E-07	100	160	4.50E-07	2.81E-07
Average					**3.20E-07**	**2.99E-07**
0.0148					**3.20E-07**	

Table I2 The raw data of conductivity measurement of $HClO_4$ doped poly(3-thiopeheneacetic acid) at doping ratio, Na:Nm = 0.1:1

Thickness (cm)	Current (A)		Volt drop (V)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0163	1.00E-05	31.17	17.20	31.17	8.31E-05	9.17E-05
0.0183	2.00E-05	68.40	32.40	68.40	8.83E-05	8.36E-05
0.0162	3.00E-05	89.23	46.80	89.23	9.17E-05	9.61E-05
0.0148	4.00E-05	123.78	52.73	123.78	1.08E-04	9.24E-05
0.0166	5.00E-05	162.69	73.60	162.69	9.71E-05	8.79E-05
0.0167	6.00E-05	183.29	87.20	183.29	9.84E-05	9.36E-05
0.0153	7.00E-05	222.70	96.10	222.70	1.04E-04	8.99E-05
0.0142	8.00E-05	254.13	102.56	254.13	1.12E-04	9.00E-05
0.0163	9.00E-05	277.31	147.31	277.31	8.74E-05	9.28E-05
	1.00E-04	293.98	173.98	293.98	8.22E-05	9.73E-05
	1.10E-04	337.67	195.67	337.67	8.04E-05	9.32E-05
	1.20E-04	382.71	212.71	382.71	8.07E-05	8.97E-05
	1.30E-04	423.11	223.11	423.11	8.33E-05	8.79E-05
	1.40E-04	477.93	247.93	477.93	8.07E-05	8.38E-05
	1.50E-04	491.02	261.02	491.02	8.22E-05	8.74E-05
	1.60E-04	519.02	279.02	519.02	8.20E-05	8.82E-05
	1.70E-04	538.85	290.85	538.85	8.36E-05	9.02E-05
	1.80E-04	567.37	307.37	567.37	8.37E-05	9.07E-05
	1.90E-04	611.72	311.72	611.72	8.72E-05	8.88E-05
Average					**8.93E-05**	**9.03E-05**
0.0161					**8.98E-05**	

Table I3 The raw data of conductivity measurement of $HClO_4$ doped poly(3-thiopeheneacetic acid) at doping ratio, Na:Nm = 0.5:1

Thickness (cm)	Current (A)		Volt drop (V)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0163	2.00E-04	2.00E-04	42.83	47.26	6.68E-04	6.05E-04
0.0183	4.00E-04	3.00E-04	78.40	68.40	7.30E-04	6.27E-04
0.0162	6.00E-04	4.00E-04	115.29	88.58	7.44E-04	6.46E-04
0.0148	8.00E-04	5.00E-04	173.25	127.35	6.60E-04	5.61E-04
0.0166	1.00E-03	6.00E-04	218.24	138.24	6.55E-04	6.21E-04
0.0167	1.20E-03	7.00E-04	273.27	166.35	6.28E-04	6.02E-04
0.0153	1.40E-03	8.00E-04	319.27	184.35	6.27E-04	6.20E-04
0.0142	1.60E-03	9.00E-04	386.35	205.24	5.92E-04	6.27E-04
0.0163	1.80E-03	1.00E-03	427.35	231.58	6.02E-04	6.17E-04
0.0161	2.00E-03	1.10E-03	498.46	278.24	5.74E-04	5.65E-04
	2.20E-03	1.20E-03	535.79	295.23	5.87E-04	5.81E-04
	2.40E-03	1.30E-03	582.71	310.36	5.89E-04	5.99E-04
	2.60E-03	1.40E-03	623.11	331.46	5.97E-04	6.04E-04
	2.80E-03	1.50E-03	677.93	356.23	5.91E-04	6.02E-04
	3.00E-03	1.60E-03	791.02	381.02	5.42E-04	6.00E-04
	3.20E-03	1.70E-03	819.02	409.02	5.59E-04	5.94E-04
	3.40E-03	1.80E-03	838.85	428.85	5.80E-04	6.00E-04
	3.60E-03	1.90E-03	867.37	457.37	5.93E-04	5.94E-04
	3.80E-03	2.00E-03	911.72	481.72	5.96E-04	5.94E-04
Average					**6.16E-04**	**6.03E-04**
0.0161					**6.10E-04**	

Table I4 The raw data of conductivity measurement of $HClO_4$ doped poly(3-thiopeheneacetic acid) at doping ratio, Na:Nm = 1:1

Thickness (cm)	Current (A)		Volt drop (V)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0134	1.00E-05	1.00E-05	14.26	7.92	1.93E-04	2.02E-04
0.0148	4.00E-05	2.00E-05	22.01	15.39	1.92E-04	2.08E-04
0.0155	7.00E-05	3.00E-05	27.39	22.89	2.04E-04	2.09E-04
0.0154	1.00E-04	4.00E-05	33.56	32.04	1.87E-04	1.99E-04
0.0147	1.30E-04	5.00E-05	40.54	38.88	2.10E-04	2.05E-04
0.0132	1.60E-04	6.00E-05	49.82	45.63	1.92E-04	2.10E-04
0.0151	1.90E-04	7.00E-05	57.40	55.96	1.94E-04	2.00E-04
0.0145	2.20E-04	8.00E-05	65.04	62.35	1.95E-04	2.05E-04
0.0138	2.50E-04	9.00E-05	74.67	72.39	1.82E-04	1.99E-04
0.0135	2.80E-04	1.00E-04	84.73	78.80	1.88E-04	2.03E-04
	3.10E-04	1.10E-04	92.95	87.67	1.95E-04	2.00E-04
	3.40E-04	1.20E-04	99.48	93.13	1.97E-04	2.06E-04
	3.70E-04	1.30E-04	101.19	99.55	1.99E-04	2.09E-04
	4.00E-04	1.40E-04	110.25	102.12	2.05E-04	2.19E-04
	4.30E-04	1.50E-04	129.31	114.05	2.02E-04	2.10E-04
	4.60E-04	1.60E-04	137.55	122.94	1.91E-04	2.08E-04
	4.90E-04	1.70E-04	146.80	132.67	1.87E-04	2.05E-04
	5.20E-04	1.80E-04	154.23	141.87	1.80E-04	2.03E-04
	5.50E-04	1.90E-04	156.13	150.46	1.68E-04	2.02E-04
Average					**1.93E-04**	**2.05E-04**
0.0144					**1.99E-04**	

Table I5 The raw data of conductivity measurement of $HClO_4$ doped poly(3-thiopeheneacetic acid) at doping ratio, Na:Nm = 10:1

Thickness (cm)	Current (A)		Volt drop (V)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0105	1.00E-04	1.00E-04	10.92	11.22	1.46E-03	1.42E-03
0.0153	2.00E-04	3.00E-04	21.39	32.03	1.49E-03	1.50E-03
0.0164	3.00E-04	5.00E-04	32.89	52.53	1.46E-03	1.52E-03
0.0133	4.00E-04	7.00E-04	42.04	69.69	1.52E-03	1.60E-03
0.0119	5.00E-04	9.00E-04	50.88	92.52	1.57E-03	1.55E-03
0.0116	6.00E-04	1.10E-03	65.63	117.27	1.46E-03	1.50E-03
0.0166	7.00E-04	1.30E-03	75.96	133.61	1.47E-03	1.55E-03
0.0165	8.00E-04	1.50E-03	82.35	159.99	1.55E-03	1.50E-03
0.0162	9.00E-04	1.70E-03	92.39	170.04	1.56E-03	1.60E-03
0.0157	1.00E-03	1.90E-03	108.80	196.44	1.47E-03	1.54E-03
	1.10E-03	2.10E-03	117.67	215.31	1.49E-03	1.56E-03
	1.20E-03	2.30E-03	123.13	240.77	1.56E-03	1.53E-03
	1.30E-03	2.50E-03	139.55	267.20	1.49E-03	1.49E-03
	1.40E-03	2.70E-03	142.12	279.77	1.57E-03	1.54E-03
	1.50E-03	2.90E-03	154.05	281.69	1.55E-03	1.64E-03
	1.60E-03	3.10E-03	162.94	310.58	1.57E-03	1.59E-03
	1.70E-03	3.30E-03	172.67	330.31	1.57E-03	1.59E-03
	1.80E-03	3.50E-03	187.87	385.52	1.53E-03	1.45E-03
	1.90E-03	3.70E-03	198.46	396.11	1.53E-03	1.49E-03
Average					**1.52E-03**	**1.54E-03**
0.0144					**1.53E-03**	

Table I6 The raw data of conductivity measurement of $HClO_4$ doped poly(3-thiopeheneacetic acid) at doping ratio, Na:Nm = 50:1

