REFERENCES

Almazan-Almazan, M.C., Paredes, J.I., Perez-Mendoza, M., Domingo-Garcia, M., Lopez-Garzon, F.J., Martinez-Alonso, A., Tascon, J.M.D., (2006). Surface characterisationof plasma-modified poly(ethylene terephthalate. Journal of Colloid and Interface Science, 293, 353–363.

Biniak, S., Pakula, M., and Swiatkowski, A., (1999). Infuence of surface chemical structure of active carbon on its electrochemical behaviour in the presence of silver. Journal of Applied Electrochemistry, 29, 421–487.

Borcia, G., Anderson, C.A., and Brown, N.M.D., (2003) Using a nitrogen dielectric barrier discharge for surface treatment. Plasma Sources Science Technology. 12, 335.

Chan Chi-Ming, (1994). Polymer Surface Modification and Characterization. New York: Hanser.

Chang, J.-S., Lawless, P.A., and Yamamoto, T., (1991). Corona discharge processes. IEEE Transactions on Plasma Science, 19(6), 1152-1166.

Liu Chaozong, Naiyi Cui, Norman, M.D. Brown, Bria, J. Meenan, (2004). Effects of DBD plasma operating parameters on the polymer surface modification. Surface and Coatings Technology, 185, 311–320.

Davenas, J., Thevenard P., Philippe, F., Arnaud, M.N., (2002). Low energy oxygen ion beam modification of the surface morphology and chemical structure of polyurethane fibers. Biomolecular Engineering, 243(1), 63-74.

De Geyter, N., Morent R., Leys C., (2006). Surface modification of a polyester non-woven with a dielectric barrier discharge in air at medium pressure. Surface and Coatings Technology, 201, 2460–2466.

De Geyter, N., Morent R., Leys, C., Gengembre, L., and Payen, E., (2007). Treatment of polymer films with a dielectric barrier discharge in air, helium and argon at medium pressure. Surface and Coatings Technology, 201(16-17), 7066-7075.

Denes, F.S., and Manolache, S., (2004). Macromolecular plasma-chemistry: an emerging field of polymer science. Progress in Polymer Science, 29, 815-885.

Eliasson, B., Hirth, M., and Kogeischatz, U., (1987). Ozone synthesis from oxygen in dielectric barrier discharge. Journal of Applied Physics, 20, 1421-1437.

Fang, Z., Qiu, Y., and Luo Y., (2003) Surface modification of polytetrafluoroethylene film using the atmospheric pressure glow discharge in air. Apply Physics, 36, 2980-2985

Fridman, A., Naster, S., Kennedy, L.A., Savaliev, A., and Mutaf-Yardimci O. (1999) Gliding arc discharge. Journal of Progress in Energy and Combustion Science, 25, 211-213.

Foerch, R., McIntyre, N.S., and Hunter, D.H., (1990). Gold coating of polyethylene modified by argon plasma discharge, Journal of Applied Polymer Science, 46(9), 1326 – 1332.

Foerch, R., McIntyre, N.S., Sodhi, R.N.S., and Hunter, D.H., (1990). Nitrogen plasma treatment of polyethylene and polystyrene in a remote plasma reactor. Journal of Applied Polymer Science, 40, 1903-1915.

Han, M.H., Jong, P.J., Ki, W.P., Jai, H.C., Hong, K.B., Joo, H.N., Kie, M.S., and Yong, S.L., (2006). Surface modification for adhesion enhancement of PET-laminated steel using atmospheric pressure plasma. Surface and Coatings Technology, 201(9-11), 4948-4952.

Hansen, R.H., and Schonhorn, H., (1966). Selective surface functionalization of polyolefins by plasma treatment followed by chemical reduction. Journal of Applied Polymer Science, 21(3), 837 – 853.

Harndumrongsak, B., (2002). Oxidation of Ethylene in a Plasma Environment. M.S.Thesis, Chulalongkorn University, Bangkok.

Hettlich, H.-J., Otterbach, F., Mittermayer, Ch., Kaufmann, R., and Klee, D., (2003). Surface engineering of biomaterials with plasma techniques. Journal of Biomaterials Science, 14, 1005-1028.

