REFERENCES

Ahmad, Z. (2012) Polymeric Dielectric Material. Intech Open Access.

Achaby, M.E., Arrakhiz, F.Z., Vaudreuil, S., Essassi, E.M. and Qaiss, A. (2012) Piezoelectric β-polymorph formation and properties enhancement in graphene oxide - PVDF nanocomposite films. Applied Surface Science, 258(19), 7668-7677.

Altmutter, W., Keckes, J., Plackner, J., Liebner, F., Englund, K. and Laborie, M.P. (2012) All-cellulose composites prepared from flax and lyocell fibers compared to epoxy-matrix composites. Composites Science and Technology, 72, 1304-1309.

Arneson, T.R. and Chalie, M.L. (2006) U.S. Patent US 7129854 B2.

Barrett, G. and Omote, R. (2010) Projected-Capacitive Touch Technology. Journal of the Society for Information Display, 26(3), 16-21.

Barud, H.S., Ribeiro, C.A., Crespi, M.S., Martines M.A.U., Dexpert-Ghys, J., Marques, R.F.C., Messaddeq, Y. and Ribeiro, S.J.L. (2007) Thermal characterization of bacterial cellulose-phosphate composite membranes. Journal of Thermal Analysis and Calorimetry, 87(3), 815-818.

Bhatnager, A. and Sillanpaa, M. (2009) Applications of chitin- and chitosan-derivatives for the detoxification of water and wastewater - A short review. Advanced in Colloid and Interface Science, 152, 26-38.

Betz, R. (1984) Properties and aging of SOLEF PVDF piezo- and pyroelectric films for medical transducer. Ferroelectrics, 60(1), 37-43.

Bokma, L.W., Fisher, J., Vora J.R., and Saket (2013) U.S. Patent US 20130141342 A1.

Branciforti, M.C., Sencadas, V., Lanceros-Mendez, S., and Rinaldo Gregorio, J. (2007) New technique of processing highly oriented poly(vinylidene fluoride) films exclusively in the β-phase Journal of Polymer Science: Part B: Polymer Physics, 45(19), 2793-2801.

Brown, D., Steinbacher, C., Turpin T., Butler R. and Bales C. "History of Elo." Elotouch. <http://www.elotouch.com/AboutElo/History/default.asp>

Brown, E.E. and Laborie, M.P.G. (2007) Bioengineering bacterial cellulose/poly(ethylene oxide) nanocomposites. Biomacromolecules, 8(10), 3074-3081.

Cao, X., Chen, Y., Chang, P.R., Muir, A.D., and Falk, G. (2008) Starch-based nanocomposites reinforced with flax cellulose nanocrystals. Express Polymer Letters, 2(7), 502-510.

Cao, X., Chen, Y., Chang, P.R., Stumborg, M., and Huneault, M.A. (2008) Green composites reinforced with hemp nanocrystals in plasticized starch. Journal of Applied Polymer Science, 109(6), 3804-3810.

Chae, D.W. and Hong, S. M. (2010) Dynamic crystallization behavior, morphology and physical properties of highly concentrated poly(vinylidene fluoride)/silver nanocomposites. Journal of Polymer Science: Part B: Polymer Physics, 48(22), 2379-2385.

Chae, D.W., Hwang, S.S., Hong, S.M., Hong, S.P., Cho, B.G., and Kim, B.C. (2007) Influence of high contents of silver nanoparticles on the physical properties of poly(vinylidene fluoride). Molecular Crystals and Liquid Crystals, 464(1), 233-241.

Chang, W.Y., Fang, T.H., and Lin, Y.C. (2008) Thermomechanical and optical characteristics of stretched polyvinylidene fluoride. Journal of Polymer Science: Part B: Polymer Physics, 46(10), 949-958.

Chinaglia, D.L., Rinaldo Gregorio, J., Stefanello, J.C., Altafim, R.A.P., Wirges, W., Wang, F., and Gerhard, R. (2009) Influence of the solvent evaporation rate on the crystalline phases of solution-cast poly(vinylidene fluoride) films. Journal of Applied Polymer Science, 116(2), 785-791.

Czaja, W., Romanovicz, D., and Malcom Brown, J.R. (2004) Structural investigations of microbial cellulose produced in stationary and agitated culture. Cellulose, 11(3-4), 403-411.

Dahan, R.M., Ismail, S.I., Latif, F., Sarip, M.N., Wahid, M.H., and Arshad, A.N. (2012) Dielectric properties of collagen on plasma modified polyvinylidene fluoride. Journal of Applied Sciences, 9(5), 694.

Dargaville, T.R., Celina, M.C., Elliot, J.M., Chaplya, P.M., Jones, G.D., Mowery, D.M., Assink, R.A., Clough, R.L., and Martin, J.W. (2005)

Characterization, performance and optimization of PVDF as a Piezoelectric film for advanced space mirror concepts. Sandia report. Sandia National Laboratories.

Downs, R. (2005) Using resistive touch screens for human/machine interface (pp. 5-10).