Thickness (cm)	Current (A)		Volt drop (V)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0180	1.00E-04	1.00E-04	2.22	2.24	5.64E-03	5.57E-03
0.0197	2.00E-04	3.00E-04	4.35	6.41	5.74E-03	5.85E-03
0.0213	3.00E-04	5.00E-04	6.53	10.5	5.74E-03	5.95E-03
0.0173	4.00E-04	7.00E-04	8.69	13.9	5.75E-03	6.28E-03
0.0131	5.00E-04	9.00E-04	10.86	18.5	5.75E-03	6.08E-03
0.0155	6.00E-04	1.10E-03	12.73	23.5	5.89E-03	5.86E-03
0.0211	7.00E-04	1.30E-03	13.97	26.7	6.26E-03	6.08E-03
0.0190	8.00E-04	1.50E-03	15.99	32.0	6.25E-03	5.86E-03
0.0193	9.00E-04	1.70E-03	17.97	34.0	6.26E-03	6.25E-03
0.0197	1.00E-03	1.90E-03	20.44	39.3	6.11E-03	6.04E-03
	1.10E-03	2.10E-03	22.31	43.1	6.16E-03	6.09E-03
	1.20E-03	2.30E-03	24.77	48.2	6.05E-03	5.97E-03
	1.30E-03	2.50E-03	26.20	53.4	6.20E-03	5.84E-03
	1.40E-03	2.70E-03	27.98	56.0	6.25E-03	6.03E-03
	1.50E-03	2.90E-03	29.95	56.3	6.26E-03	6.43E-03
	1.60E-03	3.10E-03	31.58	62.1	6.33E-03	6.24E-03
	1.70E-03	3.30E-03	34.39	66.1	6.18E-03	6.24E-03
	1.80E-03	3.50E-03	36.52	77.1	6.16E-03	5.67E-03
	1.90E-03	3.70E-03	36.56	79.2	6.49E-03	5.84E-03
Average					**6.08E-03**	**6.01E-03**
0.0184					**6.05E-03**	

Table I7 The raw data of conductivity measurement of $HClO_4$ doped poly(3-thiopeheneacetic acid) at doping ratio, Na:Nm = 100:1

Thickness (cm)	Current (A)		Volt drop (V)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0133	5.00E-03	2.00E-03	9.22	3.72	7.62E-02	7.55E-02
0.0162	6.00E-03	4.00E-03	11.35	7.35	7.42E-02	7.64E-02
0.0163	7.00E-03	6.00E-03	12.53	11.53	7.84E-02	7.31E-02
0.0160	8.00E-03	8.00E-03	15.69	15.69	7.16E-02	7.16E-02
0.0132	9.00E-03	1.00E-02	16.86	18.86	7.50E-02	7.45E-02
0.0191	1.00E-02	1.20E-02	18.73	21.73	7.50E-02	7.76E-02
0.0159	1.10E-02	1.40E-02	20.84	25.84	7.41E-02	7.61E-02
0.0185	1.20E-02	1.60E-02	22.99	29.99	7.33E-02	7.49E-02
0.0175	1.30E-02	1.80E-02	24.97	34.97	7.31E-02	7.23E-02
0.0177	1.40E-02	2.00E-02	25.44	38.44	7.73E-02	7.31E-02
	1.50E-02	2.20E-02	27.73	42.73	7.60E-02	7.23E-02
	1.60E-02	2.40E-02	29.77	44.77	7.55E-02	7.53E-02
	1.70E-02	2.60E-02	31.20	48.20	7.65E-02	7.58E-02
	1.80E-02	2.80E-02	33.98	53.98	7.44E-02	7.28E-02
	1.90E-02	3.00E-02	35.95	56.95	7.42E-02	7.40E-02
	2.00E-02	3.20E-02	37.58	58.58	7.47E-02	7.67E-02
	2.10E-02	3.40E-02	39.39	60.39	7.49E-02	7.91E-02
	2.20E-02	3.60E-02	41.52	65.52	7.44E-02	7.72E-02
	2.30E-02	3.80E-02	43.56	68.56	7.41E-02	7.78E-02
Average					**7.49E-02**	**7.50E-02**
0.0164					**7.50E-02**	

Table I8 The raw data of conductivity measurement of $HClO_4$ doped poly(3-thiopeheneacetic acid) at doping ratio, Na:Nm = 200:1

Thickness (cm)	Current (A)		Volt drop (V)		Conductivity (S/cm)	
	1	2	1	2	1	2
0.0105	5.00E-03	2.00E-03	9.45	3.81	8.20E-02	8.13E-02
0.0153	6.00E-03	4.00E-03	11.63	7.53	7.99E-02	8.23E-02
0.0164	7.00E-03	6.00E-03	12.84	11.81	8.45E-02	7.87E-02
0.0133	8.00E-03	8.00E-03	16.08	16.07	7.71E-02	7.71E-02
0.0119	9.00E-03	1.00E-02	17.27	19.33	8.07E-02	8.02E-02
0.0160	1.00E-02	1.20E-02	19.19	22.26	8.07E-02	8.35E-02
0.0166	1.10E-02	1.40E-02	21.35	26.47	7.98E-02	8.19E-02
0.0165	1.20E-02	1.60E-02	23.55	30.73	7.89E-02	8.07E-02
0.0162	1.30E-02	1.80E-02	25.58	35.82	7.87E-02	7.78E-02
0.0157	1.40E-02	2.00E-02	26.06	39.39	8.32E-02	7.87E-02
	1.50E-02	2.20E-02	28.41	43.78	8.18E-02	7.78E-02
	1.60E-02	2.40E-02	30.50	45.87	8.13E-02	8.11E-02
	1.70E-02	2.60E-02	31.97	49.38	8.24E-02	8.16E-02
	1.80E-02	2.80E-02	34.81	55.30	8.01E-02	7.84E-02
	1.90E-02	3.00E-02	36.83	58.35	7.99E-02	7.96E-02
	2.00E-02	3.20E-02	38.50	60.02	8.05E-02	8.26E-02
	2.10E-02	3.40E-02	40.36	61.88	8.06E-02	8.51E-02
	2.20E-02	3.60E-02	42.54	67.13	8.01E-02	8.31E-02
	2.30E-02	3.80E-02	44.63	70.25	7.98E-02	8.38E-02
Average					**8.06E-02**	**8.08E-02**
0.0148					**8.07E-02**	

Appendix J The electrorheological properties under the oscillatory shear measurement

Table J1 The data of the viscoelastic properties without applied electric field in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency (rad/s)	Sample 1			Sample 2		
	G'	G"	tan δ	G'	G"	tan δ
0.01	2.52E-4	0.0024	9.6825	9.87E-5	0.0019	18.744
0.02	3.83E-4	0.0048	12.428	1.12E-4	0.0045	40.179
0.05	4.41E-4	0.0066	14.921	2.10E-4	0.0080	38.095
0.10	5.15E-4	0.0163	31.553	9.24E-4	0.0210	22.695
0.16	6.98E-4	0.0351	50.229	0.0015	0.0312	21.252
0.25	0.0015	0.0501	33.393	0.0016	0.0449	28.081
0.40	0.0025	0.0704	28.168	0.0018	0.0723	40.825
0.63	0.0038	0.1200	31.318	0.0018	0.1121	62.256
1.00	0.0055	0.1910	34.856	0.0034	0.1771	51.624
1.58	0.0061	0.2955	48.444	0.0042	0.2846	68.093
2.51	0.0081	0.4659	57.737	0.0043	0.4455	102.89
3.98	0.0080	0.7641	95.156	0.0046	0.5369	117.48
6.31	0.0110	0.7816	71.379	0.0149	0.7599	51.000
10.00	0.0249	1.1644	46.688	0.0117	1.1372	97.20
15.85	0.0257	1.7178	66.762	0.0140	1.7101	122.15
25.12	0.0297	2.5932	87.372	0.0298	2.5781	86.51
39.81	0.0393	3.8696	98.588	0.0458	3.8562	84.20
63.10	0.0419	5.8258	139.04	0.0503	5.8103	115.51
100.00	0.0506	8.9379	176.64	0.0573	8.9169	155.62

Table J2 The data of the viscoelastic properties under the electric field strength of 1 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	3.10E-4	0.0046	14.903	3.10E-4	0.0027	8.6452
0.02	4.80E-4	0.0079	16.479	4.23E-4	0.0053	12.624
0.05	5.32E-4	0.0116	21.786	5.30E-4	0.0097	18.321
0.10	8.06E-4	0.0208	25.831	8.46E-4	0.0192	22.695
0.16	9.59E-4	0.0342	35.641	9.46E-4	0.0373	39.391
0.25	0.0028	0.0514	18.443	0.0025	0.0487	19.241
0.40	0.0038	0.0647	17.017	0.0037	0.0563	15.062
0.63	0.0049	0.0874	17.721	0.0048	0.0764	15.927
1.00	0.0060	0.1853	31.019	0.0058	0.1550	26.639
1.58	0.0123	0.2346	19.074	0.0095	0.2185	23.046
2.51	0.0123	0.3582	29.075	0.0098	0.3339	33.928
3.98	0.0130	0.5512	42.266	0.0098	0.5143	52.318
6.31	0.0182	0.8060	44.237	0.0174	0.7775	44.789
10.00	0.0240	1.2214	50.830	0.0211	1.1749	55.790
15.85	0.0262	1.8787	71.680	0.0220	1.8126	82.502
25.12	0.0294	2.9015	98.590	0.0142	2.7906	196.24
39.81	0.0391	4.4753	114.60	0.0324	4.3511	134.50
63.10	0.0413	7.0100	169.78	0.0426	6.8338	160.27
100.00	0.0595	10.918	183.56	0.0532	10.646	200.27

