REFERENCES

Adams, P.N., Bowman, D., Brown, L., Yang, D. and Mattes, B.R. (2001) Molecular weight dependence of the physical properties of protonated polyaniline films and fibers. Proceedings of SPIE, 4329, 475-481.

Bar-Cohen, Y. (2004) Electroactive polmer (EAP) actuators as artificial muscles : reality, potential, and challenges. Washington: SPIE-The International Society for Optical Engineering.

Bowman, D. and Mattes, B.R. (2005) Conductive fibre prepared from Ultra-high molecular weight polyaniline for smart fabric and interactive textile applications. Synthetic Metals, 154, 29-32.

Camillo, E.C., Constantino, C.J.L., Teruya, M.Y., Alves, N., Mattoso, L.H.C. and Job, A.E. (2005) Dependence of the electrical conductivity and elastomeric properties on sample preparation of blends of polyaniline and natural rubber. Journal of Applied Polymer Science, 97, 1498-1503.

Cao, Y., Andreatta, A., Heeger, A.J and Smith, P. (1989) Influence of chemical polymerization condition on the properties of polyaniline. Institute for Polymer and Organic Solids, University of California, USA.

Chan, H.S.O., Teo, M.Y.B., Khor, E. and Lim, C.N. (1989) Thermogravimetry of acid-doped polyanilines. Journal of Thermal Analysis and Calorimetry, 35, 765-774.

Chandrasekhar, P. (1999) Conducting polymers: Fundamentals and Applications. Boston: Kluwer Academic Publishers.

Chiang, L. Y., Wang, L. Y., Kuo, C. S., Lin, J. G. and Huang, C. Y. (1997) Synthesis of novel conducting elastomers as polyaniline-interpenetrated networks of fullerenol-polyurethanes. Synthetic Metals, 84, 721-724.

Chwang, C., Liu, C., Huang, S. and Chao, D. (2004) Synthesis and characterization of high dielectric constant polyaniline/polyurethane blends. Synthetic Metals, 142, 275-281.

Dick, J. S. (2001) Rubber Technology compounding and testing for Performance. Cincinnati: Hanser Gardner Publications.

Faez, R., Gazotti, W.A. and De Paoli, M. (1999) An elastomeric conductor based on polyaniline prepared by mechanical mixing. Polymer, 40, 5497-5503.

Heeger, A.J. (2001) The semiconducting and metallic polymers: The fourth generation of polymeric materials. Reviews of Modern Physics, 73, 681-700.

Henon, J.M. and Nicolas, D. (1989) The composition of latex from Hevea brasiliensis as a laticiferous cytoplasm. In D'Auzac, J. Jacob, J.L. and Chrestin, H (Eds.), Physicology of rubber tree latex (pp. 59-88). Florida: CRC Press.

Hirase, R., Hasegawa, M. and Shirai, M. (2003) Conductive fibers based on poly(ethylene terephthalate)-polyaniline composite manufactured by electrochemical polymerization. Journal of Applied Polymer Science, 87, 1073-1078.

Ho, C.C., Kondon, T. And Ohshima, H. (1996) Surface structure of natural rubber latex particles from electrophoretic mobility data. Journal of Natural Rubber Research, 178, 442-445.

Hofmann, W. (1989) Rubber Technology Handbook. New York: Hanser Publishers.

Jeevananda, T. and Siddaramaiah. (2001) Thermal and morphological studies on ethylene-vinyl acetate copolymer-polyaniline blends. Thermochimica, 376, 51-61.

Jia, W., Tchoudakov, R., Segel, E., Joseph, R., Narkis, M. and Siegmann, A. (2003) Electrically conductive composites based on epoxy resin with polyaniline-DBSA fillers. Synthetic Metals, 132, 269-278.

Jianming, J., Wei, P., Shenglin, Y. and Guang, Li. (2005) Electrically conductive PANI-DBSA/Co-PAN composite fibers prepared by wet spinning. Synthetic Metals, 149, 181-186.

Job, A.E., Constantino, C.J.L., Mendes, T.S.G., Teruya, M.Y., Alves, N. and Mattoso, L.H.C. (2003) Effect of natural rubber latex on the conducting state of polyaniline blends determined by raman spectroscopy. Journal of Raman Spectroscopy, 34, 831-836.

Job, A.E., Oliveira, F.A., Alves, N., Giacometti, J.A. and Matosa, L.H.C. (2003) Conductive composites of natural rubber and carbon black for pressure sensors. Synthetic Metals, 135-136, 99-100.

Kang, E.T., Neoh, K.G., Tan, K.L. (1998) Polyaniline: A polymer with many interesting intrinsic redox states. Process in Polymer Science. 23, 277-324.

Kang, H., Kang, M.Y. and Hun, K. (2000) Identification of natural rubber and characterization of rubber biosynthetic activity in fig tree. Plant Physiology, 123, 1133-1142.

Koul, S., Chandra, R. and Dhawan, S.K. (2000) Conducting polyanilne composite for ESD and EMI at 101 GHz. Polymer, 41, 9305-9310.

Kraft, A., Grimsdale, A.C. and Holmes, A.B. (1998) Electroluminescent Conjugated Polymers - Seeing Polymers in a New Light. Angewandte Chemie International Edition, 37, 403-428.

Kyokane, J., Tokugi, K., Uranishi, D., Miyata, M., Ueda, T. and Yoshino, K. (2001) Application to actuators of fullerenol doped polyurethane elastomer (PUE). Synthetic Metals, 121, 1129-1130.

Laska, J., Zak, K. and Pron, A. (1997) Conducting blends of polyaniline with conventional polymers. Synthetic Metals, 84, 117-118.

MacDiarmid, A.G. (2001) Synthetic metal: A novel role for organic polymers. Review of Modern Physics, 73, 701-712.

Mattes, B.R., Wang, H.L., Yang, D., Zhu, Y.T., Blumenthal, W.R. and Hundley, M.F. (1997) Formation of conductive polyaniline fibers derived from highly concentrated emeraldine base solutions. Synthetic Metals, 84, 45-49.

McQuade, D.T., Pullen, A.E. and Swager, T.M. (2000) Conjugated polymer-based chemical sensors. Chemical reviews, 100, 2537-2574.

Mitschke, U., and Bäuerle, P. (2000) The electroluminescence of organic materials. Journal of Materials Chemistry, 10, 1471-1507.

Moreno, R.M.B., Medeiros, E.S., Ferreira, F.C., Alves, N., Goncalves, P.S. and Mattoso, L.H.C. (2006) Thermogravimetric studies of decomposition kinetics of six different IAC Hevea rubber clones using Flynn-Wall-Ozawa approach. Plastics, Rubber and Composites, 35, 15-21.

Nalva, H.S. (Ed.) (1997) Handbook of Organic Conductive Molecules and Polymers. New York: Wiley.

Nor, H.M. and Ebdon, J.R. (2000). Ozonolysis of natural rubber in chloroform solution Part 1. A study by GPC and FTIR spectroscopy. Polymer, 41, 2359-2365.

Pan, W., Yang, S.L., Li, G. And Jiang, J.M. (2005) Electrical and structural analysis of conducitve polyaniline/polyacrylonitrile composites. European Polymer Journal, 41, 2127-2133.

Parhi, P., Ramanan, A. and Ray, A.R. (2006) Preparation and characterization of alginate and hydroxyapatite-based biocomposite. Journal of Applied Polymer Science, 102, 5162-5165.

Peethambaran, N.R., Kuriakose, B., Rajan, M. and Kuriakose, A.P. (1990) Rheological behavior of natural rubber latex in the presence of surface-active agents. Journal of Applied Polymer Science, 41, 975-983.

Pendle T.D., Swinyard, P.E. (1991) The particle size of natural rubber latex concentrates by photon correlation spectroscopy. Journal of Natural Rubber Research, 6, 1-2.

Pomfret, S.J., Adams, P.N., Comfort, N.P. and Monkman, A.P. (2000) Electrical and mechanical properties of polyaniline fibres produced by a one-step wet spinning process. Polymer, 41, 2265-2269.

Puvanatvattana, T., Chotpattananont, D., Hiamtup, P., Niamlang, S., Sirivat, A. and Jamieson, A.M. (2006) Electric field induced stress moduli in polythiophene/polyisoprene elastomer blends. Reactive and Functional Polymers, 66, 1575-1588.

Qi, B., Lu, W. and Mattes, B.R. (2004) Strain and Energy Efficiency of Polyaniline Fiber Electrochemical Actuators in Aqueous Electrolytes. The Journal of Physical Chemistry B, 108, 6222-6227.

Roberts, A.D. (1988) Latex concentrates: properties and composition. Natural Rubber Science and Technology. New York: Oxford University Press.

Salaneck, W.R., Luncstrom, I. and Ranby, B. (1993) Conjugated polymer and related materials: The interaction of chemical and electronic structure. New york: Oxford Science Publications.

Schmidt, V., Domenech, S.C., Soldi, M.S., Pinheiro, E.A. and Soldi, V. (2004) Thermal stability of polyaniline/ethylene propylene diene rubber blends

prepared by solvent casting. Polymer Degradation and Stability, 83, 519-527.

Shirakawa, H. (2001) The discovery of polyacetylene film-the dawning of an era of conducting polymers. Review of Modern Physics, 73, 713-718.

Shirakawa, H., Louis, E.J., MacDiarmid, A.G., Chiang, C.K. and Heeger, A.J. (1977) Synthesis of electrically conducting organic polymers: halogen derivatives of polyacetylene, $(CH)_x$. Journal of the Chemical Society, Chemical Communications, 578-580.

Skotheim, T.A., Elsenbaumer, R.L. and Reynolds, J.R. (Eds.) (1998) Handbook of Conducting Polymers. New York: Marcel Dekker.

Souza Jr, F.G., Soares, B.G., Mantovani, G.L., Manjunath, A., Somashekarappa, H., Somashekar, R. and Siddaramaiah. (2006) Blends of styrene butadiene styrene TRI block copolymer/polyaniline-Characterization by WAXS. Polymer, 47, 2163-2171.

Stejskal, J., Kratochvil, P. and Jenkins, A.D. (1996) The formation of polyaniline and the nature of its structures. Polymer, 37(2), 367-369.

Thanpitcha, T., Sirivat, A., Jamieson, A.M. and Rujiravanit, R. (2006) Preparation and characterization of polyaniline/chitosan blend film. Carbohydrate Polymers, 64, 560-568.

Tzou, K.T. and Gregory, R.V. (1995). Improved solution stability and spinnability of concentrated polyaniline solutions using N,N'-Dimethyl propylene urea as the spin bath solvent. Synthetic Metals, 69, 109-112.

Virtanen, E., Laakso, J., Ruohonen, H., Vakiparta, K., Jarvinen, H., Jussila, M., Passiniemi, P. and Osterholm, J.-E. (1997) Electrically conductive compositions based on processible polyanilines-PANIPOL^{TM}. Synthetic Metals, 84, 113-114.

Wang, H.L.; Romero, R.J. and Mattes, B.R. (2000) Effect of processing conditions on the properties of high molecular weight conductive polyaniline fiber. Journal of Polymer Science Part B: Polymer Physics, 38,194.

Weder, C. and Greiner, A. (2001) In Encyclopedia of Polymer Science and Technology, Kroschwitz, J. I. (Ed.), Light-Emitting Diodes (pp. 87-100). New York: Wiley-Interscience.

Xue, H., Shen, Z. and Li, Y. (2001) Polyaniline-polyisoprene composite film based glucose biosensor with high permselectivity. Synthetic Metals, 124, 345-349.

Yang, D., Fadeev, A., Adams, P.N. and Mattes, B.R. (2001) Controlling macrovoid formation in wet-spun polyaniline fibers. Proceedings of SPIE, 4329, 59-71.

Yong, K.C., Foot, P.J.S., Morgan, H., Cook, S. and Tinker, A.J. (2006) Conductive poly(butadiene-co-acrylonitrile)-polyaniline dodecylbenzenesulfonate [NBR-PAni.DBSA] blends prepared in solution. European Polymer Journal, 42, 1716-1727.

Yoshikawa. H., Hino, T. and Kuramoto, N. (2006) Effect of temperature and moistue on electrical conductivity in polyaniline/polyurethane (PANI/PU) blends. Synthetic Metals, 156, 1187-1193.

Yu, Y., Zhihuai, S., Chen, S., Bian, C., Chen, W. and Xue, G. (2006) Facile Synthesis of Polyaniline-Sodium Alginate Nanofibers. Langmuir, 22, 3899-3905.

Yuping, D., Shunhua, L. and Hongtao, G. (2005) Investigation of electrical conductivity and electromagnetic shielding effectiveness of polyaniline composite. Science and Technology of Advanced Materials, 6, 513-518.

Zeng, X.R. and Ko, T.M. (1998). Structure and properties of chemically reduced polyaniline. Polymer, 39(5), 1187-1195.

Zhang, Q., Jin, H., Wang, X. and Jin, X. (2001) Morphology of conductive blend fibers of polyaniline and polyamide-11. Synthetic Metals, 123, 481-485.

Zhang, W. and MacDiaramid, A.G. (1995) Conformation effect in doped polyaniline: protonation of amine and imine sites vs protonation of only imine sites. Polymer Reprints, 26(2), 73-74.