Erdohan, Z.O., Cam, B., and Turhan, K.N. (2013) Characterization of antimicrobial polylactic based films. Journal of Food Engineering, 119(2), 308-315.

Eyraud, L., Clements, B., and Wane, A. (2013) Green investment: Trends and Determinants. Energy Policy, 60, 852-865.

Faruk, O., Bledzki, A.K., Fink, H.P., and Sain, M. (2012) Biocomposites reinforced with natural fibers:2000-2010. Progress in Polymer Science, 37(11), 1552-1596.

Fernandes, S.C.M., Oliveira, L., Freire, C.S.R., Silvestre, A.J.D., Neto, C.P., Gandini, A., and Desbrieres, J. (2009) Novel transparent nanocomposite films based on chitosan and bacterial cellulose. Green Chemistry, 11(12), 2023-2029.

Ferreira, A., Rocha, J.G., Anson-Casaos, A., Martinez, M.T., Vaz, F., and Lanceros-Mendez, S. (2012) Electromechanical performance of poly(vinylidene fluoride)/carbon nanotube composites for strain sensor applications. Sensors and Actuators A: Physical, 178, 10-16.

Frollini, E., Bartolucci, N., Sisti, L., and Celli, A. (2013) Poly(butylene succinate) reinforced with different lignocellulosic fibers. Industrial Crops and Products, 45, 160-169.

Fukada, E. and Furukawa, T. (1981) Piezoelectricity and ferroelectricity in polyvinylidene fluoride. Ultrasonics, 19(1), 31-39.

George, J., Ramana, K.V., Bawa, A.S., and Siddaramaiah. (2011) Bacterial cellulose nanocrystals exhibiting high thermal stability and their polymer nanocomposites. International Journal of Biological Macromolecules, 48(1), 50-57.

George, J., Sajeevkumar, V.A., Kumar, R., Ramana, K.V., Sabapathy, S.N., and Bawa, A.S. (2007) Enhancement of thermal stability associated with the

chemical treatment of bacterial (gluconacetobacter xylinus) cellulose. Journal of Applied Polymer Science, 108(3), 1845-1851.

Goncalves, R., Martins, P.M., Caparro, C., Martins, P., Benelmekki, M., Botelho, G., Lanceros-Mendez, S., Lasheras, A., Gutierrez, J., and Barandiaran, J.M. (2012) Nucleation of the electroactive β-phase, dielectric and magnetic response of poly(vinylidene fluoride) composties with Fe_2O_3 nanoparticles. Journal of Non-Crystalline Solids, 361, 93-99.

Halib, N., Iqbal, M.C., Amin, M., and Ahmad, I. (2012) Physicochemical properties and characterization of Nata de Coco from local food industries as a source of celluose. Sains Malaysiana, 42(2), 205-211.

Hall, B.H. and Helmers, C. (2013) Innovation and diffusion of clean/green technology: Can patent commons help? Journal of Environmental Economics and Management, 66(1), 33-51.

Harrison, J.S. and Ounaies, Z. (2001) Piezoelectric Polymers. ICASE, 211422. Virginia, Natrional Aeronautics and Spcae Administration, Langley Research Center, Hampton, Virginia.

Huan, Y., Liu, Y., Yang, Y., and Wu, Y. (2007) Influence of extrusion, stretching and poling on the structural and piezoelectric properties of poly(vinylidene fluoride-hexafluoropropylene) copolymer films. Journal of Applied Polymer Science, 104(2), 858-862.

Jayakumar, R., Prabaharan, M., Nair, S.V., Tokura, S., Tamura, H., and Selvamurugan, N. (2010) Novel carboxymethyl derivatives of chitin and chitosan materials and their biomedical applications. Progress in Materials Science, 55(7), 675-709.

Jiang, Y., Ye, Y., Yu, J., Wu, Z., Li, W., Xu, J., and Xie, G. (2007) Study of thermally poled and corona charged poly(vinylidene fluoride) films. Polymer Engineering and Science, 47(9), 1344-1350.

Johnson, E.A. (1965) Touch display - a novel input/output device for computers. Electronics Letters I, 8, 219-220.

Kasaai, M.R. (2008) A review of several reported procedures to determine the degree of N-acetylation for chitin and chitosan using infrared spectroscopy. Carbohydrate Polymers, 71(4), 497-508.

Kawai, H. (1969) The piezoelectricity of poly(vinylidene fluoride). Japanese Journal of Applied Physics, 8, 975-976.

Khalil, H.P.S.A., Bhat, A.H., and Yusra, A.F.I. (2012) Green composites from sustainable cellulose nanofibrils: A review. Carbohydrate Polymers, 87(2), 963-979.

Kim, J., Yun, S., and Ounaies, Z. (2006). Discovery of cellulose as a smart material. Macromolecules, 39(12), 4202-4206.

Kuang, X., Liu, Z., and Zhu, H. (2013) Dielectric Properties of Ag@C/PVDF Composites. Applied Polymer Science, 129(6), 3411-3416.

