REFERENCES

Avella, M., Martuscelli, E., and Raimo, M. (2000) Properties of blends and composite based on poly (3-hydroxybutyrate) and poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) copolymers. Journal Materials Science. 35, 523–545.

Baimark, Y., Molloy, R., Molloy, N., Siripitayananon, J., Punyodom, W., and Sriyai, M. (2005) Synthesis, characterization and melt spinning of a block copolymer of L-lactide and ε-caprolactone for potential use as an absorbable monofilament surgical suture Journal of materials science: material in medicine 16, 699–707.

Brozl, M.E., VanderHart, D.L., and Washburn, N.R. (2003) Structure and mechanical properties of poly(d,l-lactic acid)/ poly(ε-caprolactone) blends. Biomaterials 24, 4181–4190.

Cai, Q., Yang, J., Bei, J., and Wang S. (2002) A novel porous cells scaffold made of polylactide–dextran blend by combining phase-separation and particle-leaching techniques. Biomaterials. 23 , 4483–4492.

Chandra, R., and Rustgi, R. (1998) Biodegradable polymers. Progress in Polymer Science. 23, 1273-1335.

Chena, C.C., Chueha, J.Y., Tsengb, H., Huangc, H.M., Lee, and S.Y. (2003) Preparation and characterization of biodegradable PLA polymeric blends. Biomaterials. 24, 1167–1173.

Chen, L.,Wang, H., Wang, J., Chen, M., and Shang, L. (2007) Ofloxacin-delivery system of a polyanhydride and polylactide blend used in the treatment of bone infection. Journal of Biomedical Materials Research Part B: Applied Biomaterials. 83, 589–595.

Choi, J. S., Park, and W. H. (2003) Effect of biodegradable plasticizers on thermal and mechanical properties of poly(3-hydroxybutyrate). Polymer Testing. 23, 455–460.

Chung, H.P., Eun, Y.H., Yun, and K.K. (2007) Effects of Spinning Speed and Heat Treatment on the Mechanical Properties and Biodegradability of Poly(lactic acid) Fibers. Journal of Applied Polymer Science, 103, 3099–3104.

Couchman, P.R, and Karasz, F.E., (1978). Macromolecules. 11, 117.

Fambri, L., Pegoretti, A., Fenner, R., Incardona, S.D., and Migliaresi, C. (1997) Biodegradable fibres of poly(L-lactic acid) produced by melt spinning. Polymer 38 (1), 79–85.

Fei, B., Chen, C., Wu, H., Peng, S., Wang, X., and Dong., L. (2003) Quantitative FTIR study of PHBV/bisphenol A blends. European Polymer Journal. 39. 1939–1946.

Fox, T.G., and Bull. (1956) American Physical Society. 2, 123.

Fukada, E., and Ando, Y. (1986) Piezoelectric properties of poly β-hydroxybytyrate and copolymers of β-hydroxybutyrate and β-hydroxyvalerate. International Journal of Biological Macromolecules, 8, 361–366.

Furuhashi, Y., Imamurab, Y., Jikiharab, Y., and Yamane, H. (2004) Higher order structures and mechanical properties of bacterial homo poly(3-hydroxybutyrate) fibers prepared by cold-drawing and annealing processes. Polymer, 45, 5703–5712.

Gogolewski, S., Jovanovic, M., Perren, S.M., Dillon, J.G., and Hughes, M.K. (1993) Tissue response and in vivo degradation of select polyhydroxyacid: polylactides (PLA), poly (3-hydroxybutyrate) (PHB), and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHB/VA). Journal Biomedicine Materials Research, 27, 1135–1148.

Gordon M, and Taylor J.S. (1952) Journal Application Chemistry. 2, 493.

Harada, M., Ohya, T., Iida, K., Hayashi, H., Hirano, K., and Fukuda, H., (2007) Increased impact strength of biodegradable poly(lactic acid)/poly(butylene succinate) blend composites by using isocyanate as a reactive processing agent. Journal of Applied Polymer Science, 106, 1813–1820.

Ignatius, A.A., and Claes, L.E. (1996) In vitro biocompatibility of bioresorbable polymers: poly(L,DL-lactide) and poly(L-lactide-co-glycolide). Biomaterials, 17, 831-839.

Im, J.N., Kim, J.K., Kim, H.K., In, C.H., Lee K.Y., and Park, W.H. (2007) In vitro and in vivo degradation behaviors of synthetic absorbable bicomponent monofilament suture prepared with poly(p-dioxanone) and its copolymer. Polymer Degradation and Stability. 92, 667-674.

Jacobsen, S., Fritz, H.G., Degé, P., Dubois P., and Jérôme. R., (2000) New developments on the ring opening polymerization of polylactide. Industrial Crops and Products, 11, 265-275.