Hoffman, A.S., (1988). Surface properties and platelet adhesion characteristics of acrylic acid and allylamine plasma-treated polyethylene. Journal of Applied Polymer Science, 47(9), 1601 – 1619.

Ishikawa, Y., Sasakawa, S., Takase, M., Iriyama, Y., and Osada, Y., Makromol, (1985). Ex vivo and in vitro platelet adhesion on radio frequency glow discharge (RFGD) deposited polymers. Chemistry Rapid Communications, 26(3), 357-372.

Jaššo, M., Krump, H., Hudec, I., St'ahel', P., Kováčik, D., and Šíra, M., (2005). Coating of PET cords at atmospheric pressure plasma discharge in the presence of butadiene/nitrogen gas mixtures. Surface and Coatings Technology, 201(1-2), 57-62.

Kawakami, M., Koya H., and Gondo, S., (1988). Plasma minofunctionalisation of PVDF microfiltration membranes: comparison of the in plasma modifications with a grafting method using ESCA and an amino-selective fluorescent probe, Biotechnology Bioengineering, 32, 1229–1231.

Khorasani, M.T., (2006). Effect of oxygen plasma treatment on surface charge and wettability of PVC blood bag. In vitro assay Radiation Physics and Chemistry, 76(6), 1011-1016.

Kim, K., Cho, S., Park, J.H., Byun, Y., Chung, H., Kwon, I.C., and Jeong, S.Y., 2004. Resonance Studies of the Direct Interaction Between a Drug/Intestinal Brush Border Membrane. Pharmaceutical Research, 21(7).

Kogelschatz, U., (2003). Dielectric-barrier discharges: Their history discharge Physics, and industrial applications. Plasma Chemistry and Plasma Processing, 23(1), 1-46.

Kotál V., (2006). Water permeability of poly(ethylene) terephthalate track membranes modified in plasma. Desalination, 146(1-3), 279-286.

Ko, T.-M., and Cooper, S.L., (1993). Plasma treatment of polyethylene ultrafiltration membranes. Journal of Applied Polymer Science, 219, 117 – 124.

Ko, T.-M., (1991). Surface Characterization and Platelet Adhesion Studies of Plasma Treated Polyethylene. Ph.D. Dissertation, University of Wisconsin-Madison.

Ko, T.-M., and Cooper, S.L., (1994). Frontiers of Polymers and Advanced Materials. New York: Plenum.

Kruapong, A. (2000). Partial Oxidation of Methane to Synthesis Gas in Low Temperature Plasmas. M.S.Thesis, Chulalongkorn University, Bangkok.

Kyung- Hwan Cho, Jong- Eun Park, Tetsuya Osaka and Soo-Gil Park (2005) The study of antimicrobial activity and preservative effects of nanosilver ingredient. Electrochimica Acta, 51, 956–960.

Lee, J.H., Park J.W., and Lee, H.B., (1991). Surface photo-grafting of polyurethane with 2-hydroxyethyl acrylate for promotion of human endothelial cell adhesion and growth. Biomaterials, 11(5), 523-536.

Lub, J., Vroonhoven van, F.C.B.M., Bruninx, E., and Benninghoven, A., (1989). Polystyrene thin films treatment under DC pulsed discharges conditions in oxygen. Polymer, 16, 141-147.

Markkula, T. K., Hunt, J.A., Pu, F.R., Williams, R.L., (2002). Surface chemical derivatization of plasma-treated and PTFE. Surface and Interface Analysis, 34(1), 583 – 587.

McQuarrie, D.A., Rock, P.A. (1987). General Chemistry. New York: Freeman.

Morinaga, K., and Suzuki, M., (1962). The Chemical Reaction in Silent Electric Discharge: 11. The Frequency Effect on Ozone Formation, Bulletin of The Chemical Society of Japan, 35, 204

Morra, M., Occhiello, E., and Garbassi, F., (1990). Inhibition of aging in plasma-treated high-density polyethylene. Journal of Adhesion Science and Technology, 16, 1155-1169.