Li, H., Kiang, M., Dond, L., Xie, H., and Xiong, C. (2013) Particle size dependence of the dielectric properties of polyvinylidene fluoride/silver composites. Journal of Macromolecular Science, Part B:Physics, 52(8), 1058-1066.

Li, J., Luo, X., and Lin, X. (2013) Preparation and characterization of hollow glass microsphere reinforced poly(butylene succinate) composites. Materials & Design, 46, 902-909.

Lovinger, A.J. (1982) Developments in crystalline polymer. London: Applied Science Publisher.

Maneerung, T., Tokura, S., and Rujiravanit, R. (2008) Impregnation of silver nanoparticles into bacterial cellulose for antimicrobial wound dressing. Carbohydrate Polymers, 72(1), 43-51.

Manna, S., Batabyal, S.K., and Nandi, A.K. (2006) Preparation and characterization of silver-poly(vinylidene fluoride) nanocomposites: formation of piezoelectric polymorph of poly(vinylidene fluoride). Journal of Physical Chemistry B, 110(25), 12318-12326.

Marcovich, N.E., Auad, M.L., Bellesi, N.E., Nutt, S.R., and Aranguren, M.I. (2006) Cellulose Micro/Nanocrystals Reinforced Polyurethane. Journal of Materials Research, 21(4), 870-881.

Miranda, D., Sencadas, V., Sánchez-Iglesias, A., Pastoriza-Santos, I., and Liz-Marzán, J.L.G.R.L.M., and Lanceros-Mendez, S. (2008) Influence of Silver Nanoparticles Concentration on the α- to β-Phase Transformation and the Physical Properties of Silver Nanoparticles Doped Poly(vinylidene

fluoride) Nanocomposites. Journal of Nanoscience and Nanotechnology, 9(5), 1-7.

Murayama, N., Nakamura, K., Obara, H., and Segawa, M. (1976) The strong piezoelectricity in polyvinylidene fluoride (PVDF). Ultrasonics, 14(1), 15-24.

Nalwa and Sing, H. (1995) Ferroelectric polymers chemistry, physics and applications. New York: Marcel Dekker, Inc.

Nogi, M. and Yano, H. (2008) Transparent nanocomposites based on cellulose produced by bacteria offer potential innovation in the electronics device industry. Advanced Materials, 20(10), 1849-1852.

O-Rak, K., Phakdeepataraphan, E., Bunnak, N., Ummartyotin, S., Sain, M., and Manuspiya, H. (2014) Development of bacterial cellulose and poly(vinylidene fluoride) binary blend system: Structure and properties. Chemical Engineering Journal, 237, 396-402.

O-Rak, K., Ummartyotin, S., Sain M., and Manuspiya, H. (2013) Covalently grafted carbon nanotube on bacterial cellulose composite for flexible touch screen application. Materials Letters, 107, 247-250.

O-Rak, K. (2013) Poly(vinylidene fluoride)/bacterial cellulose nanocomposite films for touch sensor applications. M.S. Thesis, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.

Ojijo, V. and Ray, S.S. (2014) Nano-biocomposites based on synthetic aliphatic polyesters and nanoclays. Progress in Materials Science, 62, 1-57.

Patro, T.U., Mhalgi, M.V., Khakhar, D.V., and Misra, A. (2008) Studies on poly(vinylidene fluoride)–clay nanocomposites: Effect of different clay modifiers. Polymer, 49(16), 3486-3499.

Pillai, C.K.S., Paul, W., and Sharma, C.P. (2009) Chitin and chitosan polymers: Chemistry, solubility and fiber formation. Progress in Polymer Science, 34(7), 641-678.

Puspitasari, T. and Radiman, C.L. (2006) Study of graft copolymerization of acrylic acid on to nata de coco and its application as microfiltration menbrane. Atom Indonesia Journal, 32(2), 119-128.

Ramos, M.M.D., Correia, H.M.G., and Lanceros-mendez, S. (2005) Atomistic modelling of processes involved in poling PVDF. Computational Materials Science, 33(1-3), 230-236.

Rao, V., Ashokan, P.V., and Amar, J.V. (2002) Studies on dielectric relaxation and AC conductivity of cellulose acetate hydrogen phthalate-poly(vinyl pyrrolidone) blend. Journal of Applied Polymer Science, 86(7), 1702-1708.

Ratanakamnuana, U., Atong, D., and Aht-Ong, D. (2012) Cellulose esters from waste cotton fabric via conventional and microwave heating. Carbohydrate Polymers, 87(1), 84-94.

Rekik, H., Ghallabi, Z., Royqud, I., Arous, M., Seytre, G., Boiteux, G., and Kallel, A. (2013) Dielectric relaxation behavior in semi-crystalline polyvinylidene fluoride (PVDF)/TiO_2 nanocomposites. Composites: Part B, 45(1), 1199-1206.

Salimi, A. and Yousefi, A.A. (2003) FTIR studies of β-phase crystal formation in stretched PVDF films. Polymer Testing, 22(6), 699-704.