Ke, T., and Sun X.S. (2003) Thermal and mechanical properties of poly(lactic acid)/ starch/methylenediphenyl diisocyanate blending with triethyl citrate tianyi. Journal of Applied Polymer Science, 88, 2947–2955.

Ke, Z. B., Zheng, Z. F., Zhu, H. Y., Zhang, L. x., and Gao, X. P. (2009) Metal oxide nanofibres membranes assembled by spin-coating method. Desalination. 236, 1-7.

Kulinski, Z., and Piorkowska E. (2005) Crystallization, structure and properties of plasticized poly(L-lactide). Polymer. 46, 10290–10300.

Li, Y., Shimizu, H. (2007). Toughening of polylactide by melt blending with a biodegradable poly(ether)urethane elastomer Macromolecule Bioscience, 7, 921–928.

Liu, X., Dever, M., Fair, N., and Benson, R.S. (1997) Thermal and Mechanical Properties of Poly(lactic Acid) and Poly(ethylene/butylene Succinate) Blends. Journal of Environmental Polymer Degradation. 5, 225–235.

Luo, C., Zhang, Y., Zeng, X., Zeng, Y., and Wang, Y. (2005) Journal Colloidal Interface Science, 288, 444.

Mi, F.L., Shyu, S.S., Linc, Y.M., Wuc, Y.B., Peng, C.K., and Tsai, Y.H. (2003) Chitin/PLGA blend microspheres as a biodegradable drug delivery system: a new delivery system for protein. Biomaterials, 24, 5023–5036.

Middleton, J.C., and Tipton, A.J. (2000) Synthetic biodegradable polymers as orthopedic devices. Biomaterials, 21, 2335–2346.

Muriel, S., Jean, C., and Michel, V. (2006) Effects of polymerization conditions on the in vitro hydrolytic degradation of plaques of poly(d,l-lactic acid-blockethylene glycol) diblock copolymers. Polymer Degradation and Stability. 91, 2853–9.

Martin, O., and Averous, L., (2001) Poly(lactictic acid): plasticization and properties of biodegradable multiphase system. Polymer. 42, 6209-6219.

Parra, D.F., Fusaro, J., Gaboardi, F., and Rosa, D.S., (2006) Influence of poly(ethylene glycol) on the thermal, mechanical, morphological, physical–chemical and biodegradation properties of poly(3-hydroxybutyrate). Polymer Degradation and Stability 91, 1954–9.

Penning, J.P., Dijkstra, H., and Pennings, A.J. (1993) Preparation and properties of absorbable fibers from Llactide copolymers. Polymer. 34, 942–951.

Pillin, I., Montrelay, N., and Grohens, Y. (2006) Thermo-mechanical characterization of plasticized PLA: Is the miscibility the only significant factor? Polymer. 47, 4676–4682.

Piorkowska, E., Kulinski, Z., Galeski, A., and Masirek, R. (2006) Plasticization of semicrystalline poly(L-lactide) with poly(propylene glycol). Polymer. 47, 7178–7188.

Prudencio, W.R. Osinaga., Rosa, Helena, M. GFrande., Rafael, Y. Bellester., Maria, Regina, L. Simionato., Celia, Regina M. Degaldo, Rodrigues., Antonio, Muench. (2203) Zinc sulfate addition to glass-ionomer- based cement: influence on physical and antibacterial properties, Zinc and fluoride release. Dental materials. 19, 212–217.

Schmack, G., Jehnichen, D., Vogel, R., Tandler, B., Beyreuther, R., Jacobsen , S., and Fritz, G.H. (2001) Biodegradable fibres spun from poly(lactide) generated by reactive extrusion Journal of Biotechnology. 86, 151–160.

Sheth, M., Kumar, R.A., Dave, V., Gross, R.A., and Mccarthy, S.P. (1997) Biodegradable polymer blends of poly (lactic acid) and poly (ethylene glycol). Journal of Applied Polymer Science. 66, 1495–1505.

Shinoda, H., Asou, Y., Kashima, T., Kato, T., Tseng, Y., and Yagi, T. (2003) Amphiphilic biodegradable copolymer, poly(aspartic acid-colactide): acceleration of degradation rate and improvement of thermal stability for poly(lactic acid), poly(butylene succinate) and poly(e-caprolactone)Polymer. Degradation and Stability, 80, 241–250.

Tanaka, T., Fujita, M., Takeuchi A., Suzuki, Y., Uesugi, K., Ito, K., Fujisawa, T., Doi, Y., and Iwata T. (2006) Formation of highly ordered structure in poly[(R)-3-hydroxybutyrate-co-(R)-3-hydroxyvalerate] high-strength fibers. Macromolecules, 39, 2940-2946.