Zrínyi, M., Fehér, J. and Filipcsei, G. (2000) Novel gel Actuator containing TiO_2 particles operated under static electric field. Macromolecules, 33, 5751-5753.

APPENDICES

Appendix A Determination of Particle Size of Undoped Polyaniline

Table A1 Raw data from particle size analysis of undoped PANI, which has average diameter of 20.75 μm

Size Low (μm)	In %	Size High (μm)	Under %	Size Low (μm)	In %	Size High (μm)	Under %
0.20	0.00	0.48	0.00	8.48	8.03	10.27	29.35
0.48	0.00	0.59	0.00	10.27	9.11	12.43	38.46
0.59	0.00	0.71	0.00	12.43	9.68	15.05	48.13
0.71	0.00	0.86	0.00	15.05	9.63	18.21	57.76
0.86	0.00	1.04	0.00	18.21	9.03	22.04	66.78
1.04	0.00	1.26	0.00	22.04	8.09	26.68	74.88
1.26	0.11	1.52	0.11	26.68	7.04	32.29	81.92
1.52	0.20	1.84	0.30	32.29	5.89	39.08	87.81
1.84	0.31	2.23	0.62	39.08	4.57	47.30	92.38
2.23	0.52	2.70	1.13	47.30	3.25	57.25	95.63
2.70	0.88	3.27	2.02	57.25	2.14	69.30	97.77
3.27	1.51	3.95	3.52	69.30	1.32	83.87	99.09
3.95	2.43	4.79	5.95	83.87	0.73	101.52	99.81
4.79	3.65	5.79	9.60	101.52	0.18	122.87	100.00
5.79	5.10	7.01	14.70	122.87	0.00	148.72	100.00
7.01	6.62	8.48	21.32	148.72	0.00	180.00	100.00
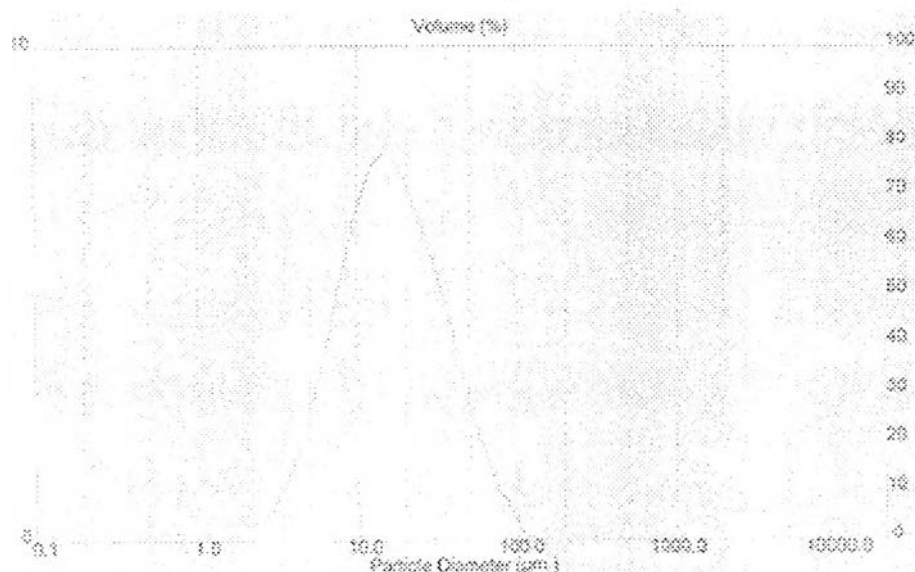
Figure A1 Particle size distribution histogram of undoped PANI, which has average diameter of 20.75 μm.

Table A2 Raw data from particle size analysis of undoped PANI, which has average diameter of 20.65 μm

Size Low (μm)	In %	Size High (μm)	Under %	Size Low (μm)	In %	Size High (μm)	Under %
0.20	0.00	0.48	0.00	8.48	8.01	10.27	29.37
0.48	0.00	0.59	0.00	10.27	9.09	12.43	38.46
0.59	0.00	0.71	0.00	12.43	9.67	15.05	48.13
0.71	0.00	0.86	0.00	15.05	9.66	18.21	57.79
0.86	0.00	1.04	0.00	18.21	9.09	22.04	66.88
1.04	0.02	1.26	0.02	22.04	8.18	26.68	75.06
1.26	0.10	1.52	0.12	26.68	7.11	32.29	82.17
1.52	0.19	1.84	0.31	32.29	5.90	39.08	88.07
1.84	0.31	2.23	0.62	39.08	4.52	47.30	92.58
2.23	0.53	2.70	1.15	47.30	3.17	57.25	95.75
2.70	0.89	3.27	2.04	57.25	2.07	69.30	97.82
3.27	1.52	3.95	3.56	69.30	1.29	83.87	99.11
3.95	2.44	4.79	6.00	83.87	0.72	101.52	99.82
4.79	3.65	5.79	9.65	101.52	0.17	122.87	100.00
5.79	5.09	7.01	14.75	122.87	0.00	148.72	100.00
7.01	6.61	8.48	21.36	148.72	0.00	180.00	100.00
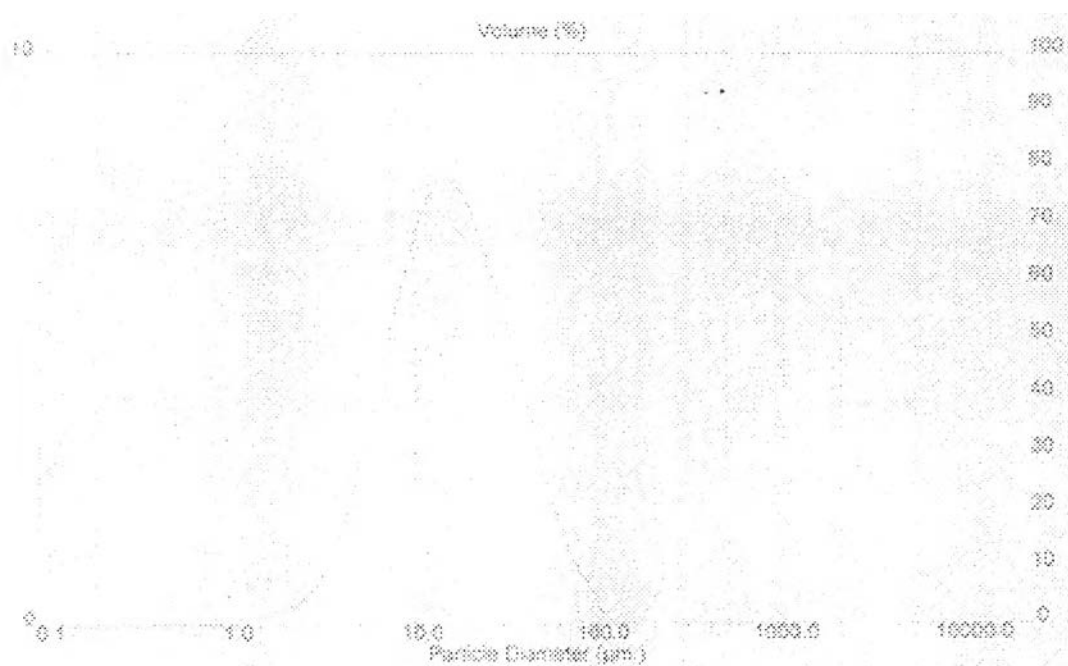
Figure A2 Particle size distribution histogram of undoped PANI, which has average diameter of 20.65 μm.

Table A3 Raw data from particle size analysis of undoped PANI, which has average diameter of 20.71 μm

Size Low (μm)	In %	Size High (μm)	Under %	Size Low (μm)	In %	Size High (μm)	Under %
0.20	0.00	0.48	0.00	8.48	8.01	10.27	29.44
0.48	0.00	0.59	0.00	10.27	9.09	12.43	38.53
0.59	0.00	0.71	0.00	12.43	9.64	15.05	48.17
0.71	0.00	0.86	0.00	15.05	9.58	18.21	57.75
0.86	0.00	1.04	0.00	18.21	8.98	22.04	66.73
1.04	0.01	1.26	0.01	22.04	8.07	26.68	74.81
1.26	0.10	1.52	0.12	26.68	7.06	32.29	81.86
1.52	0.19	1.84	0.31	32.29	5.94	39.08	87.81
1.84	0.32	2.23	0.63	39.08	4.63	47.30	92.44
2.23	0.54	2.70	1.18	47.30	3.29	57.25	95.73
2.70	0.91	3.27	2.09	57.25	2.13	69.30	97.86
3.27	1.53	3.95	3.62	69.30	1.27	83.87	99.13
3.95	2.45	4.79	6.08	83.87	0.68	101.52	99.81
4.79	3.66	5.79	9.73	101.52	0.18	122.87	100.00
5.79	5.09	7.01	14.83	122.87	0.00	148.72	100.00
7.01	6.61	8.48	21.43	148.72	0.00	180.00	100.00

Figure A3 Particle size distribution histogram of undoped PANI, which has average diameter of 20.71 μm.

Table A4 Raw data from particle size analysis of undoped PANI, which has average diameter of 20.96 µm

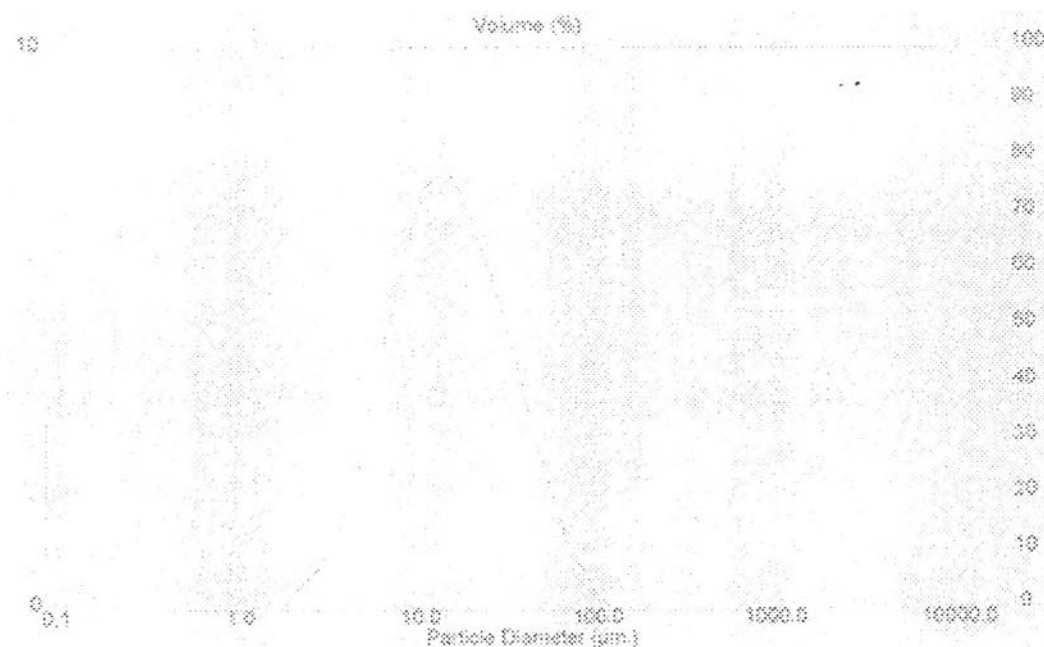| Size Low (µm)	In %	Size High (µm)	Under %	Size Low (µm)	In %	Size High (µm)	Under %
0.20	0.00	0.48	0.00	8.48	7.97	10.27	29.22
0.48	0.00	0.59	0.00	10.27	9.04	12.43	38.26
0.59	0.00	0.71	0.00	12.43	9.59	15.05	47.85
0.71	0.00	0.86	0.00	15.05	9.53	18.21	57.38
0.86	0.00	1.04	0.00	18.21	8.95	22.04	66.33
1.04	0.00	1.26	0.00	22.04	8.05	26.68	74.39
1.26	0.11	1.52	0.11	26.68	7.06	32.29	81.45
1.52	0.20	1.84	0.31	32.29	5.97	39.08	87.41
1.84	0.32	2.23	0.63	39.08	4.68	47.30	92.10
2.23	0.53	2.70	1.15	47.30	3.36	57.25	95.45
2.70	0.89	3.27	2.04	57.25	2.20	69.30	97.66
3.27	1.51	3.95	3.55	69.30	1.34	83.87	99.00
3.95	2.42	4.79	5.98	83.87	0.75	101.52	99.76
4.79	3.63	5.79	9.60	101.52	0.24	122.87	100.00
5.79	5.07	7.01	14.67	122.87	0.00	148.72	100.00
7.01	6.58	8.48	21.25	148.72	0.00	180.00	100.00

Figure A4 Particle size distribution histogram of undoped PANI, which has average diameter of 20.96 µm.