Table J3 The data of the viscoelastic properties under the electric field strength of 10 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0020	0.0046	2.3632	0.0016	0.0039	2.3537
0.02	0.0026	0.0079	3.0623	0.0021	0.0053	2.4907
0.05	0.0027	0.0116	4.2610	0.0025	0.0097	3.8228
0.10	0.0032	0.0208	6.5063	0.0035	0.0262	7.4221
0.16	0.0059	0.0342	5.8427	0.0043	0.0373	8.6651
0.25	0.0066	0.0536	8.1212	0.0061	0.0487	7.9836
0.40	0.0092	0.0724	7.8856	0.0091	0.0664	7.2624
0.63	0.0198	0.1045	5.2778	0.0129	0.0941	7.2776
1.00	0.0269	0.1853	6.8786	0.0231	0.1550	6.7030
1.58	0.0274	0.2346	8.5593	0.0344	0.2185	6.3456
2.51	0.0380	0.3582	9.4387	0.0457	0.3339	7.3101
3.98	0.0696	0.5512	7.9211	0.0568	0.5143	9.0528
6.31	0.0930	0.8060	8.6684	0.0771	0.7775	10.085
10.00	0.1177	1.2214	10.378	0.0882	1.1749	13.321
15.85	0.1273	1.8787	14.760	0.0975	1.8126	18.591
25.12	0.1687	2.9015	17.196	0.1210	2.7906	23.062
39.81	0.1550	4.4753	28.873	0.2600	4.3511	16.735
63.10	0.1654	7.0100	42.382	0.2712	6.8338	25.198
100.00	0.1713	10.918	63.736	0.2816	10.646	37.807

Table J4 The data of the viscoelastic properties under the electric field strength of 20 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0069	0.0179	2.5942	0.0030	0.0148	4.9333
0.02	0.0085	0.0301	3.5424	0.0062	0.0343	5.5274
0.05	0.0132	0.0749	5.6765	0.0096	0.0391	4.0760
0.10	0.0270	0.1080	3.9996	0.0126	0.0761	6.0206
0.16	0.0343	0.1352	3.9466	0.0161	0.0773	4.7923
0.25	0.0351	0.1412	4.0191	0.0193	0.1158	6.0125
0.40	0.0348	0.2084	5.9905	0.0256	0.1459	5.6988
0.63	0.0363	0.2235	6.1528	0.0374	0.1723	4.6067
1.00	0.0469	0.2498	5.3258	0.0453	0.2245	4.9530
1.58	0.0672	0.3329	4.9556	0.0535	0.2619	4.8935
2.51	0.0796	0.4763	5.9872	0.0556	0.3381	6.0815
3.98	0.0871	0.6043	6.9355	0.0699	0.4975	7.1175
6.31	0.0934	0.8710	9.3269	0.0815	0.7753	9.5147
10.00	0.1137	1.2779	11.238	0.0860	1.1410	13.265
15.85	0.1342	1.8869	14.058	0.1303	1.7153	13.164
25.12	0.1402	2.7865	19.875	0.1341	2.5333	18.891
39.81	0.2208	4.0810	18.480	0.2175	3.7998	17.468
63.10	0.2597	6.0786	23.406	0.2637	5.7239	21.709
100.00	0.3387	9.2154	27.211	0.3124	8.7558	28.026

Table J5 The data of the viscoelastic properties under the electric field strength of 50 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0517	0.1252	2.4217	0.0343	0.0763	2.2251
0.02	0.0571	0.1672	2.9267	0.0369	0.0842	2.2818
0.05	0.0648	0.2330	3.5957	0.0391	0.0943	2.4093
0.10	0.0653	0.2998	4.5932	0.0450	0.1465	3.2548
0.16	0.0666	0.3503	5.2574	0.0601	0.1644	2.7354
0.25	0.0684	0.3900	5.7018	0.0614	0.1773	2.8867
0.40	0.0737	0.3985	5.4107	0.0708	0.1865	2.6331
0.63	0.0749	0.4328	5.7776	0.0715	0.1967	2.7514
1.00	0.0827	0.4807	5.8126	0.0715	0.2258	3.1576
1.58	0.0858	0.5623	6.5536	0.0751	0.2416	3.2170
2.51	0.0918	0.7303	7.9553	0.0800	0.3620	4.5233
3.98	0.0970	0.7314	7.5406	0.0802	0.6904	8.6124
6.31	0.1267	1.1329	8.9403	0.1024	1.0909	10.658
10.00	0.1553	1.7593	11.329	0.1135	1.6926	14.913
15.85	0.2154	2.7204	12.629	0.1202	2.6197	21.790
25.12	0.2618	4.1822	15.974	0.1470	4.0932	27.853
39.81	0.2902	6.4771	22.319	0.2194	6.3557	28.970
63.10	0.3241	10.029	30.947	0.2488	9.8931	39.763
100.00	0.3874	15.642	40.377	0.2932	15.460	52.725

Table J6 The data of the viscoelastic properties under the electric field strength of 100 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	35.980	2.7566	0.0766	40.200	3.9200	0.0975
0.02	40.746	2.6677	0.0655	41.000	4.0964	0.0999
0.05	40.249	3.8950	0.0968	44.600	4.4265	0.0992
0.10	42.719	4.0512	0.0948	45.000	3.8439	0.0854
0.16	43.918	3.9851	0.0907	44.500	3.7504	0.0843
0.25	43.872	4.0599	0.0925	44.476	4.4622	0.1003
0.40	43.890	3.5917	0.0818	44.400	3.9768	0.0896
0.63	44.102	3.8896	0.0882	45.015	4.5160	0.1003
1.00	44.594	6.2707	0.1406	45.400	4.4346	0.0977
1.58	46.613	4.9768	0.1068	49.200	5.9557	0.1211
2.51	47.535	6.8216	0.1435	49.700	5.7940	0.1166
3.98	46.759	4.9008	0.1048	47.700	6.7410	0.1413
6.31	47.475	5.8056	0.1223	50.200	6.5565	0.1306
10.00	48.255	6.1931	0.1283	49.800	7.0287	0.1411
15.85	46.986	7.1498	0.1522	49.400	8.5588	0.1733
25.12	44.188	12.303	0.2784	46.200	12.796	0.2770
39.81	44.664	23.645	0.5294	45.800	24.207	0.5285
63.10	47.019	32.303	0.6870	54.100	30.146	0.5572
100.00	52.634	44.820	0.8515	53.800	44.536	0.8278

Table J7 The data of the viscoelastic properties under the electric field strength of 200 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	180.33	10.046	0.0557	195.78	8.3153	0.0425
0.02	204.32	10.287	0.0503	197.53	9.8891	0.0501
0.05	192.10	11.720	0.0610	218.16	9.9347	0.0455
0.10	212.49	12.468	0.0587	233.72	8.9067	0.0381
0.16	219.55	14.135	0.0644	263.80	9.8785	0.0374
0.25	217.58	16.311	0.0750	263.61	14.105	0.0535
0.40	227.67	19.492	0.0856	251.78	16.284	0.0647
0.63	229.57	16.756	0.0730	262.43	17.373	0.0662
1.00	236.79	15.759	0.0666	260.28	17.459	0.0671
1.58	248.22	12.947	0.0522	265.01	15.194	0.0573
2.51	252.56	11.734	0.0465	273.98	18.727	0.0684
3.98	257.67	17.318	0.0672	280.62	24.315	0.0866
6.31	260.50	24.046	0.0923	278.48	24.583	0.0883
10.00	250.63	23.927	0.0955	271.14	24.996	0.0922
15.85	240.62	27.424	0.1140	268.56	29.140	0.1085
25.12	235.52	24.071	0.1022	278.79	26.498	0.0950
39.81	241.68	29.570	0.1224	277.46	25.961	0.0936
63.10	252.25	32.756	0.1299	287.37	34.393	0.1197
100.00	254.62	40.324	0.1584	286.96	38.093	0.1327

Table J8 The data of the viscoelastic properties under the electric field strength of 500 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	617.55	334.17	0.5411	691.02	238.64	0.3453
0.02	648.10	320.30	0.4942	714.25	260.05	0.3641
0.05	674.40	298.14	0.4421	729.45	241.41	0.3309
0.10	709.32	362.70	0.5113	734.68	233.21	0.3174
0.16	812.75	298.52	0.3673	752.01	212.23	0.2822
0.25	892.91	413.08	0.4626	738.85	294.20	0.3982
0.40	880.49	278.75	0.3166	836.73	272.22	0.3253
0.63	1033.2	170.50	0.1650	785.00	278.68	0.3550
1.00	990.56	238.89	0.2412	811.01	262.89	0.3241
1.58	1193.6	220.40	0.1846	859.11	260.44	0.3032
2.51	1150.8	454.21	0.3947	912.47	244.48	0.2679
3.98	1161.8	302.96	0.2608	854.91	210.64	0.2464
6.31	1160.2	415.23	0.3579	886.23	203.95	0.2301
10.00	1203.2	303.58	0.2523	845.64	238.57	0.2821
15.85	1381.7	289.66	0.2096	876.56	245.89	0.2805
25.12	1319.8	282.18	0.2138	880.03	233.52	0.2654
39.81	1256.6	287.84	0.2291	899.77	268.99	0.2990
63.10	1378.0	260.73	0.1892	907.64	292.34	0.3221
100.00	1495.2	380.55	0.2545	961.91	349.07	0.3629