Salimi, A. and Yousefi, A.A. (2004) Conformational changes and phase transformation mechanisms in PVDF solution-cast films. Journal of Polymer Science: Part B: Polymer Physics, 42(18), 3487-3495.

Sanook. "What is the difference between Resistive touchscreen and Capacitive touchscreen?" Sanook. <http://hitech.sanook.com/technology/news_13265.php>

Shah, N., Ul-Islam, M., Khattak, W.A., and Park, J.K. (2013) Overview of bacterial cellulose composites: A multipurpose advanced material. Carbohydrate Polymers, 98(2), 1585-1598.

Shin, Y.H., Cho, C.K., and Kim, H.K. (2013) Resistance and transparency tunable Ag-inserted transparent InZnO films for capacitive touch screen panels. Thin Solid Films, 548, 641-645.

Tang, C. and Liu, H. (2008) Cellulose nanofiber reinforced poly(vinyl alcohol) composite film with high visible light transmittance. Composites: Part A, 39(10), 1638-1643.

Tee, D.I., Mariatti, M., Azizan, A., See, C.H., and Chong, K.F. (2007) Effect of silane-based coupling agent on the properties of silver nanoparticles filled epoxy composites. Composites Science and Technology, 67(11-12), 2584-2591.

Trovatti, E., Oliveira, L., Freire, C.S.R., Silvestre, A.J.D., Neto, C.P., Pinto J.J.C.C., and Gandini, A. (2010) Novel bacterial cellulose–acrylic resin nanocomposites. Composites Science and Technology, 70(7), 1148-1153.

Ummartyotin, S., Bunnak, N., Juntaro, J., Sain, M., and Manuspiya, H. (2012) Hybrid organic-inorganic of ZnS embedded PVP nanocomposite film for photoluminescent application. Comptes Rendus Physique, 13(9-10), 994-1000.

Ummartyotin, S., Bunnak, N., Juntaro, J., Sain, M., and Manuspiya, H. (2012) Synthesis and luminescence properties of ZnS and metal (Mn,Cu)-doped-ZnS ceramic powder. Solid State Sciences, 14(3), 299-304.

Ummartyotin, S., Bunnak, N., Juntaro, J., Sain, M., and Manuspiya, H. (2012) Synthesis of colloidal silver nanoparticle for printed electronic. Comptes Rendus Chimie, 15(6), 539-544.

Ummartyotin, S., Juntaro, J., Sain, M., and Manuspiya, H. (2011) Si-O barrier technology for bacterial cellulose nanocomposite flexible displays. Carbohydrate Polymers, 86(1), 337-342.

Ummartyotin, S., Juntaro, J., Sain, M., and Manuspiya, H. (2012) Development of transparent bacterial cellulose nanocomposite film as substrate for flexible organic light emitting diode (OLED) display. Industrial Crops and Products, 35(1), 92-97.

Ummartyotin, S., Juntaro, J., Sain, M., and Manuspiya, H. (2012) The role of ferrofluid on surface smoothness of bacterial cellulose nanocomposite flexible display. Chemical Engineering Journal, 193-194, 16-20.

Ummartyotin, S., Juntaro, J., Wu, C., Sain, M., and Manuspiya, H. (2011) Deposition of PEDOT:PSS nanoparticles as a conductive microlayer anode in OLEDs device by desktop inkjet printer. Journal of Nanomaterials, 1(Article) ID 606714.

Vijayakumar, R.P., Khakhar, D.V., and Misra, A. (2010) Studies on α to β phase transformations in mechincally deformed PVDF films. Journal of Applied Polymer Science, 117(6), 3491-3497.

Walker, G. (2012) A review of technologies for sensing contact location on the surface of a display. Journal of the Society of Information Display, 20(8), 413-440.

Wang, W., Zhang, S., Srisombat, L.O., Lee, T.R., and Advincula, R.C. (2011) Gold-nanoparticle- and gold-nanoshell- induced polymorphism in poly(vinylidene fluoride). Macromolecular Materials and Engineering, 296(2), 178-184.

Wu, J., Zheng, Y., Song, W., Luan, J., Wen, X., Wu, Z., Chen, X., Wang, Q., and Guo, S. (2014) In situ synthesis of silver-nanoparticles/bacterial cellulose composites for slow-released antimicrobial wound dressing. Carbohydrate Polymers, 102, 762-771.

Zhang, X., Feng, J., Liu, X., and Zhu, K. (2012) Preparation and characterization of regenerated cellulose/poly(vinylidene fluoride) (PVDF) blend films. Carbohydrate Polymers, 89(1), 67-71.

Zhang, Y.Y., Jiang, S.L., Yu, Y., Xiong, G., Zhang, Q.F., and Guang, G.Z. (2012) Phase tranformation mechanisms and piezoelectric properties of poly(vinylidene fluoride)/montmorillonite composite. Journal of Applied Polymer Science, 123(5), 2595-2600.