61

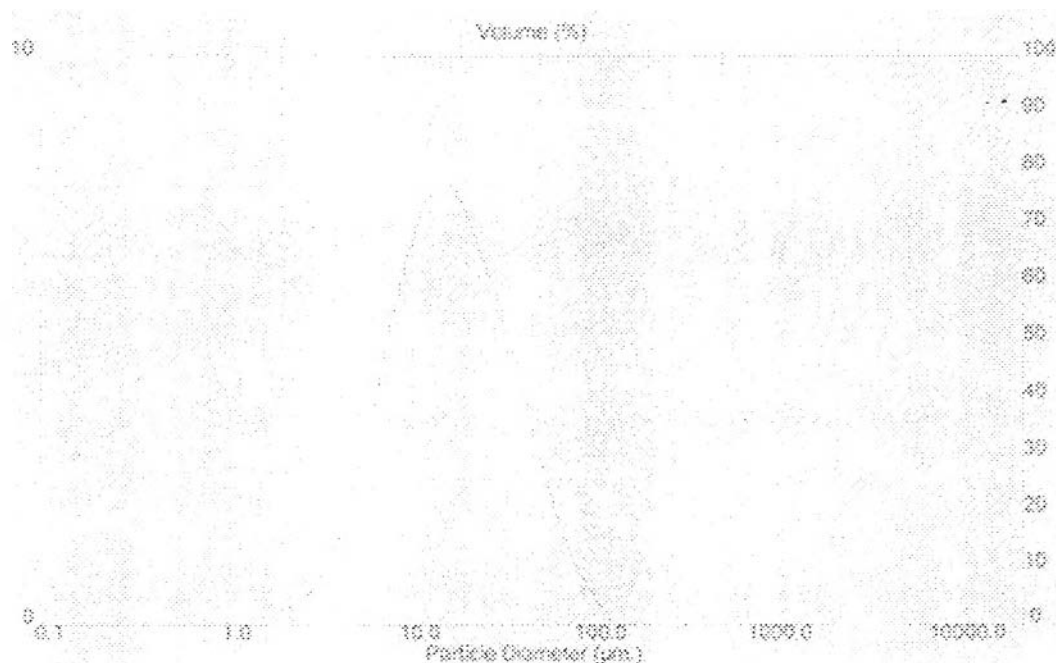**Table A5** Raw data from particle size analysis of undoped PANI, which has average diameter of 20.73 μm

Size Low (μm)	In %	Size High (μm)	Under %	Size Low (μm)	In %	Size High (μm)	Under %
0.20	0.00	0.48	0.00	8.48	7.97	10.27	29.22
0.48	0.00	0.59	0.00	10.27	9.04	12.43	38.26
0.59	0.00	0.71	0.00	12.43	9.59	15.05	47.85
0.71	0.00	0.86	0.00	15.05	9.53	18.21	57.38
0.86	0.00	1.04	0.00	18.21	8.95	22.04	66.33
1.04	0.00	1.26	0.00	22.04	8.05	26.68	74.39
1.26	0.11	1.52	0.11	26.68	7.06	32.29	81.45
1.52	0.20	1.84	0.31	32.29	5.97	39.08	87.41
1.84	0.32	2.23	0.63	39.08	4.68	47.30	92.10
2.23	0.53	2.70	1.15	47.30	3.36	57.25	95.45
2.70	0.89	3.27	2.04	57.25	2.20	69.30	97.66
3.27	1.51	3.95	3.55	69.30	1.34	83.87	99.00
3.95	2.42	4.79	5.98	83.87	0.75	101.52	99.76
4.79	3.63	5.79	9.60	101.52	0.24	122.87	100.00
5.79	5.07	7.01	14.67	122.87	0.00	148.72	100.00
7.01	6.58	8.48	21.25	148.72	0.00	180.00	100.00

Figure A5 Particle size distribution histogram of undoped PANI, which has average diameter of 20.73 μm.

Appendix B Diameter Measurement of PANI/NR Composite Fiber

Table B1 Raw data of diameter measurement of neat natural rubber fiber (comprising sodium alginate but no PANI)

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.840	0.835	0.845	0.830	0.829
2	0.892	0.890	0.885	0.905	0.900
3	0.913	0.911	0.905	0.904	0.927
4	0.836	0.831	0.841	0.826	0.834
5	0.805	0.798	0.815	0.794	0.796
6	0.838	0.833	0.843	0.828	0.836
7	0.841	0.836	0.846	0.831	0.840
8	0.808	0.802	0.818	0.798	0.800
9	0.875	0.877	0.869	0.885	0.880
10	0.853	0.849	0.856	0.843	0.855
11	0.817	0.811	0.826	0.807	0.811
12	0.855	0.850	0.857	0.845	0.857
13	0.869	0.865	0.869	0.859	0.874
14	0.831	0.826	0.837	0.821	0.828
15	0.833	0.843	0.828	0.837	0.827
16	0.843	0.838	0.847	0.833	0.842
17	0.798	0.792	0.810	0.788	0.787
18	0.815	0.808	0.824	0.804	0.808
19	0.879	0.875	0.877	0.869	0.886
20	0.833	0.828	0.839	0.823	0.830

Average diameter   0.840

STD   0.0334

Table B2 Raw data of diameter measurement of PANI/NR composite fiber with 0.5% w/w PANI content

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.863	0.859	0.866	0.867	0.854
2	0.855	0.857	0.843	0.873	0.849
3	0.809	0.816	0.818	0.824	0.806
4	0.841	0.841	0.846	0.849	0.834
5	0.861	0.862	0.848	0.879	0.855
6	0.818	0.823	0.825	0.830	0.813
7	0.824	0.828	0.831	0.835	0.819
8	0.882	0.873	0.883	0.882	0.871
9	0.856	0.857	0.843	0.873	0.850
10	0.823	0.827	0.831	0.835	0.818
11	0.822	0.826	0.829	0.833	0.817
12	0.836	0.840	0.824	0.849	0.828
13	0.902	0.889	0.901	0.898	0.889
14	0.882	0.881	0.870	0.905	0.879
15	0.897	0.885	0.896	0.893	0.884
16	0.816	0.822	0.804	0.825	0.805
17	0.923	0.905	0.919	0.914	0.907
18	0.946	0.924	0.940	0.933	0.928
19	0.867	0.868	0.855	0.887	0.863
20	0.877	0.869	0.878	0.877	0.866

Average diameter   0.861

STD   0.0355

Table B3 Raw data of diameter measurement of PANI/NR composite fiber with 1% w/w PANI content

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.847	0.841	0.849	0.836	0.839
2	0.845	0.831	0.834	0.817	0.815
3	0.892	0.891	0.896	0.884	0.889
4	0.884	0.871	0.876	0.860	0.851
5	0.903	0.903	0.907	0.895	0.900
6	0.956	0.961	0.961	0.951	0.958
7	0.942	0.932	0.939	0.923	0.905
8	0.918	0.920	0.923	0.912	0.917
9	0.876	0.863	0.867	0.851	0.844
10	0.938	0.927	0.934	0.918	0.900
11	0.973	0.980	0.978	0.969	0.977
12	0.892	0.890	0.895	0.883	0.888
13	0.830	0.823	0.832	0.818	0.820
14	0.873	0.860	0.864	0.848	0.841
15	0.860	0.855	0.862	0.849	0.853
16	0.865	0.862	0.868	0.855	0.859
17	0.998	1.008	1.004	0.996	1.005
18	0.981	0.972	0.979	0.965	0.940
19	0.889	0.887	0.892	0.880	0.885
20	0.885	0.883	0.888	0.876	0.880

Average diameter	0.894
STD	0.0504

Table B4 Raw data of diameter measurement of PANI/NR composite fiber with 2% w/w PANI content

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.934	0.947	0.933	0.920	0.918
2	0.984	0.971	0.953	0.952	0.965
3	0.963	0.981	0.968	0.951	0.950
4	0.860	0.857	0.841	0.839	0.836
5	0.859	0.844	0.841	0.838	0.866
6	0.846	0.840	0.824	0.824	0.820
7	0.878	0.879	0.864	0.859	0.856
8	0.866	0.865	0.849	0.846	0.843
9	0.887	0.872	0.866	0.863	0.888
10	0.870	0.870	0.855	0.851	0.848
11	0.847	0.842	0.826	0.826	0.822
12	0.845	0.839	0.823	0.823	0.819
13	0.859	0.844	0.841	0.838	0.866
14	0.852	0.848	0.833	0.831	0.828
15	0.924	0.910	0.899	0.897	0.917
16	0.856	0.852	0.837	0.835	0.832
17	0.885	0.870	0.864	0.862	0.886
18	0.917	0.926	0.912	0.901	0.899
19	0.888	0.892	0.877	0.870	0.868
20	0.844	0.838	0.822	0.822	0.819

Average diameter 0.872

STD 0.0428

Table B5 Raw data of diameter measurement of PANI/NR composite fiber with 5% w/w PANI content

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.850	0.848	0.843	0.845	0.843
2	0.842	0.839	0.836	0.838	0.835
3	0.785	0.779	0.782	0.789	0.780
4	0.794	0.788	0.790	0.796	0.788
5	0.808	0.804	0.804	0.809	0.802
6	0.820	0.819	0.823	0.818	0.824
7	0.812	0.808	0.808	0.812	0.806
8	0.847	0.843	0.844	0.842	0.850
9	0.858	0.856	0.851	0.852	0.850
10	0.868	0.868	0.861	0.861	0.860
11	0.853	0.851	0.846	0.847	0.845
12	0.794	0.795	0.801	0.794	0.799
13	0.816	0.812	0.811	0.816	0.810
14	0.840	0.837	0.834	0.836	0.833
15	0.772	0.765	0.770	0.778	0.768
16	0.823	0.820	0.818	0.822	0.817
17	0.806	0.802	0.802	0.807	0.801
18	0.773	0.777	0.784	0.775	0.779
19	0.845	0.842	0.838	0.840	0.837
20	0.818	0.816	0.820	0.815	0.821

Average diameter   0.819

STD   0.0271

Table B6 Raw data of diameter measurement of PANI/NR composite fiber with 10% w/w PANI content

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.881	0.858	0.847	0.842	0.842
2	0.882	0.858	0.847	0.842	0.843
3	0.840	0.830	0.824	0.825	0.827
4	0.887	0.863	0.851	0.847	0.847
5	0.887	0.875	0.872	0.871	0.868
6	0.947	0.914	0.900	0.900	0.898
7	0.899	0.886	0.884	0.883	0.878
8	0.913	0.885	0.872	0.869	0.869
9	0.848	0.837	0.832	0.832	0.834
10	0.854	0.835	0.825	0.820	0.822
11	0.875	0.863	0.860	0.859	0.857
12	0.852	0.833	0.823	0.818	0.821
13	0.894	0.869	0.857	0.853	0.852
14	0.866	0.855	0.851	0.851	0.849
15	0.924	0.894	0.881	0.878	0.874
16	0.887	0.863	0.851	0.847	0.847
17	0.874	0.862	0.859	0.859	0.856
18	0.876	0.864	0.861	0.861	0.858
19	0.841	0.823	0.814	0.807	0.808
20	0.881	0.857	0.846	0.842	0.842

Average diameter 0.856

STD 0.0284

Appendix C Diameter Measurement of PANI/NR Composite Fiber Doped with 1 M HCl for 24 h

Table C1 Raw data of diameter measurement of neat natural rubber fiber (comprising sodium alginate but no PANI) doped with 1 M HCl for 24 h

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.828	0.845	0.834	0.826	0.824
2	0.842	0.855	0.847	0.838	0.837
3	0.842	0.855	0.847	0.838	0.835
4	0.796	0.802	0.799	0.795	0.804
5	0.815	0.836	0.821	0.816	0.812
6	0.809	0.831	0.810	0.806	0.813
7	0.797	0.822	0.803	0.800	0.796
8	0.830	0.846	0.835	0.825	0.829
9	0.890	0.889	0.894	0.878	0.872
10	0.878	0.879	0.866	0.865	0.861
11	0.822	0.802	0.799	0.795	0.804
12	0.825	0.806	0.803	0.799	0.807
13	0.818	0.837	0.823	0.814	0.820
14	0.826	0.843	0.831	0.824	0.821
15	0.849	0.860	0.854	0.844	0.842
16	0.852	0.862	0.857	0.847	0.845
17	0.831	0.847	0.836	0.826	0.829
18	0.780	0.810	0.786	0.786	0.792
19	0.828	0.810	0.806	0.802	0.810
20	0.816	0.836	0.822	0.813	0.819

Average diameter   0.831

STD   0.0272

Table C2 Raw data of diameter measurement of PANI/NR composite fiber with 0.5% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.805	0.816	0.828	0.842	0.848
2	0.840	0.821	0.828	0.838	0.851
3	0.861	0.857	0.863	0.872	0.878
4	0.822	0.797	0.810	0.838	0.844
5	0.807	0.796	0.811	0.827	0.834
6	0.816	0.805	0.819	0.834	0.840
7	0.832	0.810	0.820	0.831	0.845
8	0.813	0.802	0.816	0.831	0.838
9	0.806	0.776	0.795	0.811	0.827
10	0.830	0.808	0.818	0.844	0.850
11	0.835	0.838	0.847	0.858	0.865
12	0.856	0.843	0.844	0.852	0.863
13	0.840	0.828	0.838	0.851	0.857
14	0.826	0.803	0.815	0.841	0.847
15	0.866	0.857	0.854	0.860	0.870
16	0.812	0.821	0.832	0.846	0.852
17	0.812	0.784	0.801	0.815	0.831
18	0.825	0.814	0.827	0.841	0.847
19	0.842	0.824	0.830	0.840	0.852
20	0.811	0.800	0.815	0.830	0.836