Nakayama, Y., Takahagi, T., Soeda, F., Hatada, K., Nagaoka, S., Suzuki, J., and Ishitani, A., (1988). Surface modification of porous polymeric membranes by RF-plasma treatment. Journal of Applied Polymer Science, 26, 732-736.

Nasser, E., (1971). Fundamentals of Gaseous Ionization and Plasma Electronics. USA: John Wiley & Sons, Inc.

Park, J.-W., and Kang, M., (2007). Synthesis and characterization of Ag_xO, and hydrogen production from methanol photodecomposition over the mixture of Ag_xO and TiO_2, International Journal of Hydrogen Energy, 32, 4840 – 4846

Rosacha, L.A., Anderson, G.K., Bechtold, L.A., Coogan, J.J., Heck, H.G., Kang, M., McCulla, W.H., Tennant, R.A., and Wantuck, P.J., (1993). Treatment of hazardous organic wastes using silent discharge Plasmas. Non-Thermal Plasma Technique for Pollution Control, 34, 128-139.

Sconnichsen, C. , Franzl, T., Wilk, T., Lessen, G. and Feldmann, J. (2002). Plasmon resonances in large noble-metal clusters. New Journal of Physics, 93, 1-93.

Sheu, M.S., Hoffman, A.S., and Feijen, J., (1992). Reduced adhesion of human blood platelets to polyethylene tubing by microplasma surface modification. Journal of Adhesion Science and Technology, 96(8), 4539-4546.

Sipehia, R., and Chawla, A.S., (1982). Multifunctional thrombo-resistant coating and methods of manufacture, Biomaterial and Medical Devices Artificial Organs, 10, 229-238.

Sipehia, R., Chawla, A.S., Daka, J., and Chang, T.M.S., (1988). Contact angle studies of the surface properties of covalently bonded poly-L-lysine to surfaces treated by glow-discharge. Journal of Biomedical Materials Research, 22, 1245-1251.

Strobel, M., (1994). Plasma Surface Modification of Polymer. Utrecht. Netherland: VSP.

Tran, C.N.B. and D.R. Walt., (1989). Plasma Modification and Collagen Binding to PTFE Grafts. Journal Colloid and Interface Science, 132, 373-381.

Terlingen, J.G.A., Feijen, J., and Hoffman, A.S., (1993). Affinity binding on argon plasma-immobilized biotinylated phospholipids. Journal Colloid and Interface Science, 155, 261-277.

Vargo, T.G., Gardella, J.A., and Salvati, L., (1989). Multitechnique surface spectroscopic studies of plasma modified polymers III. H_2O and O_2/H_2O plasma modified poly(methyl methacrylate)s. Journal of Applied Polymer Science, 27, 1267-1286.

Weaver, J.F., and Hoflund, G.B., (1994). Surface Characterization Study of the Thermal Decomposition of Ago. Journal of Physics Chemistry. 98 8519–8524.

Wypych, J., (1988). Polymer Modified Textile Materials. New York : Wiley.

Yasuda, H.K., Yeh, Y.S., and Fusselman, S., (1990). Plasma polymerization of 1265 – 1270.