Table J9 The data of the viscoelastic properties under the electric field strength of 1000 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	1482.1	456.64	0.3081	1355.3	855.50	0.6312
0.02	1627.2	478.26	0.2939	1682.0	684.49	0.4069
0.05	1654.2	483.26	0.2921	1826.5	689.16	0.3773
0.10	1740.8	504.37	0.2897	2165.4	876.31	0.4047
0.16	2320.9	598.75	0.2580	2913.0	719.28	0.2469
0.25	2325.0	664.30	0.2857	2555.9	753.12	0.2947
0.40	2398.2	640.20	0.2670	2959.9	745.98	0.2520
0.63	2484.4	726.42	0.2924	2743.6	728.13	0.2654
1.00	3060.3	782.23	0.2556	2869.6	784.21	0.2733
1.58	2956.1	622.57	0.2106	3165.5	812.08	0.2565
2.51	3463.5	639.45	0.1846	3183.3	733.06	0.2303
3.98	3508.6	711.81	0.2029	3278.1	726.02	0.2215
6.31	3473.7	700.61	0.2017	3424.8	813.24	0.2375
10.00	3661.9	683.90	0.1868	3711.6	668.21	0.1800
15.85	3738.1	606.37	0.1622	3738.0	688.52	0.1842
25.12	3591.9	719.67	0.2004	3620.3	689.02	0.1903
39.81	3817.1	654.13	0.1714	3500.6	806.89	0.2305
63.10	3853.5	676.42	0.1755	3870.4	829.13	0.2142
100.00	4079.8	749.27	0.1837	3996.5	787.92	0.1972

Table J10 The data of the viscoelastic properties under the electric field strength of 2000 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	7523.9	1437.5	0.1911	7772.7	1253.4	0.1613
0.02	7794.9	2004.9	0.2572	9738.1	1738.4	0.1785
0.05	9641.2	2208.6	0.2291	9191.9	2348.0	0.2554
0.10	9699.1	1933.3	0.1993	10246	1443.2	0.1408
0.16	9558.5	1582.8	0.1656	10446	1272.9	0.1219
0.25	8426.1	2100.2	0.2492	11162	1930.4	0.1729
0.40	9161.9	1645.5	0.1796	11363	1529.9	0.1346
0.63	9114.2	2208.8	0.2423	10136	2460.4	0.2427
1.00	9094.5	2271.3	0.2497	10976	2478.8	0.2258
1.58	9426.1	2365.2	0.2509	11088	2617.8	0.2361
2.51	8614.7	2379.5	0.2762	11655	2647.3	0.2271
3.98	8522.8	2396.8	0.2812	9116.2	2674.9	0.2934
6.31	9516.1	2414.7	0.2538	10838	2904.0	0.2680
10.00	9327.7	2493.7	0.2673	10757	3041.5	0.2827
15.85	9184.7	2691.2	0.2930	10649	3168.9	0.2976
25.12	10086	2849.1	0.2825	11366	3810.7	0.3353
39.81	10648	4825.3	0.4532	12608	4839.2	0.3838
63.10	11197	3444.8	0.3077	12125	4051.1	0.3341
100.00	13776	4216.3	0.3061	14510	4867.7	0.3355

Table J11 The data of the viscoelastic properties without applied electric field in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	1.93E-4	0.0015	7.6373	1.45E-4	0.0014	9.3793
0.02	2.57E-4	0.0030	11.673	3.20E-4	0.0029	9.0625
0.05	3.92E-4	0.0041	10.459	6.87E-4	0.0057	8.2969
0.10	6.62E-4	0.0099	14.955	9.96E-4	0.0073	7.3293
0.16	0.0012	0.0148	12.333	0.0014	0.0185	13.214
0.25	0.0016	0.0303	18.589	0.0017	0.0349	20.409
0.40	0.0027	0.0406	15.206	0.0021	0.0444	20.748
0.63	0.0029	0.0685	23.379	0.0031	0.0668	21.410
1.00	0.0055	0.1192	21.712	0.0035	0.1222	34.618
1.58	0.0074	0.1859	24.987	0.0038	0.1861	48.590
2.51	0.0101	0.2967	29.493	0.0075	0.2941	39.424
3.98	0.0102	0.4784	46.856	0.0086	0.4571	53.400
6.31	0.0134	0.7296	54.448	0.0091	0.7127	78.233
10.00	0.0175	1.1335	64.920	0.0109	1.1237	103.09
15.85	0.0258	1.7662	68.351	0.0128	1.7562	137.32
25.12	0.0273	2.7455	100.57	0.0124	2.7324	220.32
39.81	0.0318	4.2356	133.19	0.0144	4.2555	294.89
63.10	0.0393	6.6344	168.73	0.0251	6.6036	262.67
100.00	0.0459	10.293	224.34	0.0392	10.302	262.74

Table J12 The data of the viscoelastic properties under the electric field strength of 1 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	1.00E-4	0.0047	47.000	1.00E-4	0.0018	18.000
0.02	2.00E-4	0.0063	31.500	2.00E-4	0.0037	18.500
0.05	3.00E-4	0.0081	27.000	5.00E-4	0.0080	16.000
0.10	7.00E-4	0.0222	31.714	0.0011	0.0095	8.6364
0.16	0.0014	0.0427	30.500	0.0013	0.0241	18.538
0.25	0.0019	0.0362	19.053	0.0016	0.0475	29.688
0.40	0.0031	0.0469	15.129	0.0022	0.0634	28.818
0.63	0.0035	0.0264	7.5429	0.0032	0.0684	21.375
1.00	0.0053	0.1269	23.943	0.0039	0.1320	33.846
1.58	0.0080	0.1948	24.350	0.0053	0.1797	33.906
2.51	0.0111	0.2987	26.910	0.0074	0.2946	39.811
3.98	0.0109	0.4515	41.422	0.0093	0.4384	47.140
6.31	0.0157	0.7217	45.968	0.0149	0.6976	46.819
10.00	0.0205	1.1272	54.985	0.0178	1.0966	61.607
15.85	0.0303	1.7160	56.634	0.0187	1.7013	90.979
25.12	0.0292	2.6483	90.695	0.0201	2.6219	130.44
39.81	0.0339	4.0814	120.40	0.0281	4.0578	144.41
63.10	0.0371	6.3050	169.95	0.0360	6.2553	173.76
100.00	0.0462	9.7161	210.31	0.0421	9.7627	231.89

Table J13 The data of the viscoelastic properties under the electric field strength of 10 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	1.00E-4	0.0060	60.000	3.00E-4	0.0025	8.3333
0.02	4.00E-4	0.0073	18.250	6.00E-4	0.0036	6.0000
0.05	6.00E-4	0.0153	25.500	9.00E-4	0.0084	9.3333
0.10	0.0010	0.0286	28.600	0.0015	0.0161	10.733
0.16	0.0019	0.0385	20.263	0.0019	0.0229	12.053
0.25	0.0024	0.0513	21.375	0.0021	0.0337	16.048
0.40	0.0039	0.1013	25.974	0.0038	0.0772	20.316
0.63	0.0049	0.1207	24.633	0.0054	0.1502	27.815
1.00	0.0066	0.1594	24.152	0.0075	0.1854	24.720
1.58	0.0097	0.2342	24.144	0.0088	0.2076	23.591
2.51	0.0183	0.3419	18.683	0.0163	0.3825	23.466
3.98	0.0186	0.5151	27.694	0.0193	0.5288	27.399
6.31	0.0298	0.7795	26.158	0.0220	0.7913	35.968
10.00	0.0419	1.1851	28.284	0.0214	1.2052	56.318
15.85	0.0451	1.8058	40.040	0.0356	1.8330	51.489
25.12	0.0607	2.7667	45.580	0.0373	2.7978	75.008
39.81	0.0703	4.2656	60.677	0.0425	4.2819	100.75
63.10	0.0743	6.4952	87.419	0.0733	6.5072	88.775
100.00	0.0841	9.9333	118.11	0.0940	9.9695	106.06