Zulkarnaim, M., Mariatti, M., and Azid, I.A. (2008) Prediction Studies on Percolation Threshold Behaviour of Silver Filled Epoxy Composite for Electrically Conductive Adhesives Applications. Paper presented at Electronic Manufacturing Technology Symposium (IEMT), 2008 33rd IEEE/CPMT International, Penang, Malaysia.

Zuo, J. and Zhao, Z.Y. (2014) Green building research-current status and future agenda: A review. Renewable and Sustainable Energy Reviews, 30, 271-281.

APPENDICES

Appendix A β-phase Crystallinity Calculation

The β-phase crystallinity of BC/PVDF blend films and AgNP-BC/PVDF nanocomposite films were calculated as follow the equation 3.1

Beer-Lambert's Law $$F(\beta) = \frac{X_\beta}{X_\alpha + X_\beta} = \frac{A_\beta}{1.26A_\alpha + A_\beta} \quad (3.1)$$

Where X_α and X_β are the degree of crystallinity of α and β phases, A_α and A_β are the absorbances of α and β phases at 765 and 840 cm^{-1}, respectively.

Table A1 The identification of FT-IR peaks analyzed of BC/PVDF blend films compared with neat PVDF

Sample	A_α (763 cm^{-1})	A_β (840 cm^{-1})	F(β)
Neat PVDF	0.200	0.411	0.62
BC2.5PVDF97.5	0.136	0.305	0.64
BC5PVDF95	0.277	0.710	0.67
BC10PVDF90	0.379	0.887	0.65
BC15PVDF85	0.204	0.340	0.57

Table A2 The identification of FT-IR peaks analyzed of AgNP-BC/PVDF nanocomposite films compared with BC2.5PVDF97.5

Sample	A_α (763 cm^{-1})	A_β (840 cm^{-1})	F(β)
BC2.5PVDF97.5	0.136	0.305	0.64
ABP(0.125/2.375)	0.235	0.170	0.36
ABP(0.25/2.25)	0.180	0.132	0.37
ABP(0.5/2.0)	0.315	0.223	0.36

Appendix B %Crystallinity Calculation

The %crystallinity of BC/PVDF blend films and AgNP-BC/PVDF nanocomposite films were calculated as follow the equation 3.2

$$\% \text{ crystallinity } (X_C) = \frac{\Delta H_m, \Delta H_c}{\Delta H_m^o, \Delta H_c^o (1-\alpha)} \times 100\% \qquad (3.2)$$

Where ΔH_m is the melting enthalpy of the material under study, ΔH_c is the crystallization enthalpy of the material under study and ΔH_m^0 is the melting enthalpy of totally crystalline material (100% crystalline), ΔH_m^0 for PVDF = 92.4 J/g, and α is fiber weight content.

Table B1 The identification of DSC peaks analyzed of BC/PVDF blend films with neat PVDF

Sample	ΔH_m (J/g)	T_m (°C)	X_c (%)	ΔH_c (J/g)	T_c (°C)	X_c (%)
Neat PVDF	45.10	170.7	48.81	45.58	138.5	50.53
BC2.5PVDF97.5	38.55	171.8	42.79	38.61	146.6	43.90
BC5PVDF95	36.72	174.4	41.83	35.18	147.7	41.05
BC10PVDF90	34.57	173.3	41.57	33.08	149.0	40.74
BC15PVDF85	37.49	172.9	47.73	40.25	149.1	52.49

Table B2 The identification of DSC peaks analyzed of AgNP-BC/PVDF blend films with BC2.5PVDF97.5

Sample	ΔH_m (J/g)	T_m (°C)	X_c (%)	ΔH_c (J/g)	T_c (°C)	X_c (%)
BC2.5PVDF97.5	38.55	171.8	42.79	38.61	146.6	43.90
ABP(0.125/2.375)	34.73	172.0	38.55	36.24	147.8	41.21
ABP(0.25/2.25)	33.43	173.8	37.11	33.08	146.9	37.61
ABP(0.5/2.0)	32.05	171.9	35.57	33.52	147.9	38.11

Appendix C Crystalline Size Calculation

The crystalline size of BC/PVDF blend films and AgNP-BC/PVDF nanocomposite films were calculated as follow the equation 3.3 (Hartono *et al.*, 2013)

$$\beta_{cryst} = \frac{k\lambda}{Lcos\theta} \tag{3.3}$$

Where β_{cryst} is the peak width of the diffraction peak profile at half maximum height resulting from small crystalline size in radians, λ is the wavelength of the x-ray used in nanometer (0.154 nm), θ is the Bragg angle, L is the "average" crystallite size measured in a direction perpendicular to the surface of the specimen, and k is a constant. The constant k has been determined to vary between 0.89 and 1.39, but is usually taken as close to unity, the assumption that k = 1.0 is generally justifiable.