APPENDIX

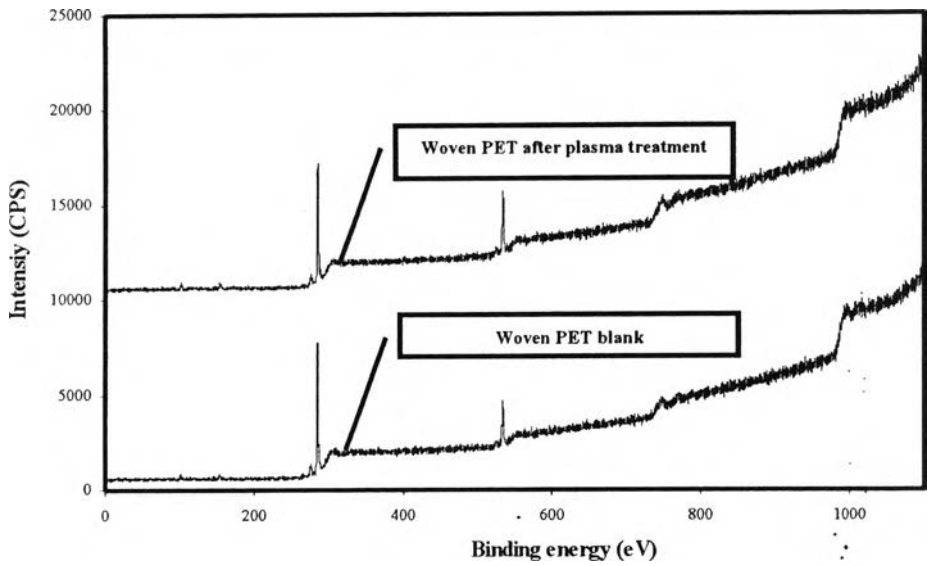


Figure 1 Wide range XPS survey of woven PET surface before and after plasma treatment: electrode gap distance, 4 mm; treatment time, 10 s; applied voltage, 60 V (low side); input frequency, 400 Hz.

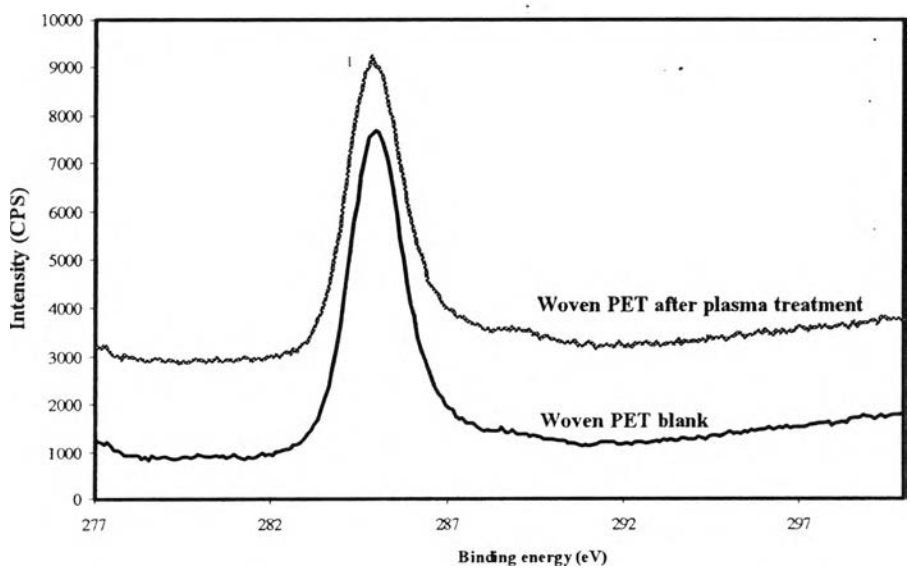


Figure 2 C1s XPS spectra range of woven PET before and after plasma treatment: electrode gap distance, 4 mm; treatment time, 10 s; applied voltage, 60 V (low side); input frequency, 400 Hz.