Table J14 The data of the viscoelastic properties under the electric field strength of 20 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency (rad/s)	Sample 1			Sample 2		
	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0022	0.0131	5.9545	0.0014	0.0137	9.7857
0.02	0.0052	0.0205	3.9423	0.0031	0.0310	10.000
0.05	0.0091	0.0379	4.1648	0.0061	0.0380	6.2295
0.10	0.0153	0.0637	4.1634	0.0096	0.0383	3.9896
0.16	0.0201	0.0846	4.2090	0.0130	0.0700	5.3846
0.25	0.0239	0.0967	4.0460	0.0157	0.0915	5.8280
0.40	0.0330	0.1341	4.0636	0.0228	0.0975	4.2763
0.63	0.0388	0.1582	4.0773	0.0246	0.1442	5.8618
1.00	0.0502	0.1815	3.6155	0.0318	0.1807	5.6824
1.58	0.0526	0.2524	4.7985	0.0347	0.2321	6.6888
2.51	0.0573	0.3593	6.2705	0.0374	0.3593	9.6070
3.98	0.0631	0.5248	8.3170	0.0411	0.5201	12.655
6.31	0.0767	0.7939	10.351	0.0541	0.7852	14.514
10.00	0.0947	1.2003	12.675	0.0605	1.1926	19.712
15.85	0.1155	1.8269	15.817	0.0651	1.8218	27.985
25.12	0.1475	2.7839	18.874	0.0751	2.7878	37.121
39.81	0.2143	4.2733	19.941	0.0903	4.2855	47.458
63.10	0.2354	6.5156	27.679	0.1154	6.5359	56.637
100.00	0.2631	10.009	38.041	0.1248	10.044	80.477

Table J15 The data of the viscoelastic properties under the electric field strength of 50 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0094	0.0167	1.7777	0.0103	0.0309	3.0000
0.02	0.0175	0.0256	1.4668	0.0137	0.0372	2.7146
0.05	0.0251	0.0412	1.6418	0.0158	0.0412	2.6127
0.10	0.0370	0.0683	1.8457	0.0205	0.0383	1.8679
0.16	0.0410	0.0913	2.2261	0.0253	0.0700	2.7690
0.25	0.0413	0.0937	2.2704	0.0271	0.1097	4.0483
0.40	0.0452	0.0946	2.0938	0.0313	0.1514	4.8383
0.63	0.0460	0.1380	3.0011	0.0369	0.1598	4.3327
1.00	0.0500	0.2105	4.2094	0.0408	0.2133	5.2315
1.58	0.0529	0.2501	4.7251	0.0454	0.3570	7.8630
2.51	0.0676	0.3649	5.3972	0.0476	0.5206	10.937
3.98	0.0706	0.5370	7.6089	0.0585	0.7299	12.481
6.31	0.1117	0.8145	7.2916	0.0651	0.7978	12.253
10.00	0.1308	1.2252	9.3671	0.0843	1.2145	14.409
15.85	0.1774	1.8646	10.513	0.1134	1.8506	16.324
25.12	0.2147	2.8532	13.291	0.1399	2.8437	20.324
39.81	0.2724	4.3762	16.065	0.1697	4.3659	25.727
63.10	0.3179	6.6386	20.883	0.1896	6.6306	34.977
100.00	0.3538	10.189	28.802	0.2464	10.172	41.279

Table J16 The data of the viscoelastic properties under the electric field strength of 100 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0282	0.0432	1.5319	0.0175	0.0295	1.6848
0.02	0.0287	0.0667	2.3259	0.0176	0.0359	2.0398
0.05	0.0365	0.0817	2.2354	0.0186	0.0625	3.3638
0.10	0.0383	0.0857	2.2368	0.0189	0.0680	3.6039
0.16	0.0405	0.0916	2.2602	0.0221	0.0751	3.3973
0.25	0.0405	0.0978	2.4133	0.0245	0.0959	3.9127
0.40	0.0406	0.1339	3.2968	0.0422	0.1117	2.6474
0.63	0.0407	0.1544	3.7899	0.0425	0.1140	2.6821
1.00	0.0584	0.1841	3.1558	0.0586	0.1246	2.1261
1.58	0.0707	0.2920	4.1319	0.0825	0.1875	2.2736
2.51	0.0800	0.3432	4.2872	0.0889	0.3695	4.1566
3.98	0.0804	0.5337	6.6417	0.0990	0.5387	5.4428
6.31	0.0842	0.8307	9.8649	0.1166	0.8085	6.9326
10.00	0.1033	1.2570	12.174	0.1458	1.2268	8.4145
15.85	0.1240	1.8958	15.285	0.1548	1.8801	12.143
25.12	0.1712	2.8921	16.894	0.1722	2.8599	16.608
39.81	0.2433	4.4171	18.156	0.2369	4.3966	18.558
63.10	0.3772	6.6693	17.681	0.3728	6.6633	17.874
100.00	0.4516	10.212	22.613	0.4955	10.226	20.637

Table J17 The data of the viscoelastic properties under the electric field strength of 200 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.1099	0.2383	2.1679	0.1190	0.1563	1.3132
0.02	0.1469	0.2635	1.7935	0.1283	0.2568	2.0012
0.05	0.1512	0.3115	2.0603	0.1351	0.2573	1.9046
0.10	0.1554	0.3171	2.0411	0.1417	0.2756	1.9449
0.16	0.1566	0.3280	2.0946	0.1419	0.2978	2.0978
0.25	0.1611	0.4233	2.6268	0.1440	0.3523	2.4470
0.40	0.1634	0.4257	2.6043	0.1463	0.4374	2.9906
0.63	0.1714	0.4975	2.9029	0.1610	0.4776	2.9658
1.00	0.1717	0.5454	3.1756	0.1631	0.4825	2.9590
1.58	0.1851	0.6172	3.3336	0.1654	0.7799	4.7154
2.51	0.1937	0.8314	4.2917	0.1678	0.9092	5.4171
3.98	0.1945	1.0653	5.4771	0.1735	1.1467	6.6108
6.31	0.1965	1.4460	7.3594	0.1819	1.4943	8.2143
10.00	0.2051	1.9664	9.5889	0.2060	2.0267	9.8405
15.85	0.2080	2.7293	13.122	0.2088	2.7756	13.291
25.12	0.2327	3.8777	16.667	0.2327	3.9128	16.815
39.81	0.2827	5.5554	19.651	0.2640	5.5932	21.186
63.10	0.3909	8.0923	20.700	0.3594	8.1510	22.681
100.00	0.5302	12.003	22.640	0.5315	12.081	22.729

Table J18 The data of the viscoelastic properties under the electric field strength of 500 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	419.53	172.71	0.4117	575.80	159.90	0.2777
0.02	511.78	192.70	0.3765	755.00	168.61	0.2233
0.05	540.66	203.14	0.3757	763.00	220.41	0.2889
0.10	579.19	213.44	0.3685	815.00	223.24	0.2739
0.16	640.81	216.89	0.3385	890.00	226.10	0.2540
0.25	657.60	237.13	0.3606	932.00	227.46	0.2441
0.40	661.93	255.89	0.3866	1010.0	234.81	0.2325
0.63	758.68	269.98	0.3559	1040.0	266.64	0.2564
1.00	804.54	278.75	0.3465	1080.0	267.11	0.2473
1.58	874.01	282.17	0.3228	1090.0	270.13	0.2478
2.51	899.47	284.33	0.3161	1270.0	279.90	0.2204
3.98	984.52	292.84	0.2974	1270.0	298.40	0.2350
6.31	1084.3	298.52	0.2753	1340.0	307.38	0.2294
10.00	1086.4	338.92	0.3120	1360.0	337.41	0.2481
15.85	1155.3	365.70	0.3165	1400.0	358.05	0.2557
25.12	1217.5	366.19	0.3008	1410.0	362.70	0.2572
39.81	1226.8	369.85	0.3015	1450.0	370.57	0.2556
63.10	1256.3	391.11	0.3113	1562.8	389.82	0.2494
100.00	1293.1	402.74	0.3115	1564.3	475.87	0.3042

Table J19 The data of the viscoelastic properties under the electric field strength of 1000 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	1128.2	411.81	0.3650	1355.3	445.33	0.3286
0.02	1304.6	440.20	0.3374	1682.0	460.44	0.2737
0.05	1523.2	446.13	0.2929	1826.5	488.52	0.2675
0.10	1740.8	454.13	0.2609	2165.4	489.02	0.2258
0.16	2320.9	461.02	0.1986	2555.9	506.89	0.1983
0.25	2325.0	476.16	0.2048	2743.6	513.24	0.1871
0.40	2398.2	500.61	0.2087	2869.6	528.13	0.1840
0.63	2484.4	504.37	0.2030	2913.0	529.13	0.1816
1.00	2956.1	506.37	0.1713	2959.9	533.06	0.1801
1.58	3060.3	519.67	0.1698	3165.5	553.12	0.1747
2.51	3463.5	522.57	0.1509	3183.3	568.21	0.1785
3.98	3473.7	539.45	0.1553	3278.1	587.92	0.1793
6.31	3508.6	549.27	0.1566	3424.8	645.98	0.1886
10.00	3591.9	564.30	0.1571	3500.6	684.49	0.1955
15.85	3661.9	576.42	0.1574	3620.3	689.16	0.1904
25.12	3738.1	583.90	0.1562	3711.6	719.28	0.1938
39.81	3817.1	598.75	0.1569	3738.0	784.21	0.2098
63.10	3853.5	726.42	0.1885	3870.4	855.50	0.2210
100.00	4079.8	782.23	0.1917	3996.5	876.31	0.2193