Takagi, Y., Yasuda, R., Yamaoka, M., and Yamane, T. (2004) Morphologies and mechanical properties of polylactide blends with medium chain length poly(3-Hydroxyalkanoate) and chemically modified Poly(3-Hydroxyalkanoate). Journal of Applied Polymer Science, 93, 2363–2369.

Tsuji, H, and Ikada, Y. (1996) Macromol Chem Phys, 197, 3483.

Utracki, L.A., (1985) Advance Polymer Technology. 5, 33.

Wang, S., Ma, P., Wang, R., Wang, S., Zhang Y., and Zhang, Y., (2008) Mechanical, thermal and degradation properties of poly(d,l-lactide)/poly(hydroxybutyrate-co-hydroxyvalerate)/poly(ethylene glycol) blend Polymer Degradation and Stability. 93, 1364-1369.

Xu, X., Yang, Q., Wang Y., Yu, H., Chen, X., and Jing, X. (2006) Biodegradable electrospun poly(L-lactide) fibers containing antibacterial silver nanoparticles. European Polymer Journal, 42, 2081–2087.

Yang, D. S., Park, S.K., and Neale, W.K. (2009) Flexural behaviour of reinforced concrete beams strengthened with prestressed carbon composite. Composite Structures. 88, 497-508.

Zafar, F., Ashraf, S.M., and Ahmad, S. (2007) Studies on zinc-containing linseed oil based polyesteramide. Reactive & Functional Polymers, 67, 928–93.

APPENDICES

Appendix of Melt rheology of PDLLA/PHBV blends

Table A1 The melt viscosities and piston velocity for PDLLA, PHBV and their blends.

Piston velocity ($mm.S^{-1}$)	Melt Viscocities (Pa.S)						
	PDLLA	PHBV	50/50	60/40	70/30	80/20	90/10
0.01	3418.749	1296.528	981.944	1256.944	1256.944	1296.528	1886.111
0.025	2420.555	581.389	597.222	723.056	738.611	1037.222	1414.444
0.05	1721.111	400.833	447.917	534.444	510.833	730.833	1053.055
0.1	1182.847	310.417	345.764	404.722	424.375	557.986	719.097
0.2	793.785	220.035	257.396	306.493	306.493	408.681	467.639
0.4	455.851	150.312	173.889	190.59	209.253	284.896	282.934
0.8	273.116	98.238	98.733	136.554	144.905	190.095	169.47

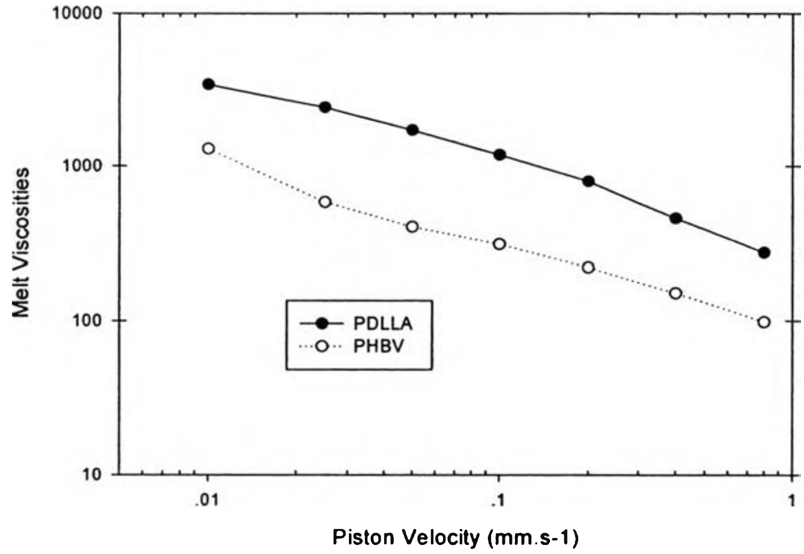

Figure A1 Relation between the melt viscosities and piston velocity for PDLLA and PHBV polymers at 180°C.