Average diameter	0.831
STD	0.0211

Table C3 Raw data of diameter measurement of PANI/NR composite fiber with 1% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.814	0.806	0.781	0.789	0.771
2	0.823	0.802	0.807	0.797	0.809
3	0.828	0.808	0.813	0.805	0.815
4	0.830	0.831	0.812	0.816	0.809
5	0.824	0.804	0.809	0.799	0.811
6	0.818	0.812	0.789	0.796	0.781
7	0.819	0.797	0.803	0.791	0.804
8	0.816	0.809	0.785	0.792	0.792
9	0.819	0.813	0.789	0.796	0.781
10	0.825	0.802	0.807	0.797	0.810
11	0.834	0.838	0.821	0.824	0.828
12	0.827	0.827	0.807	0.812	0.814
13	0.818	0.812	0.788	0.795	0.796
14	0.814	0.805	0.780	0.787	0.769
15	0.808	0.783	0.791	0.774	0.791
16	0.827	0.807	0.811	0.802	0.814
17	0.841	0.849	0.834	0.835	0.836
18	0.822	0.819	0.797	0.803	0.791
19	0.813	0.790	0.797	0.782	0.797
20	0.834	0.837	0.819	0.822	0.826

Average diameter 0.808

STD 0.0169

Table C4 Raw data of diameter measurement of PANI/NR composite fiber with 2% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.812	0.839	0.814	0.833	0.823
2	0.822	0.858	0.832	0.850	0.834
3	0.819	0.820	0.830	0.848	0.832
4	0.825	0.864	0.838	0.856	0.837
5	0.834	0.880	0.853	0.871	0.847
6	0.816	0.818	0.851	0.825	0.844
7	0.823	0.861	0.835	0.853	0.836
8	0.843	0.899	0.872	0.888	0.858
9	0.835	0.834	0.855	0.872	0.848
10	0.816	0.846	0.821	0.840	0.827
11	0.840	0.893	0.866	0.882	0.854
12	0.834	0.881	0.855	0.872	0.848
13	0.852	0.910	0.882	0.898	0.864
14	0.833	0.832	0.878	0.851	0.868
15	0.817	0.852	0.827	0.845	0.831
16	0.821	0.857	0.831	0.850	0.833
17	0.857	0.853	0.918	0.889	0.869
18	0.848	0.908	0.880	0.896	0.863
19	0.811	0.837	0.812	0.831	0.822
20	0.859	0.855	0.922	0.893	0.871

Average diameter   0.847

STD   0.0266

Table C5 Raw data of diameter measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h

Sample No	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.828	0.858	0.859	0.829	0.868
2	0.860	0.915	0.922	0.881	0.922
3	0.845	0.889	0.894	0.858	0.898
4	0.884	0.888	0.853	0.893	0.827
5	0.855	0.906	0.913	0.873	0.841
6	0.865	0.923	0.932	0.888	0.930
7	0.846	0.891	0.896	0.859	0.899
8	0.839	0.877	0.847	0.887	0.823
9	0.857	0.909	0.916	0.876	0.843
10	0.858	0.911	0.918	0.877	0.918
11	0.833	0.868	0.870	0.838	0.877
12	0.879	0.948	0.960	0.954	0.868
13	0.874	0.940	0.950	0.904	0.946
14	0.915	0.922	0.881	0.922	0.847
15	0.884	0.958	0.971	0.921	0.963
16	0.882	0.953	0.966	0.916	0.959
17	0.836	0.873	0.876	0.843	0.820
18	0.834	0.870	0.872	0.840	0.879
19	0.914	0.921	0.880	0.921	0.846
20	0.844	0.887	0.891	0.855	0.895

Average diameter   0.888

STD   0.0379

Table C6 Raw data of diameter measurement of PANI/NR composite fiber with 10% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Diameter Measurement (mm)				
	1	2	3	4	5
1	0.856	0.849	0.845	0.866	0.847
2	0.839	0.833	0.807	0.826	0.845
3	0.841	0.815	0.835	0.855	0.837
4	0.837	0.831	0.824	0.842	0.826
5	0.874	0.865	0.839	0.864	0.887
6	0.831	0.826	0.817	0.835	0.820
7	0.851	0.844	0.839	0.859	0.841
8	0.812	0.786	0.801	0.817	0.805
9	0.867	0.840	0.866	0.889	0.867
10	0.892	0.882	0.855	0.883	0.909
11	0.856	0.849	0.845	0.866	0.847
12	0.844	0.837	0.811	0.831	0.850
13	0.826	0.821	0.795	0.812	0.815
14	0.839	0.833	0.826	0.845	0.829
15	0.853	0.846	0.819	0.841	0.843
16	0.881	0.872	0.845	0.872	0.873
17	0.831	0.837	0.824	0.842	0.826
18	0.833	0.827	0.801	0.819	0.822
19	0.865	0.857	0.854	0.876	0.856
20	0.845	0.838	0.832	0.851	0.834

Average diameter   0.842

STD   0.0223

Appendix D Mechanical Properties of PANI/NR Composite Fiber

Table D1 Raw data of mechanical properties of neat natural rubber fiber (comprising sodium alginate but no PANI)

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08695	434.8	4.4854	1.0317	857.50
2	0.09843	492.2	4.6783	0.9506	859.64
3	0.10240	512.0	5.3999	1.0545	888.08
4	0.08598	429.9	4.2674	0.9926	815.12
5	0.07934	396.7	4.1172	1.0379	770.76
6	0.08642	432.1	4.4564	1.0313	836.22
7	0.08714	435.7	4.4958	1.0319	809.82
8	0.08011	400.6	4.1275	1.0305	778.12
9	0.09502	475.1	4.5367	0.9549	849.22
10	0.08969	448.5	4.5310	1.0104	823.50
11	0.08201	410.1	4.0971	0.9992	782.12
12	0.08998	449.9	4.5412	1.0094	860.24
13	0.09300	465.0	4.6440	0.9987	852.14
14	0.08497	424.9	4.3875	1.0327	808.94
15	0.08650	432.5	4.4578	1.0307	806.56
16	0.08749	437.5	4.5134	1.0317	816.04
17	0.07805	390.3	3.8766	0.9934	773.56
18	0.08145	407.3	3.9836	0.9782	779.20
19	0.09509	475.5	4.6232	0.9724	857.60
20	0.08537	426.9	4.2527	0.9963	820.56
Average				1.0085	822.25
STD				0.02899	34.48

Linear density (tex)   = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex)   = (Max load in Newton * 100)/ Linear density

Table D2 Raw data of mechanical properties of PANI/NR composite fiber with 0.5% w/w PANI content

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08741	437.1	3.2370	0.7406	759.74
2	0.08573	428.7	3.2455	0.7571	765.80
3	0.08011	400.6	3.0587	0.7636	725.74
4	0.08442	422.1	3.1263	0.7407	750.90
5	0.08656	432.8	3.2011	0.7396	773.12
6	0.08121	406.1	2.9876	0.7358	697.70
7	0.08206	410.3	2.5781	0.6283	703.00
8	0.08997	449.9	3.4661	0.7705	791.22
9	0.08579	429.0	3.1290	0.7295	750.48
10	0.08201	410.1	2.4659	0.6014	681.34
11	0.08176	408.8	2.7219	0.6658	691.40
12	0.08283	414.2	3.0234	0.7300	723.44
13	0.09267	463.4	3.7089	0.8004	809.28
14	0.08981	449.1	3.6269	0.8077	801.96
15	0.09193	459.7	3.6587	0.7960	799.34
16	0.07978	398.9	2.5281	0.6340	681.86
17	0.09542	477.1	3.7265	0.7811	808.56
18	0.09863	493.2	3.6841	0.7471	809.64
19	0.08755	437.8	3.3244	0.7594	767.34
20	0.08921	446.1	3.4561	0.7748	787.02
Average				0.7352	753.94
STD				0.05836	45.075

Linear density (tex)   = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex)   = (Max load in Newton * 100)/ Linear density

Table D3 Raw data of mechanical properties of PANI/NR composite fiber with 1% w/w PANI content

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08012	400.6	2.0258	0.5057	525.57
2	0.07955	397.8	1.9807	0.4980	474.00
3	0.08575	428.8	2.4354	0.5680	522.12
4	0.08431	421.6	2.2145	0.5253	511.6
5	0.08711	435.6	2.3133	0.5311	521.32
6	0.09370	468.5	2.4981	0.5332	517.61
7	0.09147	457.4	2.5639	0.5606	518.84
8	0.08905	445.3	2.5567	0.5742	520.20
9	0.08333	416.7	2.1876	0.5250	504.02
10	0.09089	454.5	2.5778	0.5672	519.16
11	0.09584	479.2	2.6742	0.5581	516.46
12	0.08569	428.5	2.4830	0.5795	524.16
13	0.07802	390.1	2.1656	0.5551	493.36
14	0.08298	414.9	2.3035	0.5552	495.50
15	0.08170	408.5	2.2412	0.5486	501.46
16	0.08241	412.1	2.4521	0.5951	490.98
17	0.09901	495.1	2.8120	0.5680	514.81
18	0.09612	480.6	2.7654	0.5754	528.12
19	0.08532	426.6	2.1587	0.5060	493.72
20	0.08484	424.2	2.2280	0.5252	512.84
Average				0.5477	510.29
STD				0.02744	14.44

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

Table D4 Raw data of mechanical properties of PANI/NR composite fiber with 2% w/w PANI content

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.09973	498.7	2.4581	0.4930	463.80
2	0.10625	531.3	2.8234	0.5315	498.58
3	0.10576	528.8	2.9840	0.5643	513.06
4	0.08387	419.4	2.3218	0.5537	475.52
5	0.08424	421.2	2.2134	0.5255	491.46
6	0.08091	404.6	1.8755	0.4636	416.48
7	0.08771	438.6	2.4581	0.5605	456.16
8	0.08525	426.3	2.6290	0.6168	482.62
9	0.08919	446.0	2.7934	0.6264	495.58
10	0.08617	430.9	2.0918	0.4855	419.54
11	0.08126	406.3	2.0598	0.5070	439.82
12	0.08069	403.5	2.0464	0.5072	437.40
13	0.08435	421.8	2.5113	0.5954	476.00
14	0.08233	411.7	2.6963	0.6545	486.62
15	0.09573	478.7	2.7856	0.5820	516.58
16	0.08314	415.7	2.4445	0.5880	443.80
17	0.08887	444.4	2.6429	0.5948	479.80
18	0.09604	480.2	2.8312	0.5896	485.66
19	0.08999	450.0	2.7289	0.6065	510.22
20	0.08056	402.8	1.9970	0.4958	435.40
Average				0.5571	471.21
STD				0.05350	30.68

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

Table D5 Raw data of mechanical properties of PANI/NR composite fiber with 5% w/w PANI content

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.09000	450.0	1.9447	0.4322	480.80
2	0.08861	443.1	1.6149	0.3645	317.20
3	0.07898	394.9	1.6075	0.4071	495.04
4	0.08046	402.3	1.5588	0.3875	417.96
5	0.08296	414.8	1.5612	0.3764	428.80
6	0.08560	428.0	1.5818	0.3696	457.38
7	0.08361	418.1	1.5437	0.3693	424.72
8	0.08986	449.3	1.9468	0.4333	481.20
9	0.09129	456.5	1.7981	0.3939	513.04
10	0.09312	465.6	1.9821	0.4257	547.22
11	0.09049	452.5	1.6872	0.3729	458.48
12	0.08145	407.3	1.4980	0.3678	367.74
13	0.08432	421.6	1.5313	0.3632	453.08
14	0.08828	441.4	1.4280	0.3235	363.24
15	0.07686	384.3	1.5092	0.3927	474.38
16	0.08551	427.6	1.8175	0.4251	472.30
17	0.08263	413.2	1.5783	0.3820	436.96
18	0.07812	390.6	1.5912	0.4074	481.04
19	0.08909	445.5	1.6065	0.3606	503.50
20	0.08516	425.8	1.7128	0.4022	463.60
Average				0.3878	451.88
STD				0.02772	54.66

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

79

Table D6 Raw data of mechanical properties of PANI/NR composite fiber with 10% w/w PANI content

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08394	419.7	1.2901	0.3074	186.76
2	0.08401	420.1	1.4132	0.3364	204.60
3	0.08094	404.7	1.2309	0.3042	177.40
4	0.0848	424.0	1.3225	0.3119	191.12
5	0.08896	444.8	1.2790	0.2875	138.38
6	0.09355	467.8	1.4211	0.3038	140.68
7	0.09101	455.1	1.3987	0.3074	149.56
8	0.08849	442.5	1.2631	0.2855	142.80
9	0.08224	411.2	1.3948	0.3392	197.92
10	0.08004	400.2	1.2536	0.3132	187.74
11	0.08688	434.4	1.2990	0.2990	132.22
12	0.07974	398.7	1.2145	0.3046	171.50
13	0.08581	429.1	1.3420	0.3128	142.50
14	0.08537	426.9	1.3578	0.3181	147.38
15	0.09008	450.4	1.1986	0.2661	114.40
16	0.08479	424.0	1.2993	0.3065	143.78
17	0.08674	433.7	1.3067	0.3013	156.32
18	0.08707	435.4	1.2887	0.2960	131.16
19	0.07805	390.3	1.2354	0.3166	217.12
20	0.08388	419.4	1.2755	0.3041	134.38
Average				0.3061	160.39
STD				0.01616	28.93

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

Appendix E Mechanical Properties of PANI/NR Composite Fiber Doped with 1 M HCl for 24 h