Table J20 The data of the viscoelastic properties under the electric field strength of 2000 V/mm in oscillatory shear flow of 10% wt. $HClO_4$ highly doped polythiophene/silicone oil suspension (HPT10) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	4435.6	967.77	0.2182	3459.0	926.81	0.2679
0.02	4500.9	1105.5	0.2456	3712.3	977.81	0.2634
0.05	4764.9	1380.9	0.2898	3713.1	1335.8	0.3598
0.10	5187.3	1590.3	0.3066	3918.8	1597.2	0.4076
0.16	6360.8	1595.7	0.2509	5657.3	1627.3	0.2876
0.25	6668.1	1730.4	0.2595	5734.3	1827.9	0.3188
0.40	6702.3	1844.4	0.2752	5950.5	2001.7	0.3364
0.63	6889.5	1882.8	0.2733	7258.4	2249.7	0.3099
1.00	7087.1	1930.5	0.2724	7370.8	2251.6	0.3055
1.58	7221.4	2111.2	0.2924	7967.5	2379.4	0.2986
2.51	8301.0	2250.7	0.2711	8890.4	2716.9	0.3056
3.98	8474.0	2287.2	0.2699	8919.8	2899.9	0.3251
6.31	8845.3	2824.5	0.3193	10243	3577.7	0.3493
10.00	8993.1	2976.2	0.3309	10539	3607.0	0.3423
15.85	9085.1	3159.5	0.3478	11400	4020.2	0.3527
25.12	10306	3223.6	0.3128	11410	4850.7	0.4251
39.81	11275	3281.0	0.2910	12034	5021.2	0.4173
63.10	11466	3283.4	0.2864	14650	6466.0	0.4414
100.00	16247	3545.0	0.2182	18234	6548.8	0.3592

Table J21 The data of the viscoelastic properties without applied electric field in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	2.07E-4	0.0020	9.5114	1.47E-4	0.0013	8.5034
0.02	3.16E-4	0.0029	9.0650	2.41E-4	0.0031	12.919
0.05	3.66E-4	0.0046	12.593	2.92E-4	0.0072	24.499
0.10	4.85E-4	0.0095	19.646	8.18E-4	0.0221	27.017
0.16	7.75E-4	0.0215	27.735	0.0011	0.0392	35.797
0.25	9.89E-4	0.0387	39.086	0.0015	0.0546	36.558
0.40	0.0015	0.0610	39.492	0.0020	0.0835	41.542
0.63	0.0023	0.1515	66.202	0.0025	0.1064	42.105
1.00	0.0026	0.2076	80.489	0.0032	0.1476	45.711
1.58	0.0040	0.2412	59.716	0.0038	0.1612	42.271
2.51	0.0047	0.3533	74.668	0.0043	0.2552	59.635
3.98	0.0053	0.5697	106.92	0.0052	0.3987	77.282
6.31	0.0082	0.8268	101.45	0.0076	0.6297	83.394
10.00	0.0083	1.2701	153.06	0.0107	0.9893	92.837
15.85	0.0093	1.9567	209.94	0.0149	1.5531	103.90
25.12	0.0128	2.9469	230.97	0.0250	2.4437	97.898
39.81	0.0161	4.5526	282.74	0.0298	3.8027	127.82
63.10	0.0165	6.8624	415.75	0.0302	5.9490	197.10
100.00	0.0259	10.358	399.30	0.0453	9.2985	205.21

Table J22 The data of the viscoelastic properties under the electric field strength of 1 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	2.52E-4	0.0033	13.241	2.05E-4	0.0018	8.7640
0.02	3.89E-4	0.0053	13.639	3.06E-4	0.0029	9.4750
0.05	4.50E-4	0.0076	16.963	3.44E-4	0.0054	15.555
0.10	6.71E-4	0.0137	20.492	6.01E-4	0.0109	18.190
0.16	0.0010	0.0216	20.557	7.73E-4	0.0153	19.766
0.25	0.0013	0.0391	29.515	0.0012	0.0236	19.051
0.40	0.0019	0.0453	24.497	0.0017	0.0366	20.929
0.63	0.0024	0.0533	22.095	0.0023	0.0569	24.898
1.00	0.0036	0.1002	27.994	0.0037	0.0687	18.630
1.58	0.0046	0.1644	35.975	0.0065	0.1211	18.577
2.51	0.0061	0.2203	35.936	0.0067	0.1873	27.931
3.98	0.0070	0.3120	44.556	0.0075	0.2940	39.408
6.31	0.0089	0.4594	51.850	0.0094	0.4498	47.913
10.00	0.0091	0.7062	77.502	0.0095	0.6872	71.980
15.85	0.0107	1.0865	101.40	0.0150	1.0703	71.350
25.12	0.0135	1.6645	123.49	0.0151	1.6433	109.04
39.81	0.0153	2.5603	167.02	0.0169	2.5346	149.62
63.10	0.0157	3.9362	251.50	0.0203	3.9170	193.24
100.00	0.0243	6.0929	251.25	0.0251	6.0485	240.87

Table J23 The data of the viscoelastic properties under the electric field strength of 10 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	6.21E-4	0.0029	4.6967	8.28E-4	0.0028	3.3233
0.02	9.38E-4	0.0040	4.2471	0.0012	0.0038	3.1098
0.05	0.0013	0.0067	5.3561	0.0018	0.0072	3.9161
0.10	0.0021	0.0144	7.0015	0.0021	0.0117	5.6846
0.16	0.0031	0.0187	6.1130	0.0028	0.0179	6.3301
0.25	0.0039	0.0358	9.2686	0.0035	0.0290	8.3549
0.40	0.0047	0.0641	13.671	0.0043	0.0516	11.900
0.63	0.0059	0.0864	14.600	0.0055	0.0620	11.272
1.00	0.0081	0.1139	14.063	0.0067	0.1270	18.833
1.58	0.0095	0.1982	20.917	0.0087	0.1381	15.963
2.51	0.0132	0.2592	19.599	0.0095	0.2324	24.418
3.98	0.0170	0.4065	23.872	0.0129	0.3980	30.856
6.31	0.0223	0.5995	26.863	0.0144	0.5734	39.805
10.00	0.0292	0.8922	30.540	0.0153	0.8618	56.496
15.85	0.0348	1.3377	38.408	0.0214	1.3193	61.736
25.12	0.0353	2.0285	57.486	0.0254	1.9973	78.635
39.81	0.0477	3.0606	64.127	0.0443	3.0390	68.632
63.10	0.0522	4.5512	87.195	0.0652	4.6609	71.529
100.00	0.0671	7.0041	104.42	0.0619	6.9723	112.59

Table J24 The data of the viscoelastic properties under the electric field strength of 20 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0013	0.0078	5.7910	0.0012	0.0089	7.3051
0.02	0.0022	0.0092	4.2342	0.0016	0.0126	7.8438
0.05	0.0033	0.0152	4.6378	0.0020	0.0160	8.1437
0.10	0.0047	0.0221	4.7448	0.0039	0.0244	6.1957
0.16	0.0050	0.0355	7.0777	0.0066	0.0336	5.0962
0.25	0.0055	0.0503	9.1965	0.0098	0.0431	4.4125
0.40	0.0058	0.0608	10.513	0.0104	0.0760	7.2796
0.63	0.0081	0.0664	8.1712	0.0118	0.0764	6.4479
1.00	0.0082	0.1227	15.038	0.0120	0.1241	10.328
1.58	0.0116	0.1985	17.077	0.0121	0.2355	19.482
2.51	0.0177	0.2391	13.521	0.0181	0.3468	19.113
3.98	0.0240	0.4116	17.177	0.0323	0.3686	11.410
6.31	0.0267	0.6170	23.078	0.0392	0.5709	14.563
10.00	0.0348	0.9236	26.564	0.0422	0.8639	20.471
15.85	0.0390	1.4611	37.451	0.0529	1.3133	24.807
25.12	0.0397	1.9208	48.354	0.0657	2.1822	33.240
39.81	0.0507	2.9114	57.462	0.0893	2.8697	32.124
63.10	0.0616	4.4869	72.878	0.0930	4.3676	46.980
100.00	0.0702	6.7526	96.191	0.0936	6.6450	71.019

Table J25 The data of the viscoelastic properties under the electric field strength of 50 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0046	0.0401	8.7890	0.0025	0.0317	12.468
0.02	0.0053	0.0594	11.309	0.0039	0.0484	12.571
0.05	0.0059	0.0716	12.084	0.0046	0.0620	13.478
0.10	0.0097	0.0949	9.8012	0.0067	0.0899	13.403
0.16	0.0118	0.0909	7.6992	0.0073	0.1313	17.924
0.25	0.0140	0.0979	6.9685	0.0076	0.1545	20.289
0.40	0.0168	0.1964	11.689	0.0102	0.1463	14.415
0.63	0.0171	0.2093	12.272	0.0113	0.1731	15.349
1.00	0.0192	0.2367	12.309	0.0141	0.2338	16.614
1.58	0.0237	0.3388	14.284	0.0158	0.3264	20.700
2.51	0.0247	0.4834	19.549	0.0166	0.4122	24.871
3.98	0.0272	0.5740	21.089	0.0166	0.8356	50.392
6.31	0.0244	0.9518	39.001	0.0241	0.9256	38.367
10.00	0.0252	1.3732	54.453	0.0350	1.3456	38.417
15.85	0.0260	2.0222	77.775	0.0530	1.9874	37.498
25.12	0.0302	3.0185	99.900	0.0406	2.9604	72.897
39.81	0.0581	4.5193	77.834	0.0533	4.4527	83.544
63.10	0.0648	6.8539	105.73	0.0558	6.7679	121.39
100.00	0.0649	10.562	162.66	0.0791	10.439	131.99