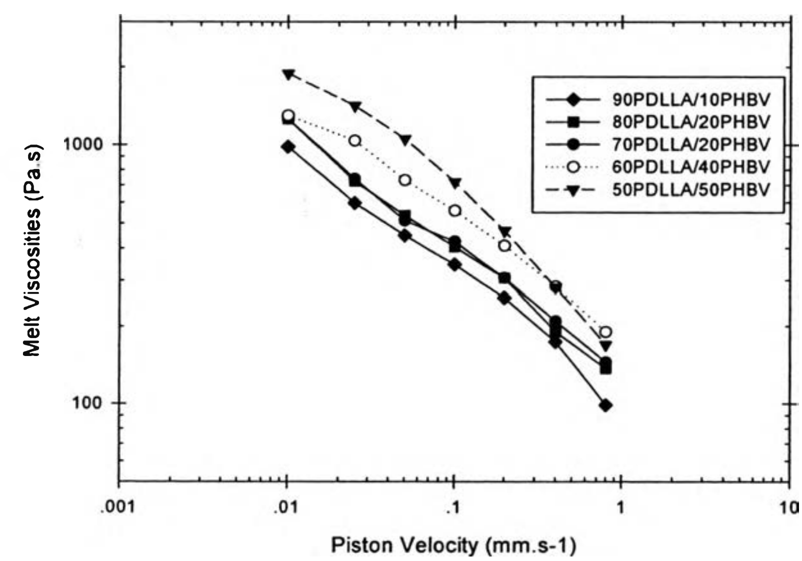

Figure A2 Relation between the melt viscosities and piston velocity for PDLLA/PHBV blended polymers at 180 °C. (◊) 90/10, (□) 80/20, (Δ) 70/30 (○) 60/40 and (×) 50/50.

Appendix of UV-visible absorption spectra

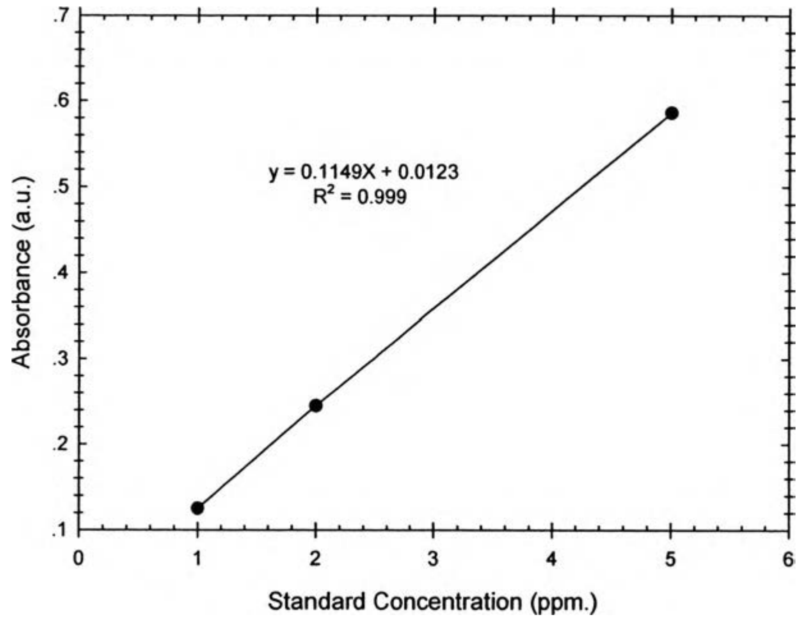

Figure A3 Standard calibration curve of silver ion.

Appendix of linear density of fiber for tensile testing

-PDLLA/PHBV

Table A2 Linear Density (denier) of PDLLA/PHBV fibers.

PDLLA/PHBV	Linear Density (denier)
neat PDLLA	324.787±10.787
90/10	360.954±15.435
80/20	264.402±19.056
70/30	138.087±20.545
60/40	185.556±25.913
50/50	167.625±32.189

-PDLLA/PHBV/PEG1000

Table A3 Linear Density (denier) of PDLLA/PHBV/PEG1000 fibers.

Blend compositions	Linear Density (denier)
50PLA/50PHBV	259.866±15.798
10%PEG	237.249±19.175
20%PEG	260.451±23.879
30%PEG	351.162±24.123

-PDLLA/PHBV/PEG1000/silver nanoparticles

Table A3 Linear Density (denier) of PDLLA/PHBV/PEG1000/silver nanoparticles fibers.

Blend compositions	Linear Density (denier)
50PLA/50PHBV/30%PEG	351.162±24.123
0.2% silver nanoparticles	198.051±17.077
0.3% silver nanoparticles	156.680±13.670
0.4% silver nanoparticles	110.166±26.578

CIRRICULUM VITAE

Name: Mr. Saran Suntarin

Date of Birth: November 15, 1984

Nationality: Thai

University Education:

2004-2007 Bachelor's Degree of Science in Major of Chemistry, Faculty of Science, Chulalongkorn University, Bangkok, Thailand.

2008-2009 Master's Degree of Science in Major of Polymer Science, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.

Proceedings:

1. Suntarin, S., Supaphol, P., (2009, Apirl 22) Thermal, Crystallization, and Mechanical Characteristics of Poly(d,l-lactide) Blend Fibers Containing Antibacterial Elements for Biomedical Applications by using Melt Spinning Technique. The 15th PPC Symposium on Petroleum, Petrochemicals, and Polymers, The Petroleum and Petrochemical College, Chulalongkorn University, Thailand.