Table E1 Raw data of mechanical properties of neat natural rubber fiber (comprising sodium alginate but no PANI) doped with 1 M HCl for 24 h

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08642	432.1	3.5847	0.8296	898.02
2	0.08853	442.7	3.6993	0.8357	873.40
3	0.08850	442.5	3.5870	0.8106	862.76
4	0.08142	407.1	3.0198	0.7418	795.96
5	0.08440	422.0	3.4228	0.8111	881.50
6	0.08333	416.7	3.3259	0.7982	875.52
7	0.08151	407.6	3.1023	0.7612	801.90
8	0.08667	433.4	3.5567	0.8207	872.82
9	0.09599	480.0	4.0180	0.8372	840.78
10	0.09365	468.3	3.8190	0.8156	869.94
11	0.08141	407.1	3.0214	0.7423	812.34
12	0.08203	410.2	3.1856	0.7767	857.24
13	0.08478	423.9	3.2786	0.7734	860.42
14	0.08601	430.1	3.7890	0.8811	879.46
15	0.08959	448.0	3.6337	0.8112	870.22
16	0.09015	450.8	3.7669	0.8357	878.12
17	0.08678	433.9	3.6465	0.8404	864.84
18	0.07884	394.2	2.3769	0.6030	842.66
19	0.08269	413.5	3.6729	0.8884	870.16
20	0.08452	422.6	3.2109	0.7598	862.60
Average				0.7987	858.53
STD				0.06144	27.07

Linear density (tex)   = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex)   = (Max load in Newton * 100)/ Linear density

Table E2 Raw data of mechanical properties of PANI/NR composite fiber with 0.5% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08608	430.4	2.9921	0.6952	751.72
2	0.08914	445.7	2.7218	0.6107	680.84
3	0.09682	484.1	2.0164	0.4165	744.22
4	0.08453	422.7	2.8210	0.6675	750.28
5	0.08081	404.1	2.4142	0.5975	756.20
6	0.08310	415.5	2.1890	0.5268	724.20
7	0.08706	435.3	2.2465	0.5161	728.50
8	0.08227	411.4	2.6754	0.6504	771.30
9	0.08051	402.6	2.4908	0.6188	758.14
10	0.08662	433.1	3.0123	0.6955	753.78
11	0.09190	459.5	2.9445	0.6408	747.38
12	0.09345	467.3	2.3656	0.5063	718.30
13	0.08916	445.8	2.2369	0.5018	721.04
14	0.08570	428.5	2.4214	0.5651	736.46
15	0.09601	480.1	2.0578	0.4287	704.20
16	0.08735	436.8	2.3512	0.5383	742.68
17	0.08201	410.1	2.5970	0.6333	765.50
18	0.08550	427.5	2.0131	0.4709	741.24
19	0.08977	448.9	2.2638	0.5044	724.32
20	0.08178	408.9	2.4428	0.5974	753.80
Average				0.5691	738.71
STD				0.08401	21.94

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

Table E3 Raw data of mechanical properties of PANI/NR composite fiber with 1% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08041	402.1	2.1930	0.5455	657.52
2	0.08567	428.4	2.5491	0.5951	646.96
3	0.08721	436.1	2.6563	0.6092	664.24
4	0.08810	440.5	2.6920	0.6111	721.96
5	0.08603	430.2	2.5890	0.6019	692.56
6	0.08233	411.7	2.6785	0.6507	717.58
7	0.08442	422.1	2.5172	0.5964	664.42
8	0.08135	406.8	2.3657	0.5816	692.82
9	0.08247	412.4	2.4816	0.6018	678.92
10	0.08572	428.6	2.5734	0.6004	654.82
11	0.09034	451.7	2.9852	0.6609	757.86
12	0.08693	434.7	2.6190	0.6026	712.00
13	0.08218	410.9	2.4643	0.5997	681.20
14	0.07998	399.9	2.0934	0.5235	638.56
15	0.08094	404.7	2.2286	0.5507	661.36
16	0.08677	433.9	2.6389	0.6083	696.38
17	0.09367	468.4	3.2721	0.6986	817.00
18	0.08440	422.0	2.5216	0.5975	667.32
19	0.08261	413.1	2.5114	0.6080	690.50
20	0.08997	449.9	2.9560	0.6571	753.20
Average				0.6050	693.36
STD				0.04024	43.81

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

Table E4 Raw data of mechanical properties of PANI/NR composite fiber with 2% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08021	401.1	1.8739	0.4672	595.64
2	0.08255	412.8	1.8284	0.4430	541.48
3	0.08228	411.4	1.7944	0.4362	548.88
4	0.08332	416.6	1.8125	0.4351	576.92
5	0.08533	426.7	2.0112	0.4714	603.14
6	0.08170	408.5	1.8974	0.4645	590.92
7	0.08297	414.9	1.8121	0.4368	552.16
8	0.08769	438.5	2.0518	0.4680	639.48
9	0.08554	427.7	2.0232	0.4730	609.78
10	0.08112	405.6	1.9208	0.4736	597.64
11	0.08691	434.6	2.0159	0.4639	631.90
12	0.08549	427.5	2.0243	0.4736	615.56
13	0.08904	445.2	2.2108	0.4966	631.60
14	0.08501	425.1	1.9878	0.4677	614.28
15	0.08190	409.5	1.885	0.4603	578.18
16	0.08248	412.4	1.8415	0.4465	557.36
17	0.09001	450.1	2.0819	0.4626	657.10
18	0.08878	443.9	2.112	0.4758	637.58
19	0.07998	399.9	1.8927	0.4733	607.34
20	0.09047	452.4	1.9974	0.4416	596.88
Average				0.4615	599.19
STD				0.01645	32.53

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

Table E5 Raw data of mechanical properties of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.07835	391.8	2.2712	0.5798	750.66
2	0.08568	428.4	2.3964	0.5594	734.50
3	0.08242	412.1	2.2985	0.5578	719.76
4	0.08179	409.0	2.1689	0.5303	707.20
5	0.08462	423.1	2.3819	0.5630	745.58
6	0.08676	433.8	2.612	0.6021	756.26
7	0.08263	413.2	2.3163	0.5606	710.54
8	0.08091	404.6	2.3615	0.5837	696.08
9	0.08498	424.9	2.3928	0.5631	737.80
10	0.08521	426.1	2.3872	0.5603	726.26
11	0.07964	398.2	2.2453	0.5639	750.42
12	0.08997	449.9	2.4972	0.5551	719.78
13	0.08889	444.5	2.4571	0.5528	717.36
14	0.08566	428.3	2.4634	0.5752	722.74
15	0.09129	456.5	2.5013	0.5480	696.68
16	0.09065	453.3	2.5296	0.5581	709.26
17	0.08032	401.6	2.3096	0.5751	664.96
18	0.07991	399.6	2.2672	0.5674	748.72
19	0.08554	427.7	2.3544	0.5505	738.92
20	0.08208	410.4	2.1842	0.5322	688.54
Average				0.5619	722.10
STD				0.01650	24.08

Linear density (tex)   = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex)   = (Max load in Newton * 100)/ Linear density

Table E6 Raw data of mechanical properties of PANI/NR composite fiber with 10% w/w PANI content doped with 1 M HCl for 24 h

Sample No.	Weight (g/20 cm.)	Linear density (tex)	Max load (N)	Tenacity (cN/tex)	Elongation at break (%)
1	0.08564	428.20	2.1553	0.5033	543.88
2	0.08256	412.80	2.1272	0.5153	538.48
3	0.08403	420.15	2.1729	0.5172	566.58
4	0.08208	410.40	2.1854	0.5325	615.42
5	0.08885	444.25	2.2536	0.5073	591.08
6	0.08106	405.30	2.0082	0.4955	546.86
7	0.08467	423.35	2.1732	0.5133	632.96
8	0.07838	391.90	1.9549	0.4988	580.16
9	0.08910	445.50	2.2080	0.4956	612.28
10	0.09204	460.20	2.2195	0.4823	630.18
11	0.08561	428.05	2.1604	0.5047	550.58
12	0.08333	416.65	2.0918	0.5021	545.88
13	0.08009	400.45	1.9986	0.4991	558.60
14	0.08255	412.75	2.1045	0.5099	605.18
15	0.08499	424.95	2.0131	0.4737	591.76
16	0.09012	450.60	2.1761	0.4829	620.28
17	0.08213	410.65	1.9890	0.4844	597.92
18	0.08136	406.80	1.9829	0.4874	562.36
19	0.08722	436.10	2.1542	0.4940	612.24
20	0.08349	417.45	2.0550	0.4923	556.30
Average				0.4996	582.95
STD				0.01411	31.62

Linear density (tex) = (Weight of fiber in gram per 20-cm length * 1000) / 0.20

Tenacity (cN/tex) = (Max load in Newton * 100)/ Linear density

Appendix F Conductivity Measurement of PANI/NR Composite Fiber

Table F1 Raw data of conductivity measurement of neat natural rubber fiber (comprising sodium alginate but no PANI) under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
Neat NR	1.002E-01	50	3.18E-11	2.02E-10
		55	3.49E-11	2.01E-10
		60	4.02E-11	2.13E-10
		65	4.32E-11	2.11E-10
		70	4.75E-11	2.15E-10
		75	4.94E-11	2.09E-10
		80	5.43E-11	2.15E-10
Average				2.09E-10
Neat NR	7.520E-02	65	2.05E-11	1.78E-10
		70	2.25E-11	1.81E-10
		75	2.51E-11	1.88E-10
		80	2.78E-11	1.96E-10
		85	2.91E-11	1.93E-10
		90	3.50E-11	2.19E-10
		95	3.74E-11	2.22E-10
Average				1.97E-10
Neat NR	8.780E-02	60	2.79E-11	1.920E-10
		65	3.22E-11	2.050E-10
		70	3.41E-11	2.010E-10
		75	3.73E-11	2.050E-10
		80	3.87E-11	2.000E-10
		90	4.56E-11	2.090E-10
Average				2.02E-10

Average conductivity   2.03E-10

STD   6.03E-12

Table F2 Raw data of conductivity measurement of PANI/NR composite fiber with 0.5% w/w PANI content under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (0.5% w/w PANI)	7.890E-02	15	5.88E-11	2.01E-09
		18	6.55E-11	1.86E-09
		25	9.18E-11	1.88E-09
		30	1.08E-10	1.84E-09
		35	1.26E-10	1.84E-09
		40	1.39E-10	1.78E-09
		45	1.56E-10	1.77E-09
Average				1.85E-09
PANI/NR (0.5% w/w PANI)	7.450E-02	10	2.97E-11	1.70E-09
		15	4.06E-11	1.55E-09
		20	5.15E-11	1.48E-09
		25	6.29E-11	1.44E-09
		30	7.60E-11	1.45E-09
		35	8.56E-11	1.40E-09
Average				1.50E-09
PANI/NR (0.5% w/w PANI)	8.320E-02	10	3.49E-11	1.61E-09
		15	5.00E-11	1.53E-09
		20	6.47E-11	1.49E-09
		25	7.98E-11	1.47E-09
		30	9.52E-11	1.46E-09
		35	1.10E-10	1.45E-09
		40	1.24E-10	1.43E-09
Average				1.49E-09

Average conductivity 1.62E-09

STD 2.06E-10

Table F3 Raw data of conductivity measurement of PANI/NR composite fiber with 1% w/w PANI content under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (1% w/w PANI)	6.500E-02	10	2.97E-11	2.24E-09
		12	3.61E-11	2.27E-09
		15	4.36E-11	2.19E-09
		20	5.69E-11	2.14E-09
		25	7.03E-11	2.12E-09
		30	8.07E-11	2.03E-09
		40	1.06E-10	2.00E-09
Average				2.14E-09
PANI/NR (1% w/w PANI)	8.240E-02	10	5.16E-11	2.42E-09
		15	7.21E-11	2.25E-09
		20	9.51E-11	2.23E-09
		25	1.23E-10	2.31E-09
		30	1.41E-10	2.20E-09
		35	1.65E-10	2.21E-09
		40	1.87E-10	2.26E-09
Average				2.27E-09
PANI/NR (1% w/w PANI)	8.550E-02	10	5.50E-11	2.40E-09
		15	8.23E-11	2.39E-09
		20	1.07E-10	2.33E-09
		25	1.32E-10	2.30E-09
		30	1.79E-10	2.60E-09
		35	1.93E-10	2.40E-09
		40	1.99E-10	2.17E-09
Average				2.37E-09

Average conductivity   2.26E-09

STD   1.15E-10

Table F4 Raw data of conductivity measurement of PANI/NR composite fiber with 2% w/w PANI content under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (2% w/w PANI)	9.130E-02	10	4.54E-11	1.73E-09
		15	6.69E-11	1.70E-09
		20	8.99E-11	1.72E-09
		25	1.11E-10	1.70E-09
		30	1.35E-10	1.72E-09
		35	1.54E-10	1.68E-09
		40	1.88E-10	1.80E-09
Average				1.72E-09
PANI/NR (2% w/w PANI)	9.180E-02	5	2.58E-11	1.95E-09
		10	4.76E-11	1.80E-09
		15	7.27E-11	1.83E-09
		20	9.29E-11	1.76E-09
		25	1.19E-10	1.80E-09
		30	1.42E-10	1.79E-09
		35	1.84E-10	1.99E-09
Average				1.85E-09
PANI/NR (2% w/w PANI)	9.550E-02	5	2.70E-11	1.89E-09
		10	4.72E-11	1.65E-09
		15	7.48E-11	1.74E-09
		20	9.87E-11	1.72E-09
		25	1.25E-10	1.75E-09
		30	1.75E-10	2.04E-09
		35	2.01E-10	2.01E-09
Average				1.83E-09