Table J26 The data of the viscoelastic properties under the electric field strength of 100 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0165	0.0720	4.3612	0.0213	0.0457	2.1465
0.02	0.0204	0.0748	3.6639	0.0317	0.0591	1.8628
0.05	0.0274	0.1049	3.8340	0.0390	0.0759	1.9464
0.10	0.0383	0.1071	2.7978	0.0490	0.0804	1.6400
0.16	0.0437	0.1531	3.5066	0.0538	0.0967	1.7974
0.25	0.0475	0.1719	3.6230	0.0523	0.1093	2.0901
0.40	0.0500	0.2224	4.4480	0.0698	0.2172	3.1117
0.63	0.0521	0.2301	4.4180	0.0733	0.2373	3.2375
1.00	0.0574	0.2727	4.7547	0.0743	0.3009	4.0499
1.58	0.0726	0.3318	4.5712	0.0843	0.4479	5.3134
2.51	0.0735	0.4589	6.2416	0.1019	0.4527	4.4430
3.98	0.0785	0.6743	8.5857	0.1348	0.6464	4.7953
6.31	0.0917	0.8884	9.6845	0.1411	1.2911	9.1505
10.00	0.1072	1.3411	12.512	0.1436	1.9723	13.735
15.85	0.1128	2.0275	17.978	0.1953	3.0217	15.472
25.12	0.2310	3.5356	15.306	0.1709	3.2104	18.785
39.81	0.2710	5.5152	20.352	0.1987	4.9520	24.922
63.10	0.2498	7.1843	28.766	0.3806	7.0662	18.566
100.00	0.2612	10.872	41.627	0.3966	10.729	27.053

Table J27 The data of the viscoelastic properties under the electric field strength of 200 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	0.0359	0.0851	2.3731	0.0410	0.0579	1.4114
0.02	0.0327	0.0898	2.7487	0.0464	0.0684	1.4738
0.05	0.0358	0.1073	2.9997	0.0518	0.0959	1.8519
0.10	0.0387	0.1399	3.6187	0.0528	0.1236	2.3408
0.16	0.0509	0.1555	3.0544	0.0575	0.1282	2.2311
0.25	0.0573	0.1704	2.9759	0.0589	0.1601	2.7163
0.40	0.0584	0.2281	3.9085	0.0665	0.1811	2.7249
0.63	0.0602	0.2770	4.6018	0.0694	0.2461	3.5451
1.00	0.0609	0.3378	5.5489	0.0701	0.2782	3.9681
1.58	0.0811	0.4645	5.7278	0.0799	0.3767	4.7152
2.51	0.1125	0.4756	4.2291	0.0949	0.6404	6.7512
3.98	0.1371	0.6790	4.9522	0.1055	0.9557	9.0600
6.31	0.1612	1.0148	6.2957	0.1254	1.3975	11.142
10.00	0.1702	1.4603	8.5797	0.1380	2.0707	15.001
15.85	0.1923	2.1579	11.222	0.1461	3.0871	21.124
25.12	0.2205	3.2094	14.553	0.3433	4.6297	13.486
39.81	0.2565	4.8085	18.749	0.3792	5.3461	14.098
63.10	0.3274	8.4550	25.825	0.3935	7.5299	19.136
100.00	0.4281	12.993	30.350	0.5294	11.813	22.314

Table J28 The data of the viscoelastic properties under the electric field strength of 500 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	368.75	71.749	0.1946	314.47	74.642	0.2374
0.02	531.05	75.631	0.1424	335.84	99.314	0.2957
0.05	543.91	82.982	0.1526	340.49	77.068	0.2263
0.10	562.31	95.359	0.1696	382.42	79.529	0.2080
0.16	584.22	106.42	0.1822	409.61	81.172	0.1982
0.25	609.76	107.20	0.1758	518.81	91.751	0.1768
0.40	665.82	112.09	0.1683	521.87	100.90	0.1933
0.63	783.52	114.79	0.1465	581.29	102.84	0.1769
1.00	827.23	115.26	0.1393	591.72	107.92	0.1824
1.58	1024.6	128.38	0.1253	599.93	108.54	0.1809
2.51	1058.4	144.87	0.1369	608.29	113.55	0.1867
3.98	1066.1	149.38	0.1401	617.37	119.20	0.1931
6.31	1231.7	168.44	0.1368	629.67	120.70	0.1917
10.00	1261.7	172.82	0.1370	649.84	127.89	0.1968
15.85	1300.2	177.75	0.1367	666.60	130.68	0.1960
25.12	1354.9	178.59	0.1318	670.88	136.09	0.2029
39.81	1358.1	184.54	0.1359	673.59	143.96	0.2137
63.10	1385.9	190.94	0.1378	724.40	168.19	0.2322
100.00	1386.5	228.67	0.1649	725.99	185.17	0.2551

Table J29 The data of the viscoelastic properties under the electric field strength of 1000 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency	Sample 1			Sample 2		
(rad/s)	G'	G"	tan δ	G'	G"	tan δ
0.01	2001.3	596.30	0.2980	1660.4	531.44	0.3201
0.02	2032.2	607.15	0.2988	1767.0	545.01	0.3084
0.05	2107.5	608.67	0.2888	1786.0	568.39	0.3182
0.10	2124.1	657.18	0.3094	1819.9	570.88	0.3137
0.16	2171.0	695.82	0.3205	1992.7	633.24	0.3178
0.25	2205.1	723.91	0.3283	2007.9	636.29	0.3169
0.40	2457.4	710.17	0.2890	2197.2	640.73	0.2916
0.63	2458.9	720.32	0.2929	2282.2	647.11	0.2835
1.00	2477.1	727.85	0.2938	2354.4	647.58	0.2751
1.58	2529.2	738.82	0.2921	2461.0	650.34	0.2643
2.51	2646.1	745.67	0.2818	2536.6	660.03	0.2602
3.98	2852.8	799.55	0.2803	2583.7	668.70	0.2588
6.31	2940.9	814.19	0.2769	2698.8	685.28	0.2539
10.00	3161.7	820.86	0.2596	2730.3	705.42	0.2584
15.85	3169.1	835.00	0.2635	2753.1	779.98	0.2833
25.12	3197.6	857.47	0.2682	2765.3	789.90	0.2856
39.81	3220.7	863.49	0.2681	2811.4	833.52	0.2965
63.10	3353.3	876.12	0.2613	2937.5	850.43	0.2895
100.00	3390.8	917.85	0.2707	3228.5	933.37	0.2891

Table J30 The data of the viscoelastic properties under the electric field strength of 2000 V/mm in oscillatory shear flow of 20% wt. $HClO_4$ lowly doped polythiophene/silicone oil suspension (LPT20) at 25 ± 0.1 °C

Frequency (rad/s)	Sample 1			Sample 2		
	G'	G"	tan δ	G'	G"	tan δ
0.01	3770.5	824.94	0.2188	3214.6	957.66	0.2979
0.02	4270.2	854.98	0.2002	3918.8	941.80	0.2403
0.05	4904.2	858.99	0.1752	4227.9	1105.6	0.2615
0.10	5045.6	975.46	0.1933	4383.9	1162.1	0.2651
0.16	5140.0	1057.2	0.2057	5000.7	1176.0	0.2352
0.25	5449.4	1128.7	0.2071	5219.6	1192.3	0.2284
0.40	6123.9	1229.1	0.2007	5268.9	1239.4	0.2352
0.63	6463.1	1235.6	0.1912	6004.8	1360.5	0.2266
1.00	6778.4	1303.1	0.1922	6093.7	1380.6	0.2266
1.58	7004.2	1330.5	0.1900	6557.9	1403.5	0.2140
2.51	7104.5	1388.7	0.1955	6815.3	1500.7	0.2202
3.98	7207.8	1393.6	0.1933	7110.5	1592.3	0.2239
6.31	7225.5	1490.8	0.2063	7337.4	1606.8	0.2190
10.00	7481.3	1662.9	0.2223	7548.3	1744.0	0.2310
15.85	7709.6	1751.0	0.2271	7855.2	2084.6	0.2654
25.12	8432.6	2024.3	0.2401	7918.7	2109.2	0.2664
39.81	8538.8	2286.2	0.2677	7989.3	2313.5	0.2896
63.10	9266.3	2744.6	0.2962	8165.5	2729.0	0.3342
100.00	9871.1	3189.3	0.3231	10438	3285.8	0.3148

Appendix K The electrorheological properties under the steady shear measurement

Table K1 The data of the static yield stress values of $HCLO_4$ doped polythiophene/silicone oil suspensions at various electric field strengths