Table C1 The crystalline size of BC/PVDF blend films compare with neat PVDF

Sample	2θ (degree)	cos θ	β (degree)	β (rad)	Crystalline size (nm)	Crystalline $size_{ave}$ (nm)
neat PVDF	18.47	0.987	0.387	0.007	23.09	17.94
	20.05	0.985	0.354	0.006	25.29	
	26.61	0.973	1.669	0.029	5.43	
BC2.5PVDF97.5	18.43	0.987	0.477	0.008	18.74	16.10
	20.02	0.985	0.373	0.007	24.03	
	26.65	0.973	1.643	0.029	5.52	
BC5PVDF95	18.40	0.987	0.402	0.007	22.23	17.47
	19.99	0.985	0.369	0.006	24.26	
	26.67	0.973	1.535	0.027	5.91	
BC10PVDF90	18.51	0.987	0.426	0.007	20.98	17.07
	20.09	0.985	0.392	0.007	22.85	
	26.75	0.973	1.230	0.021	7.38	
BC15PVDF85	18.49	0.987	0.292	0.005	30.57	19.04
	19.98	0.985	0.429	0.007	20.86	
	26.41	0.974	1.590	0.028	5.70	

Table C2 The crystalline size of AgNP-BC/PVDF nanocomposite films compare with BC2.5PVDF97.5

Sample	2θ (degree)	cos θ	β (degree)	β (rad)	Crystalline size (nm)	Crystalline $size_{ave}$ (nm)
2.5BC97.5PVDF	18.43	0.987	0.477	0.008	18.74	16.10
	20.02	0.985	0.373	0.007	24.03	
	26.65	0.973	1.643	0.029	5.52	
ABP(0.125/2.375)	18.36	0.987	0.409	0.007	21.87	17.40
	19.94	0.985	0.366	0.006	24.51	
	26.51	0.973	1.557	0.027	5.83	
ABP(0.25/2.25)	18.44	0.987	0.400	0.007	22.37	17.26
	20.01	0.985	0.365	0.006	24.55	
	26.53	0.973	1.867	0.033	4.86	
ABP(0.5/2.0)	18.45	0.987	0.299	0.005	29.86	19.90
	19.97	0.985	0.385	0.007	23.30	
	26.62	0.973	1.387	0.024	6.54	

Appendix D Surface Roughness

The morphology and surface roughness parameters were investigated by atomic force microscopy technique. The images were presented in 40 μm x 40 μm scanning area.

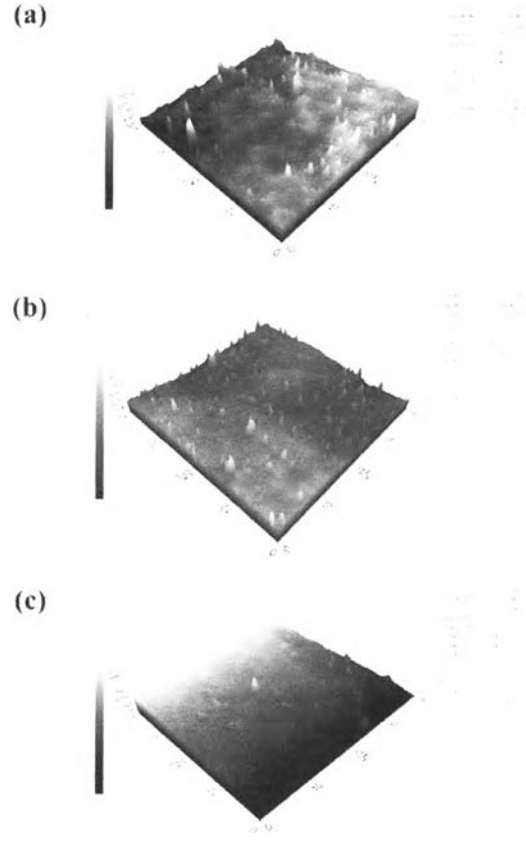

Figure D1 Atomic force microscopic topology images of (a) neat PVDF, (b) BC2.5PVDF97.5, and (c) ABP(0.125/2.375).

Appendix E Preparation and Characterization of Silver Nanoparticles Filled Bacterial Cellulose

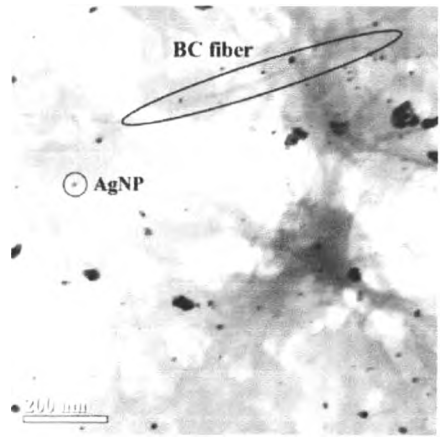

Figure E1 TEM investigation of loaded Ag NP on bacterial cellulose suspension.