Average conductivity   1.80E-09

STD   6.74E-11

Table F5 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5% w/w PANI)	7.977E-02	1	2.37E-11	1.90E-08
		3	6.27E-11	1.67E-08
		7	1.44E-10	1.65E-08
		10	1.93E-10	1.55E-08
		12	2.01E-10	1.34E-08
		15	2.28E-10	1.22E-08
Average				1.56E-08
PANI/NR (5% w/w PANI)	8.210E-02	3	7.20E-11	1.81E-08
		5	1.22E-10	1.84E-08
		7	1.54E-10	1.66E-08
		9	1.98E-10	1.66E-08
		12	2.25E-10	1.42E-08
		15	2.63E-10	1.33E-08
Average				1.62E-08
PANI/NR (5% w/w PANI)	8.520E-02	4	1.09E-10	1.90E-08
		5	1.42E-10	1.98E-08
		6	1.72E-10	2.00E-08
		7	1.91E-10	1.91E-08
		10	2.35E-10	1.64E-08
		12	2.69E-10	1.57E-08
Average				1.83E-08

Average conductivity   1.67E-08

STD   1.46E-09

Table F6 Raw data of conductivity measurement of PANI/NR composite fiber with 10% w/w PANI content under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (10% w/w PANI)	7.380E-02	15	4.78E-09	1.86E-07
		20	5.98E-09	1.75E-07
		25	7.21E-09	1.69E-07
		30	8.89E-09	1.73E-07
		35	1.09E-08	1.82E-07
		40	1.34E-08	1.96E-07
Average				1.80E-07
PANI/NR (10% w/w PANI)	8.024E-02	15	6.02E-09	1.99E-07
		20	7.86E-09	1.94E-07
		25	9.98E-09	1.97E-07
		30	1.23E-08	2.03E-07
		35	1.46E-08	2.06E-07
		40	1.68E-08	2.08E-07
Average				2.01E-07
PANI/NR (10% w/w PANI)	7.896E-02	15	5.78E-09	1.97E-07
		20	7.96E-09	2.03E-07
		25	9.97E-09	2.04E-07
		30	1.24E-08	2.11E-07
		35	1.41E-08	2.06E-07
		40	1.69E-08	2.16E-07
Average				2.06E-07

Average conductivity 1.96E-07

STD 1.38E-08

Appendix G Conductivity Measurement of PANI/NR Composite Fiber Doped with 1 M HCl for 24 h

Table G1 Raw data of conductivity measurement of neat natural rubber fiber (comprising sodium alginate but no PANI) doped with 1 M HCl for 24 h under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
Neat NR	1.139E-01	50	5.14E-11	2.52E-10
		60	6.12E-11	2.50E-10
		70	7.40E-11	2.60E-10
		75	8.09E-11	2.65E-10
		80	8.74E-11	2.68E-10
		85	9.23E-11	2.67E-10
		90	9.82E-11	2.68E-10
Average				2.61E-10
Neat NR	7.000E-02	50	2.05E-11	2.66E-10
		55	2.21E-11	2.61E-10
		60	2.40E-11	2.60E-10
		65	2.63E-11	2.63E-10
		70	2.94E-11	2.73E-10
		80	3.24E-11	2.63E-10
		90	3.83E-11	2.77E-10
Average				2.66E-10
Neat NR	8.22E-02	50	2.73E-11	2.57E-10
		55	2.85E-11	2.44E-10
		60	2.99E-11	2.35E-10
		65	3.27E-11	2.37E-10
		70	3.51E-11	2.36E-10
		75	3.89E-11	2.44E-10
		80	4.08E-11	2.40E-10
Average				2.42E-10

Average conductivity   2.57E-10

STD   1.28E-11

Table G2 Raw data of conductivity measurement of PANI/NR composite fiber with 0.5% w/w PANI content doped with 1 M HCl for 24 h under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (0.5% w/w PANI)	8.990E-02	5	4.76E-09	3.75E-07
		6	5.94E-09	3.90E-07
		8	8.14E-09	4.01E-07
		10	1.04E-08	4.10E-07
		12	1.24E-08	4.07E-07
		15	1.51E-08	3.97E-07
		20	1.78E-08	3.51E-07
Average				3.90E-07
PANI/NR (0.5% w/w PANI)	8.856E-02	5	4.78E-09	3.88E-07
		6	5.84E-09	3.95E-07
		7	7.21E-09	4.18E-07
		8	8.26E-09	4.19E-07
		10	9.43E-09	3.83E-07
		12	1.29E-08	4.37E-07
		15	1.52E-08	4.11E-07
		20	1.81E-08	3.67E-07
Average				4.02E-07
PANI/NR (0.5% w/w PANI)	9.215E-02	5	5.12E-09	3.84E-07
		7	7.21E-09	3.86E-07
		8	8.53E-09	4.00E-07
		10	1.10E-08	4.13E-07
		12	1.31E-08	4.09E-07
		15	1.64E-08	4.10E-07
		20	1.98E-08	3.71E-07
Average				3.96E-07

Average conductivity   3.96E-07

STD   6.05E-09

Table G3 Raw data of conductivity measurement of PANI/NR composite fiber with 1 % w/w PANI content doped with 1 M HCl for 24 h under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (1 % w/w PANI)	7.270E-02	5	7.69E-09	9.27E-07
		6	9.49E-09	9.53E-07
		7	1.12E-08	9.64E-07
		8	1.31E-08	9.87E-07
		9	1.50E-08	1.00E-06
		10	1.72E-08	1.04E-06
		12	2.14E-08	1.07E-06
		15	2.50E-08	1.00E-06
Average				9.93E-07
PANI/NR (1 % w/w PANI)	8.105E-02	5	9.31E-09	9.03E-07
		6	1.15E-08	9.29E-07
		7	1.29E-08	8.93E-07
		8	1.41E-08	8.54E-07
		9	1.54E-08	8.30E-07
		10	1.72E-08	8.34E-07
		12	2.14E-08	8.65E-07
		15	2.89E-08	9.34E-07
Average				8.80E-07
PANI/NR (1 % w/w PANI)	7.984E-02	4	7.79E-09	9.73E-07
		5 .	9.31E-09	9.30E-07
		7	1.35E-08	9.64E-07
		9	1.68E-08	9.33E-07
		10	1.97E-08	9.84E-07
		12	2.42E-08	1.01E-06
		15	2.87E-08	9.56E-07
Average				9.64E-07

Average conductivity   9.46E-07

STD   5.84E-08

Table G4 Raw data of conductivity measurement of PANI/NR composite fiber with 2% w/w PANI content doped with 1 M HCl for 24 h under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (2 % w/w PANI)	8.882E-02	2	8.67E-09	1.75E-06
		4	1.72E-08	1.74E-06
		6	2.46E-08	1.66E-06
		8	3.21E-08	1.62E-06
		10	3.86E-08	1.56E-06
		12	4.49E-08	1.51E-06
		15	5.67E-08	1.53E-06
Average				1.62E-06
PANI/NR (2 % w/w PANI)	9.420E-02	2	8.54E-09	1.53E-06
		4	1.62E-08	1.45E-06
		5	2.00E-08	1.44E-06
		6	2.40E-08	1.44E-06
		7	2.73E-08	1.40E-06
		8	3.08E-08	1.38E-06
		9	3.46E-08	1.38E-06
		10	3.78E-08	1.36E-06
Average				1.42E-06
PANI/NR (2 % w/w PANI)	8.094E-02	2	6.97E-09	1.69E-06
		4	1.28E-08	1.56E-06
		6	.2.02E-08	1.64E-06
		8	2.89E-08	1.76E-06
		9	3.28E-08	1.77E-06
		10	3.61E-08	1.75E-06
		12	3.98E-08	1.61E-06
Average				1.68E-06

Average conductivity   1.58E-06

STD   1.37E-07

Table G5 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	1.038E-01	2	5.95E-06	8.79E-04
		4	1.35E-05	9.98E-04
		5	1.73E-05	1.02E-03
		8	2.86E-05	1.06E-03
		10	3.33E-05	9.84E-04
		12	3.72E-05	9.16E-04
		15	4.33E-05	8.53E-04
Average				9.59E-04
PANI/NR (5 % w/w PANI)	1.047E-01	2	6.47E-06	9.40E-04
		4	1.25E-05	9.08E-04
		5	1.72E-05	9.99E-04
		8	2.92E-05	1.06E-03
		10	3.65E-05	1.06E-03
		12	4.27E-05	1.03E-03
		15	5.18E-05	1.00E-03
		20	6.61E-05	9.60E-04
Average				9.95E-04
PANI/NR (5 % w/w PANI)	9.542E-02	2	6.66E-06	1.16E-03
		4	1.23E-05	1.08E-03
		5	1.55E-05	1.08E-03
		8	2.57E-05	1.12E-03
		10	3.26E-05	1.14E-03
		12	3.81E-05	1.11E-03
		15	4.62E-05	1.08E-03
		20	5.86E-05	1.02E-03
Average				1.10E-03

Average conductivity   1.02E-03

STD   7.28E-05

97

Table G6 Raw data of conductivity measurement of PANI/NR composite fiber with 10% w/w PANI content doped with 1 M HCl for 24 h under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Diameter (cm)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (10 % w/w PANI)	9.860E-02	1	6.18E-06	2.02E-03
		2	1.07E-05	1.75E-03
		4	2.60E-05	2.13E-03
		5	3.31E-05	2.17E-03
		8	5.36E-05	2.19E-03
		10	6.01E-05	1.97E-03
		12	6.30E-05	1.72E-03
		15	7.12E-05	1.55E-03
Average				1.94E-03
PANI/NR (10 % w/w PANI)	1.042E-01	2	1.20E-06	1.76E-03
		4	2.45E-06	1.80E-03
		5	3.12E-05	1.83E-03
		8	5.27E-05	1.93E-03
		10	6.42E-05	1.88E-03
		12	7.08E-05	1.73E-03
		15	8.06E-05	1.58E-03
		20	9.97E-05	1.46E-03
Average				1.75E-03
PANI/NR (10 % w/w PANI)	9.542E-02	2	6.79E-06	1.42E-03
		4	1.19E-06	1.24E-03
		5	1.59E-05	1.33E-03
		8	2.63E-05	1.37E-03
		10	3.14E-05	1.31E-03
		12	3.58E-05	1.25E-03
		15	4.12E-05	1.15E-03
		18	4.67E-05	1.08E-03
Average				1.27E-03

Average conductivity 1.65E-03

STD 3.44E-04

Appendix H Strain-dependent Conductivity Measurement of PANI/NR Composite Fiber Doped with 1 M HCl for 24 h

Table H1 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 0% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	0	5	1.64E-05	1.15E-03
			7	2.04E-05	1.02E-03
			9	2.43E-05	9.43E-04
			12	3.49E-05	1.02E-03
			15	3.94E-05	9.17E-04
			18	4.59E-05	8.90E-04
			20	4.86E-05	8.49E-04
Average					9.68E-04
PANI/NR (5 % w/w PANI)	1.035E-01	0	2	6.14E-06	9.13E-04
			5	1.59E-05	9.45E-04
			10	3.45E-05	1.03E-03
			15	5.78E-05	1.15E-03
			20	7.91E-05	1.18E-03
			25	9.79E-05	1.16E-03
			30	1.32E-04	1.31E-03
Average					1.10E-03
PANI/NR (5 % w/w PANI)	8.270E-02	0	8	1.26E-05	7.33E-04
			10	1.95E-05	9.08E-04
			12	2.65E-05	1.03E-03
			15	3.48E-05	1.08E-03
			18	4.13E-05	1.07E-03
			21	4.51E-05	1.00E-03
Average					9.70E-04

Average conductivity　　　1.01E-03

STD　　　7.56E-05

Table H2 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 25% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	25	5	6.98E-06	7.62E-04
			8	1.07E-05	7.30E-04
			10	1.31E-05	7.15E-04
			12	1.56E-05	7.09E-04
			15	1.96E-05	7.13E-04
			18	2.38E-05	7.21E-04
			21	2.83E-05	7.35E-04
Average					7.26E-04
PANI/NR (5 % w/w PANI)	1.035E-01	25	5	9.98E-06	9.27E-04
			7	1.51E-05	1.00E-03
			10	2.38E-05	1.11E-03
			12	2.48E-05	9.60E-04
			15	3.14E-05	9.72E-04
			18	3.79E-05	9.78E-04
			21	4.52E-05	1.00E-03
			24	5.21E-05	1.01E-03
			27	6.28E-05	1.08E-03
			30	7.21E-05	1.12E-03
Average					1.02E-03
PANI/NR (5 % w/w PANI)	8.270E-02	25	5	7.24E-06	9.10E-04
			8	1.16E-05	9.11E-04
			10	1.42E-05	8.92E-04
			12	1.67E-05	8.74E-04
			15	2.02E-05	8.46E-04
			18	2.41E-05	8.41E-04
			21	2.89E-05	8.65E-04
Average					8.77E-04