E (V/mm)	Yield Stress (Pa)				
	HPT5	HPT10	HPT20	LPT20	UPT20
10	0.117	0.861	1.079	0.712	0.432
	0.177	0.821	1.079	0.603	0.406
		0.843	1.349	0.771	0.398
100	0.268	1.428	1.726	1.449	1.174
	0.267	1.449	1.749	1.786	1.125
	0.268	1.467	1.788	1.786	1.174
200	0.603	2.158	2.721	2.124	1.756
	0.603	2.182	3.059	2.461	1.729
	0.603	2.202	3.059	2.124	1.748
400	3.456	6.424	12.63	5.159	4.335
	3.120	6.498	11.80	5.497	4.324
	3.288	6.472	11.80	5.497	4.287
500	6.528	12.06	21.24	11.35	9.325
	6.481	12.15	24.61	11.85	8.906
			21.24		
600	7.915	15.78	25.93	13.25	9.672
	7.508	15.41	30.76	13.25	9.726
	7.915	15.57	25.93	13.93	9.713
800	10.85	26.73	54.24	26.19	21.83
	10.74	26.7.3	54.24	24.49	21.47
	10.85	27.36	49.32	26.95	21.58
1000	20.01	42.77	75.00	45.13	32.94
	20.14	44.29	75.00	43.53	44.12
			80.00		

Table K2 The data of the static yield stress values of $HCLO_4$ doped polythiophene/silicone oil suspensions at various electric field strengths

E (V/mm)	Yield Stress (Pa)				
	HPT5	HPT10	HPT20	LPT20	UPT20
1500	37.23	86.50	108.3	89.83	57.65
	39.81	82.20	113.2	101.0	59.24
			123.1		
2000	70.17	142.4	187.3	166.1	93.53
	50.00	149.8	187.3	169.5	99.24
			187.3		
2500	123.4	185.7	244.4	224.4	207.6
	104.2	184.0	262.0	217.6	192.9
			244.4		
3000	123.4	284.5	331.8	289.3	287.0
	129.7	267.0	331.8	326.8	284.9
			358.1		

Table K3 The data of the effect of operating temperature on static yield stress of 20 wt % HClO4 doped polythiophene suspension (HPT20) at various electric field strengths

Temperature (°C)	Yield Stress (Pa)		
	1 kV/mm	2 kV/mm	3 kV/mm
15	31.56	141.7	208.9
	32.16	132.4	209.3
	31.53	133.5	203.6
20	42.82	195.0	321.5
	42.44	185.5	306.3
	42.63	190.3	313.9
25	60.04	216.5	377.2
	60.49	206.4	366.1
	60.27	211.5	371.7
30	77.42	220.4	380.9
	75.11	215.2	376.7
	76.27	217.8	374.3
40	85.34	203.4	369.2
	79.45	203.3	376.6
	91.23	208.4	382.9
50	76.48	197.1	383.2
	78.32	199.3	390.3
	76.30	198.2	386.8
60	82.51	205.5	366.1
	79.49	209.4	
	81.00	207.5	

Table K4 The data of the Effect of addition of Tween20 on the static yield stress of 20 wt % HClO4 doped polythiophene suspension (HPT20) at various electric field strengths

Systems	Yield Stress (Pa)			
	0.5 kV/mm	1 kV/mm	1.5 kV/mm	2 kV/mm
HPT20	21.24	75.00	108.3	187.3
	24.61	75.00	113.2	187.3
	21.24	90.00	123.1	187.3
HPT20 +	21.24	81.95	156.8	246.2
1% wt Tween20	24.61	78.58	160.2	251.3
	24.61	83.05	185.6	281.5
HPT20 +	25.43	91.10	170.6	280.7
3% wt Tween20	20.34	97.71	175.9	290.9
	21.24	91.11	170.5	285.8
HPT20 +	38.98	106.5	178.3	291.6
5% wt Tween20	30.54	106.5	203.6	331.9
	30.54	81.19	190.9	321.9
HPT20 +	37.29	83.90	178.3	326.9
7% wt Tween20	35.60	78.82	182.2	337
	35.60	76.28	185.6	321.9

Appendix L The creep and recovery behaviors of $HClO_4$ doped poly(3-thiopheneacetic acid

Table L1 The data of the %recovery as a function of the applied stress of 20% wt highly doped PTAA suspension under field strength of 1 kV/mm

Applied Stress, σ_o (Pa)	% Recovery		
	Sample 1	Sample 2	Sample 3
5.0	67.4885	67.8852	67.5224
10.0	52.5708	49.7259	47.9067
20.0	37.7310	38.8238	38.5640
30.0	31.2357	31.4747	32.7456
40.0	24.2358	22.2898	22.1846
50.0	20.7027	17.0555	21.0450
60.0	12.4898	11.3986	13.2386
70.0	3.9640	4.1688	4.8312
76.5	0.2844	0.2179	0.2498
80.0	0.0000	0.0000	0.0000

Table L2 The data of creep compliance (J_C), recovery compliance (J_R), and %recovery of 5 %wt. highly doped PTAA suspension (HPT5) at a constant applied stress of 50 Pa under various electric field strengths

E (kV/mm)	J_C (Pa)	J_R (Pa)	% Recovery
1.0	-	-	-
1.5	-	-	-
2.0	0.0423	0.0138	32.7613
	0.0429	0.0128	29.9578
	0.0431	0.0156	36.1576
2.5	0.0350	0.0174	49.7801
	0.0385	0.0176	54.6652
	0.0321	0.0179	46.5153
3.0	0.0302	0.0214	70.9817
	0.0302	0.0218	72.1258
	0.0302	0.0213	70.4839

Table L3 The data of creep compliance (J_C), recovery compliance (J_R), and %recovery of 10 %wt. highly doped PTAA suspension (HPT10) at a constant applied stress of 50 Pa under various electric field strengths

E (kV/mm)	J_C (Pa)	J_R (Pa)	% Recovery
1.0	-	-	-
1.5	0.0318	7.4737E-3	23.5321
	0.0326	7.5002E-3	22.9731
	0.0328	7.4812E-3	22.7757
2.0	0.0264	9.7818E-3	37.1127
	0.0261	9.7060E-3	37.1773
	0.0264	9.7505E-3	36.9372
2.5	0.0229	0.0124	54.1304
	0.0222	0.0125	56.2651
	0.0222	0.0123	55.5328
3.0	0.0180	0.0137	76.4917
	0.0184	0.0138	75.1242
	0.0181	0.0138	76.0340

Table L4 The data of creep compliance (J_C), recovery compliance (J_R), and %recovery of 20 %wt. highly doped PTAA suspension (HPT20) at a constant applied stress of 50 Pa under various electric field strengths

E (kV/mm)	J_C (Pa)	J_R (Pa)	% Recovery
1.0	0.0230	4.7553E-3	20.7027
	0.0258	4.8902E-3	18.9290
	0.0233	4.5329E-3	19.4649
1.5	0.0188	5.8651E-3	31.2473
	0.0186	5.7231E-3	30.7300
	0.0183	5.8963E-3	32.1367
2.0	0.0165	7.1495E-3	43.3019
	0.0164	7.2180E-3	43.9615
	0.0164	7.2486E-3	44.2343
2.5	0.0133	8.7895E-3	66.2152
	0.0132	8.1947E-3	61.8983
	0.0132	8.1699E-3	61.8063
3.0	0.0108	0.0101	93.9033
	0.0106	0.0103	97.2680
	0.0106	0.0104	97.6134

Table L5 The data of creep compliance (J_C), recovery compliance (J_R), and %recovery of 20 %wt. lowly doped PTAA suspension (LPT20) at a constant applied stress of 50 Pa under various electric field strengths

E (kV/mm)	J_C (Pa)	J_R (Pa)	% Recovery
1.0	-	-	-
1.5	0.0285	6.4919E-3	22.7979
	0.0247	6.5840E-3	26.6160
	0.0282	6.1947E-3	21.9754
2.0	0.0257	8.7729E-3	34.1215
	0.0254	8.9988E-3	35.4318
	0.0258	8.7327E-3	33.7852
2.5	0.0218	0.0116	53.3393
	0.0213	0.0117	54.7782
	0.0211	0.0110	52.2509
3.0	0.0193	0.0146	75.6969
	0.0190	0.0143	75.2771
	0.0190	0.0144	75.4217

Table L6 The data of creep compliance (J_C), recovery compliance (J_R), and %recovery of 20 %wt. undoped PTAA suspension (UPT20) at a constant applied stress of 50 Pa under various electric field strengths

E (kV/mm)	J_C (Pa)	J_R (Pa)	% Recovery
1.0	-	-	-
1.5	0.0498	9.3778E-3	18.8439
	0.0483	9.3812E-3	19.4101
	0.0489	9.3711E-3	19.1767
2.0	0.0435	0.0113	26.0946
	0.0430	0.0122	28.3052
	0.0431	0.0125	28.9952
2.5	0.0393	0.0175	44.4410
	0.0383	0.0174	45.3643
	0.0383	0.0176	45.9503
3.0	0.0356	0.0220	61.6269
	0.0323	0.0214	66.3040
	0.0322	0.0215	66.7047

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