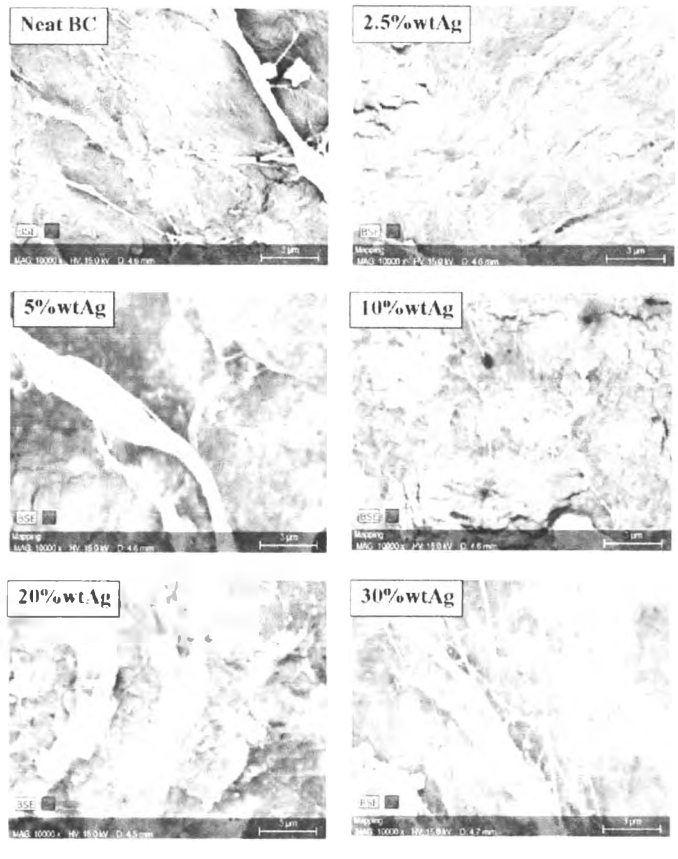

Figure E2 SEM-EDS images of various amount AgNP in AgNP-BC.

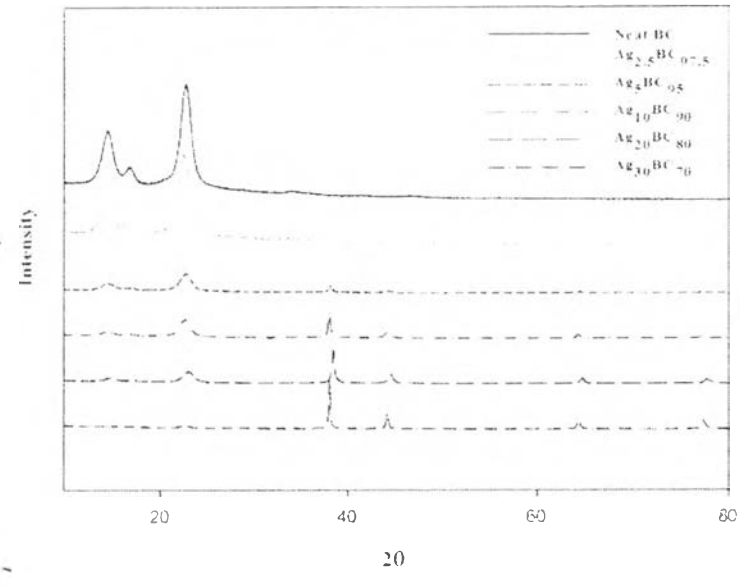

Figure E3 XRD pattern of loaded AgNP on bacterial cellulose.

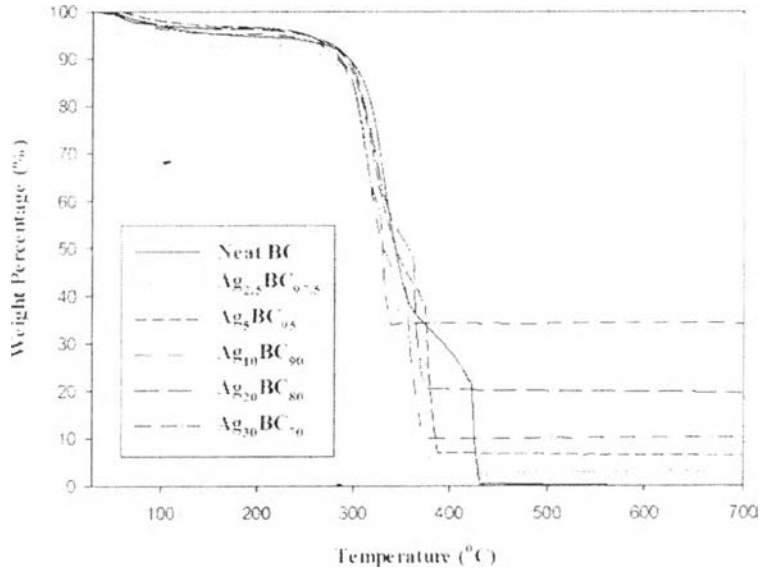

Figure E4 STA thermograms of loaded AgNP on bacterial cellulose.