Average conductivity   8.74E-04

STD   1.47E-04

Table H3 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 50% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	50	5	5.38E-06	8.45E-04
			8	8.87E-06	8.71E-04
			10	1.12E-05	8.80E-04
			12	1.35E-05	8.84E-04
			15	1.71E-05	8.96E-04
			18	2.09E-05	9.12E-04
			21	2.43E-05	9.09E-04
Average					8.85E-04
PANI/NR (5 % w/w PANI)	1.035E-01	50	5	5.47E-06	7.32E-04
			7	7.76E-06	7.42E-04
			10	1.16E-05	7.76E-04
			12	1.41E-05	7.86E-04
			15	1.82E-05	8.12E-04
			18	2.21E-05	8.21E-04
			21	2.65E-05	8.44E-04
			24	3.09E-05	8.61E-04
			27	3.58E-05	8.87E-04
Average					8.07E-04
PANI/NR (5 % w/w PANI)	8.270E-02	50	5	5.36E-06	9.70E-04
			8	8.70E-06	9.84E-04
			10	1.08E-05	9.77E-04
			12	1.25E-05	9.42E-04
			15	1.53E-05	9.23E-04
			18	1.80E-05	9.05E-04
			21	2.01E-05	8.66E-04
Average					9.38E-04

Average conductivity	8.77E-04
STD	6.59E-05

Table H4 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 75% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	75	5	4.30E-06	9.20E-04
			8	6.77E-06	9.05E-04
			10	8.35E-06	8.93E-04
			12	9.97E-06	8.88E-04
			15	1.25E-05	8.91E-04
			18	1.52E-05	9.03E-04
			21	1.81E-05	9.22E-04
Average					9.03E-04
PANI/NR (5 % w/w PANI)	1.035E-01	75	5	3.98E-06	7.25E-04
			7	5.65E-06	7.35E-04
			10	8.35E-06	7.60E-04
			12	1.02E-05	7.74E-04
			15	1.31E-05	7.95E-04
			18	1.63E-05	8.24E-04
			21	1.94E-05	8.41E-04
			24	2.28E-05	8.65E-04
Average					7.90E-04
PANI/NR (5 % w/w PANI)	8.270E-02	75	5	3.78E-06	9.31E-04
			8	5.95E-06	9.16E-04
			10	7.23E-06	8.90E-04
			12	8.78E-06	9.01E-04
			15	1.15E-05	9.44E-04
			18	1.46E-05	9.99E-04
			21	1.75E-05	1.03E-03
Average					9.44E-04

Average conductivity   8.79E-04
STD   7.97E-05

Table H5 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 100% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	100	5	4.09E-06	1.14E-03
			8	6.33E-06	1.11E-03
			10	7.64E-06	1.07E-03
			12	9.06E-06	1.05E-03
			15	1.13E-05	1.05E-03
			18	1.37E-05	1.06E-03
			21	1.62E-05	1.08E-03
Average					1.08E-03
PANI/NR (5 % w/w PANI)	1.035E-01	100	5	2.99E-06	7.11E-04
			7	4.26E-06	7.24E-04
			10	6.25E-06	7.43E-04
			12	7.54E-06	7.47E-04
			15	9.68E-06	7.67E-04
			18	1.18E-05	7.80E-04
			21	1.42E-05	8.04E-04
			24	1.66E-05	8.23E-04
			27	1.88E-05	8.28E-04
			30	2.15E-05	8.52E-04
Average					7.78E-04
PANI/NR (5 % w/w PANI)	8.270E-02	100	5	3.42E-06	1.10E-03
			8	5.29E-06	1.06E-03
			10	6.40E-06	1.03E-03
			12	7.47E-06	1.00E-03
			15	9.16E-06	9.82E-04
			18	1.07E-05	9.56E-04
			21	1.23E-05	9.42E-04
Average					1.01E-03

Average conductivity   9.56E-04

STD   1.58E-04

Table H6 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 150% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	150	5	2.79E-06	1.22E-03
			8	4.28E-06	1.17E-03
			10	5.38E-06	1.17E-03
			12	6.76E-06	1.23E-03
			15	9.14E-06	1.33E-03
			18	1.19E-05	1.44E-03
			21	1.42E-05	1.48E-03
			24	1.64E-05	1.49E-03
			27	1.89E-05	1.53E-03
			30	2.15E-05	1.56E-03
Average					1.36E-03
PANI/NR (5 % w/w PANI)	1.035E-01	150	5	2.01E-06	7.47E-04
			7	2.86E-06	7.59E-04
			10	4.06E-06	7.54E-04
			12	4.92E-06	7.62E-04
			15	6.28E-06	7.78E-04
			18	7.54E-06	7.78E-04
			21	8.94E-06	7.91E-04
			24	1.03E-05	7.97E-04
			27	1.17E-05	8.05E-04
			30	1.32E-05	8.18E-04
Average					7.79E-04
PANI/NR (5 % w/w PANI)	8.270E-02	150	5	2.10E-06	1.06E-03
			8	3.42E-06	1.07E-03
			10	4.33E-06	1.09E-03
			12	5.39E-06	1.13E-03
			15	6.96E-06	1.17E-03
			18	8.55E-06	1.19E-03
			21	1.00E-05	1.20E-03
Average					1.13E-03

Average conductivity	1.09E-03
STD	2.92E-04

Table H7 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 200% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	200	5	2.43E-06	1.53E-03
			8	3.75E-06	1.47E-03
			10	4.53E-06	1.42E-03
			12	5.34E-06	1.40E-03
			15	6.64E-06	1.39E-03
			18	7.89E-06	1.38E-03
			21	9.22E-06	1.38E-03
			24	1.05E-05	1.37E-03
Average					1.42E-03
PANI/NR (5 % w/w PANI)	1.035E-01	200	5	1.26E-06	6.74E-04
			7	1.81E-06	6.92E-04
			10	2.67E-06	7.14E-04
			12	3.13E-06	6.98E-04
			15	4.05E-06	7.22E-04
			18	4.84E-06	7.19E-04
			21	5.62E-06	7.16E-04
			24	6.53E-06	7.28E-04
			27	7.39E-06	7.32E-04
			30	8.43E-06	7.52E-04
Average					7.15E-04
PANI/NR (5 % w/w PANI)	8.270E-02	200	5	1.66E-06	1.20E-03
			8	2.49E-06	1.13E-03
			10	3.05E-06	1.10E-03
			12	3.75E-06	1.13E-03
			15	4.80E-06	1.16E-03
			18	5.82E-06	1.17E-03
			21	6.73E-06	1.16E-03
Average					1.15E-03

Average conductivity   1.10E-03

STD   3.56E-04

Table H8 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 300% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	300	5	1.86E-06	2.08E-03
			8	2.87E-06	2.00E-03
			10	3.47E-06	1.94E-03
			12	4.10E-06	1.91E-03
			15	5.01E-06	1.87E-03
			18	5.90E-06	1.83E-03
			21	6.81E-06	1.81E-03
Average					1.92E-03
PANI/NR (5 % w/w PANI)	1.035E-01	300	5	7.32E-07	6.96E-04
			7	1.03E-06	7.00E-04
			10	1.48E-06	7.04E-04
			12	1.78E-06	7.06E-04
			15	2.23E-06	7.07E-04
			18	2.71E-06	7.16E-04
			21	3.14E-06	7.11E-04
			24	3.60E-06	7.14E-04
			27	4.12E-06	7.26E-04
			30	4.59E-06	7.28E-04
Average					7.11E-04
PANI/NR (5 % w/w PANI)	8.270E-02	300	5	1.08E-06	1.39E-03
			8	1.63E-06	1.31E-03
			10	2.05E-06	1.32E-03
			12	2.52E-06	1.35E-03
			15	3.19E-06	1.37E-03
			18	3.77E-06	1.35E-03
			21	4.24E-06	1.30E-03
Average					1.34E-03

Average conductivity 1.33E-03

STD 6.00E-04

Table H9 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 400% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	400	5	1.11E-06	1.94E-03
			8	1.74E-06	1.90E-03
			10	2.21E-06	1.93E-03
			12	2.85E-06	2.07E-03
			15	3.63E-06	2.11E-03
			18	4.39E-06	2.13E-03
			21	5.09E-06	2.12E-03
Average					2.03E-03
PANI/NR (5 % w/w PANI)	1.035E-01	400	5	4.46E-07	6.63E-04
			7	6.41E-07	6.81E-04
			10	9.16E-07	6.81E-04
			12	1.14E-06	7.06E-04
			15	1.46E-06	7.23E-04
			18	1.74E-06	7.18E-04
			21	2.07E-06	7.33E-04
			24	2.32E-06	7.18E-04
			27	2.57E-06	7.07E-04
			30	2.95E-06	7.31E-04
Average					7.06E-04
PANI/NR (5 % w/w PANI)	8.270E-02	400	5	6.88E-07	1.38E-03
			8	1.07E-06	1.34E-03
			10	1.36E-06	1.37E-03
			12	1.69E-06	1.42E-03
			15	2.11E-06	1.41E-03
			18	2.52E-06	1.41E-03
			21	2.77E-06	1.33E-03
Average					1.38E-03

Average conductivity 1.37E-03

STD 6.62E-04

Table H10 Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 500% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	500	5	8.56E-07	2.15E-03
			8	1.33E-06	2.09E-03
			10	1.60E-06	2.01E-03
			12	1.92E-06	2.01E-03
			15	2.48E-06	2.08E-03
			18	3.11E-06	2.17E-03
			21	3.79E-06	2.27E-03
Average					2.11E-03
PANI/NR (5 % w/w PANI)	1.035E-01	500	5	3.26E-07	6.98E-04
			7	4.66E-07	7.12E-04
			10	6.66E-07	7.13E-04
			12	7.78E-07	6.94E-04
			15	9.80E-07	6.99E-04
			18	1.18E-06	7.02E-04
			21	1.41E-06	7.19E-04
			24	1.60E-06	7.14E-04
			27	1.79E-06	7.10E-04
			30	2.07E-06	7.38E-04
Average					7.10E-04
PANI/NR (5 % w/w PANI)	8.270E-02	500	5	4.88E-07	1.41E-03
			8	7.62E-07	1.38E-03
			10	9.81E-07	1.42E-03
			12	1.22E-06	1.47E-03
			15	1.51E-06	1.46E-03
			18	1.75E-06	1.41E-03
			21	1.92E-06	1.32E-03
Average					1.41E-03

Average conductivity   1.41E-03

STD   7.00E-04

Table H11   Raw data of conductivity measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at 600% elongation under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Original diameter (cm)	Elongation (%)	Applied voltage (V)	Current (A)	Conductivity (S/cm)
PANI/NR (5 % w/w PANI)	9.550E-02	600	8	1.00E-06	2.14E-03
			10	1.23E-06	2.10E-03
			12	1.45E-06	2.07E-03
			15	1.76E-06	2.01E-03
			18	2.07E-06	1.97E-03
			21	2.37E-06	1.93E-03
			24	2.63E-06	1.88E-03
Average					2.01E-03
PANI/NR (5 % w/w PANI)	1.035E-01	600	5	2.45E-07	7.14E-04
			7	3.32E-07	6.91E-04
			10	4.85E-07	7.07E-04
			12	5.79E-07	7.03E-04
			15	7.27E-07	7.06E-04
			18	8.77E-07	7.10E-04
			21	1.01E-06	7.01E-04
			24	1.16E-06	7.04E-04
			27	1.31E-06	7.07E-04
			30	1.42E-06	6.90E-04
Average					7.03E-04
PANI/NR (5 % w/w PANI)	8.270E-02	600	8	6.01E-07	1.48E-03
			10	7.73E-07	1.52E-03
			12	9.02E-07	1.48E-03
			15	1.03E-06	1.35E-03
			18	1.16E-06	1.27E-03
			21	1.36E-06	1.28E-03
			24	1.61E-06	1.32E-03
Average					1.37E-03

Average conductivity   1.36E-03

STD   6.54E-04

Appendix I Diameter Measurement of PANI/NR Composite Fiber in Strain-dependent Conductivity Measurement

Table I1 Raw data of diameter measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at various elongation points under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Elongation (%)	Diameter Measurement (mm)						
		1	2	3	4	5	Average	STD
PANI/NR (5 % w/w PANI)	0	0.959	0.962	0.95	0.951	0.958	0.956	0.00524
	25	0.861	0.877	0.855	0.865	0.859	0.863	0.00841
	50	0.791	0.777	0.786	0.779	0.764	0.779	0.01026
	75	0.731	0.734	0.742	0.726	0.727	0.732	0.00644
	100	0.693	0.672	0.68	0.677	0.675	0.679	0.00814
	150	0.604	0.608	0.619	0.615	0.605	0.610	0.00654
	200	0.547	0.552	0.561	0.567	0.566	0.559	0.00879
	300	0.475	0.463	0.481	0.472	0.462	0.471	0.00808
	400	0.42	0.422	0.439	0.429	0.437	0.429	0.00856
	500	0.386	0.405	0.395	0.393	0.398	0.395	0.00695
	600	0.362	0.355	0.368	0.37	0.367	0.364	0.00603

Table I2 Raw data of diameter measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at various elongation points under the condition of 1 atm, 50% relative humidity and 28°C

Sample	Elongation (%)	Diameter Measurement (mm)						
		1	2	3	4	5	Average	STD
PANI/NR (5 % w/w PANI)	0	1.030	1.028	1.044	1.024	1.032	1.032	0.00754
	25	0.93	0.923	0.938	0.931	0.944	0.933	0.00804
	50	0.854	0.87	0.855	0.845	0.846	0.854	0.01003
	75	0.784	0.797	0.787	0.774	0.771	0.783	0.01046
	100	0.726	0.74	0.741	0.731	0.725	0.733	0.00757
	150	0.637	0.648	0.67	0.666	0.651	0.654	0.01354
	200	0.599	0.601	0.59	0.596	0.589	0.595	0.00534
	300	0.527	0.52	0.516	0.526	0.53	0.524	0.00568
	400	0.465	0.477	0.458	0.443	0.447	0.458	0.01375
	500	0.415	0.422	0.417	0.427	0.424	0.421	0.00495
	600	0.394	0.398	0.386	0.392	0.381	0.390	0.00672

Table I3 Raw data of diameter measurement of PANI/NR composite fiber with 5% w/w PANI content doped with 1 M HCl for 24 h at various elongation points under the condition of 1 atm, 50% relative humidity and 28°C

| Sample	Elongation (%)	Diameter Measurement (mm)						
		1	2	3	4	5	Average	STD
PANI/NR (5 % w/w PANI)	0	0.821	0.826	0.828	0.819	0.832	0.825	0.00526
	25	0.721	0.736	0.738	0.731	0.726	0.730	0.00702
	50	0.663	0.668	0.678	0.676	0.659	0.669	0.00817
	75	0.629	0.618	0.61	0.632	0.622	0.622	0.00879
	100	0.587	0.591	0.596	0.574	0.582	0.586	0.00847
	150	0.528	0.533	0.538	0.519	0.515	0.527	0.00956
	200	0.454	0.475	0.482	0.458	0.478	0.469	0.01256
	300	0.413	0.405	0.412	0.407	0.418	0.411	0.00515
	400	0.379	0.368	0.385	0.371	0.384	0.377	0.00764
	500	0.347	0.337	0.345	0.336	0.341	0.341	0.00482
	600	0.322	0.318	0.327	0.31	0.314	0.318	0.00665

Appendix J Electromechanical actuation Measurement of PANI/NR Composite Fiber

Table J1 Raw data of deflection and electric field analyzed from video clip of neat natural rubber

| time (s)	Electric field (kV/cm)	Deflection (cm)	time (s)	Electric field (kV/cm)	Deflection (cm)
0	0.00	0	62	2.92	0.0901
2	0.16	0	65	3.00	0.124
3	0.16	0	67	3.08	0.134
4	0.32	0	70	3.16	0.159
5	0.32	0	72	3.20	0.169
8	0.40	0	75	3.28	0.203
10	0.48	0	77	3.36	0.229
12	0.56	0	80	3.44	0.250
14	0.64	0	82	3.52	0.270
16	0.72	0	85	3.64	0.341
17	0.72	0	87	3.72	0.378
18	0.80	0	89	3.76	0.432
20	0.88	0	90	3.76	0.443
22	0.96	0	93	3.80	0.495
24	1.04	0	98	3.84	0.574
25	1.12	0	99	3.92	0.591
26	1.20	0	100	3.92	0.608
28	1.28	0	101	3.92	0.619
31	1.40	0.0114	102	3.96	0.664
33	1.52	0.0114	103	3.96	0.689
34	1.52	0.0227	104	3.96	0.721
35	1.60	0.0229	105	4.00	0.745
39	1.76	0.0338	106	4.00	0.779
43	1.96	0.0359	107	4.00	0.802
49	2.20	0.0450	108	4.00	0.824
55	2.52	0.0455	109	4.00	0.858
56	2.60	0.0682	110	4.00	0.880
59	2.84	0.0788	112	4.00	0.981

Table J2 Raw data of deflection and electric field analyzed from video clip of 5% w/w HCl-doped PANI/NR composite fiber

time (s)	Electric field (kV/cm)	Deflection (cm)	time (s)	Electric field (kV/cm)	Deflection (cm)
0	0	0	26	2.20	0.218
1	0.20	0.0125	27	2.30	0.232
3	0.40	0.0251	28	2.40	0.276
5	0.60	0.0355	29	2.60	0.300
6	0.70	0.0376	30	2.80	0.359
7	0.80	0.0376	31	2.90	0.414
8	0.80	0.0376	32	2.90	0.463
9	0.90	0.0431	33	3.00	0.510
10	0.90	0.0502	34	3.00	0.531
11	0.90	0.0545	35	3.10	0.559
12	1.00	0.0552	36	3.10	0.613
13	1.00	0.0681	37	3.20	0.676
14	1.10	0.0690	39	3.20	0.745
15	1.20	0.0816	40	3.30	0.759
16	1.20	0.0818	41	3.30	0.777
17	1.30	0.0818	42	3.30	0.831
18	1.30	0.0954	43	3.30	0.886
19	1.40	0.109	44	3.40	0.940
20	1.60	0.123	45	3.40	1.01
22	1.80	0.138	46	3.40	1.23
23	1.90	0.152	47	3.50	1.25
24	2.00	0.177	48	3.50	1.25
25	2.10	0.204			
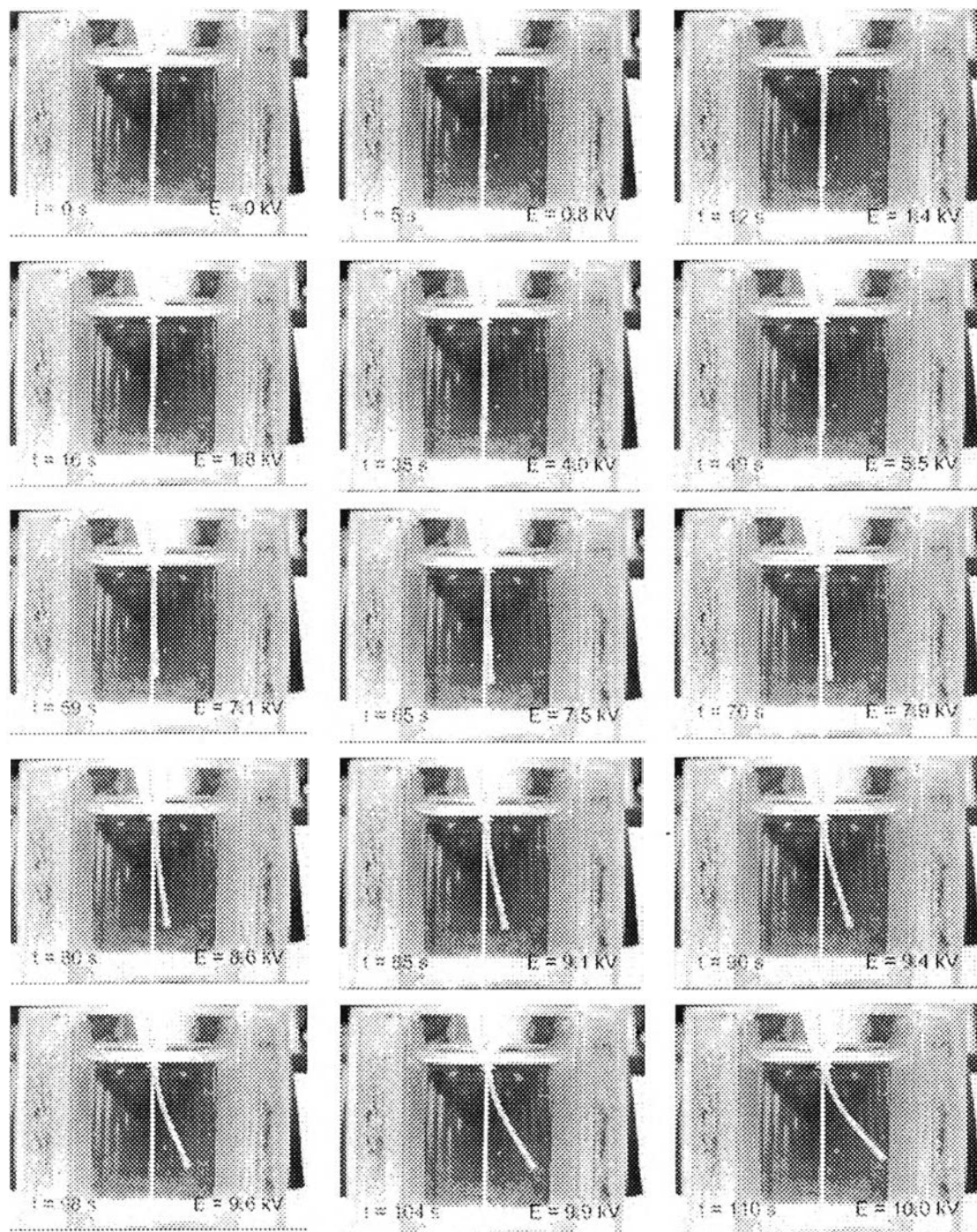
Figure J1 Selected capture digital image of neat rubber fiber.
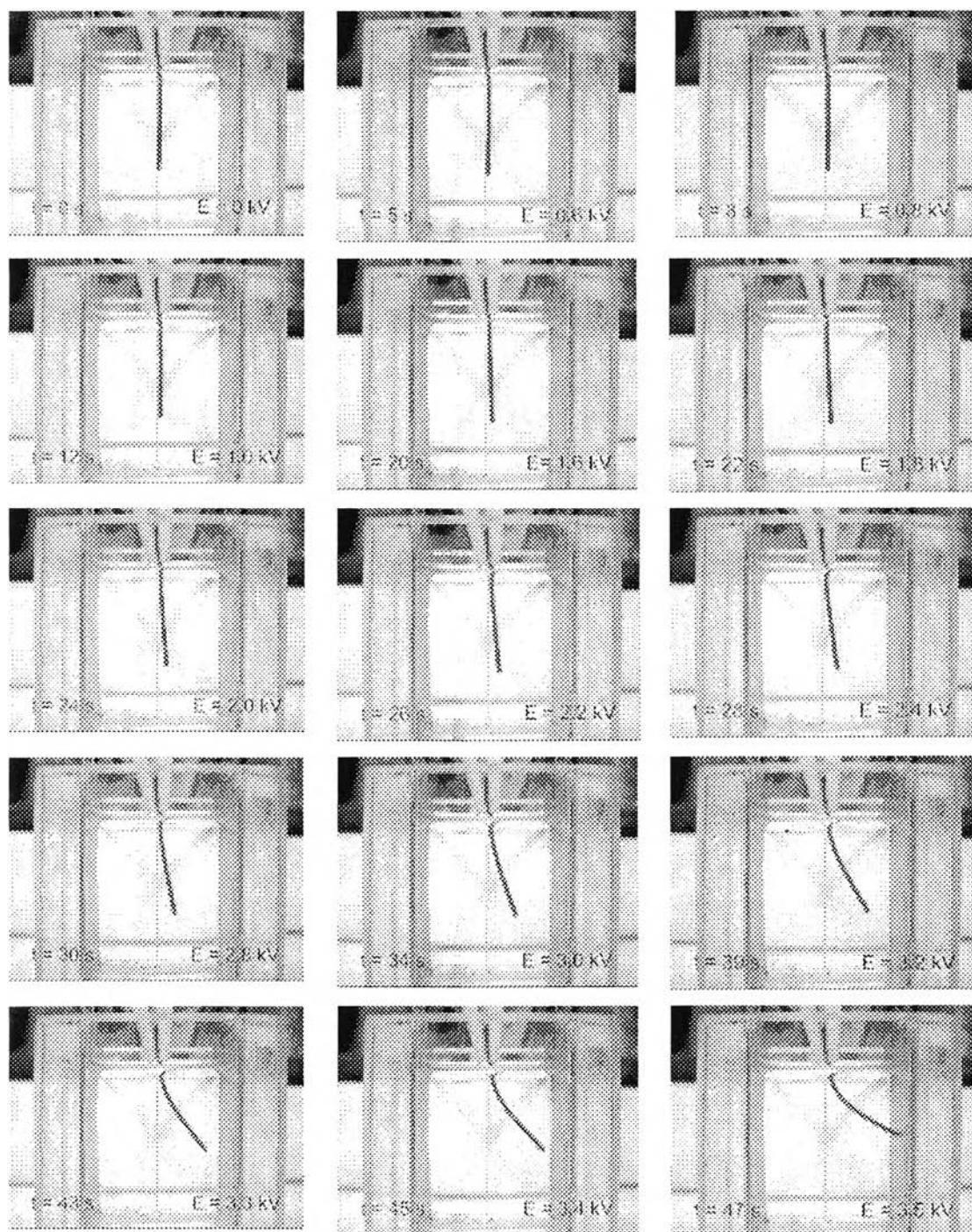
Figure J2 Selected capture digital image of 5% w/w HCl-doped PANI/NR composite fiber

CURRICULUM VITAE

Name: Mr. Panu Sukitpaneenit

Date of Birth: March 11, 1983

Nationality: Thai

University Education:

    2001-2005   Bachelor Degree of Petrochemical and Polymeric Materials, Faculty of Engineering and Industrial Technology, Silpakorn University, Nakhon Pathom, Thailand.

Working Experience:

2003	Position:	Student Internship
	Company name:	Thaiocean Co., Ltd.
2004	Position:	R&D Trainee
	Company name:	PI Industry Co., Ltd. (Innovation Group)