Table E1 STA parameters of various amount of Ag loading in BC compared with neat BC

Sample	Ag (vol%)	%Residue	T_d (°C)
Neat BC	0.0	0.00	360.4
2.5%wtAg	0.375	2.60	359.8
5%wtAg	0.73	5.97	355.4
10%wtAg	1.5	9.89	350.2
20%wtAg	3.45	19.25	338.5
30%wtAg	5.77	33.86	321.7

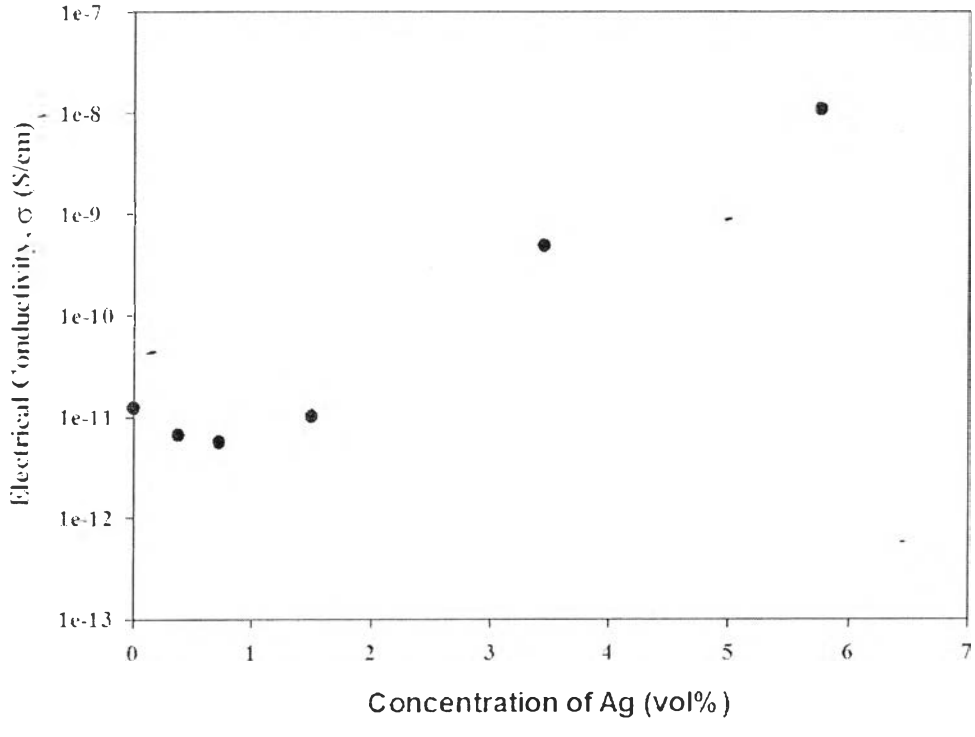

Figure E5 Electrical conductivity of nanocomposite sheet at various amount of AgNP.

Table E2 Electrical parameters at various amounts of silver in nanocomposite sheet

Sample	Ag (vol%)	ρ (ohm-cm)	σ (sement/cm)	R^2
Neat BC	0	$8.18x10^{10}$	$1.22x10^{-11}$	0.9924
2.5%wtAg	0.375	$1.53x10^{11}$	$6.55x10^{-12}$	0.9743
5%wtAg	0.73	$1.81x10^{11}$	$5.53x10^{-12}$	0.9265
10%wtAg	1.5	$9.96x10^{10}$	$1.00x10^{-11}$	0.9332
20%wtAg	3.45	$2.08x10^{10}$	$4.8x10^{-11}$	0.9243
30%wtAg	5.77	$9.28x10^{7}$	$1.08x10^{-8}$	0.9922

CURRICULUM VITAE

Name: Mr. Ekasit Phakdeepataraphan

Date of Birth: December 6, 1989

Nationality: Thai

University Education:

2008-2011 Bachelor Degree of Petrochemicals and Polymeric Materials, Faculty of Engineering and Industrial Technology, Silpakorn University, Nakonpathom, Thailand

Work Experience:

March-May2011 Position: Trainee

Company name : Grand Siam Composite Co., Ltd.

Publications:

1. Buasri, A.; Chaiyut, N.; Loryuenyong, V.; Phakdeepataraphan, E.; Watpathomsub, S.; and Kunakemakorn, V. (2013) Utilization of biodiesel wastes as a bioresource for the preparation of activated carbon. International Journal of Applied Physics and Mathematics, 3(3), 173-177.
2. O-Rak, K.; Phakdeepataraphan, E.; Bunnak, N.; Ummartyotin, S.; Sain, M.; and Manuspiya, H. (2014) Development of bacterial cellulose and poly(vinylidene fluoride) binary blend system: Structure and properties. Chemical Engineering Journal, 237, 396-402.

Proceedings:

1. Phakdeepataraphan, E.; Ummartyotin, S.; and Manuspiya, H. (2013, December 18-21) Effect of bacterial cellulose on polarization behavior of PVDF blends. Proceedings of the 11th Eco-Energy and Materials Science and Engineering Symposium, Phuket, Thailand.