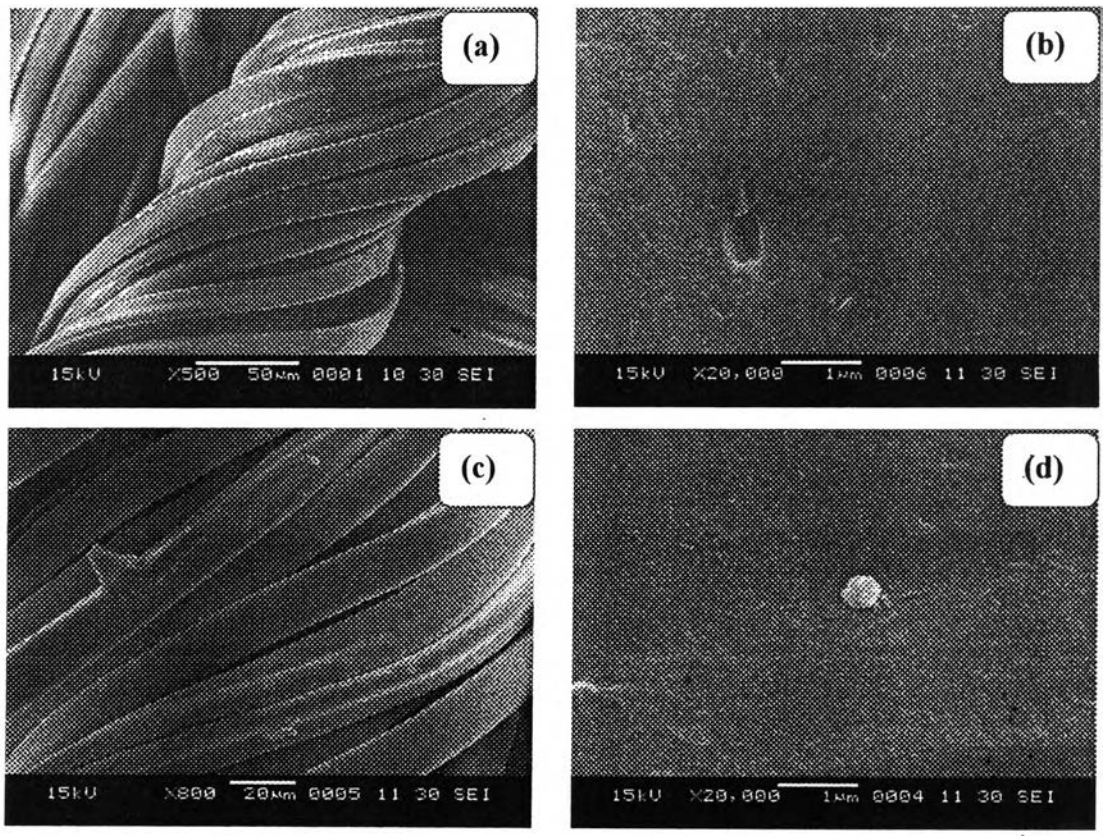


Figure 3 SEM images of woven PET (a) and (b) without Ag coating, (c) and (d) with Ag coating at concentration of $AgNO_3$ 0.05 M.

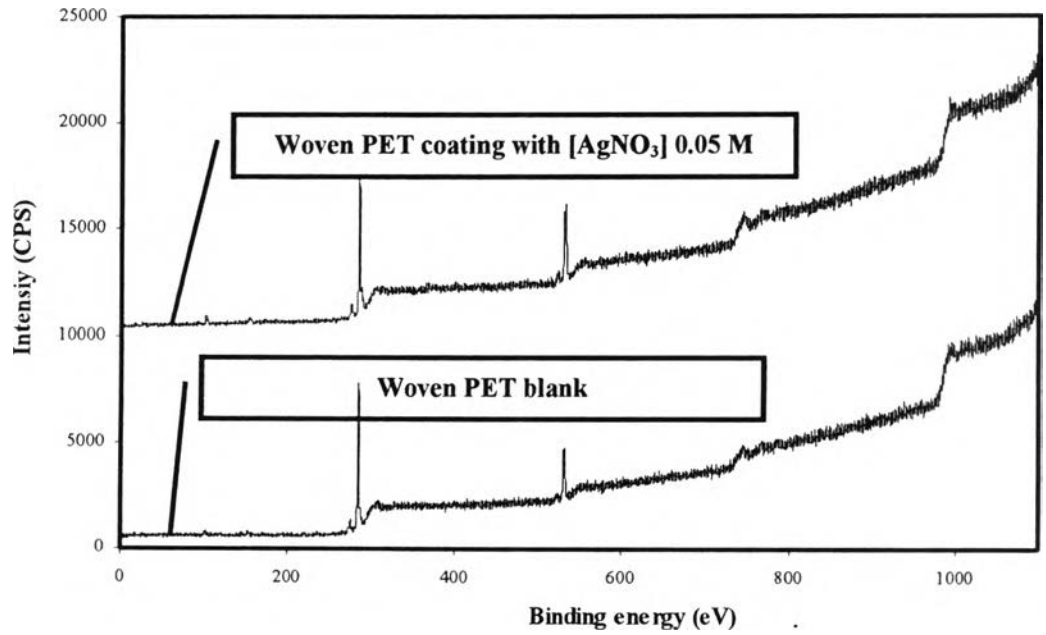


Figure 4 Wide range XPS survey of woven PET with air-plasma treatment

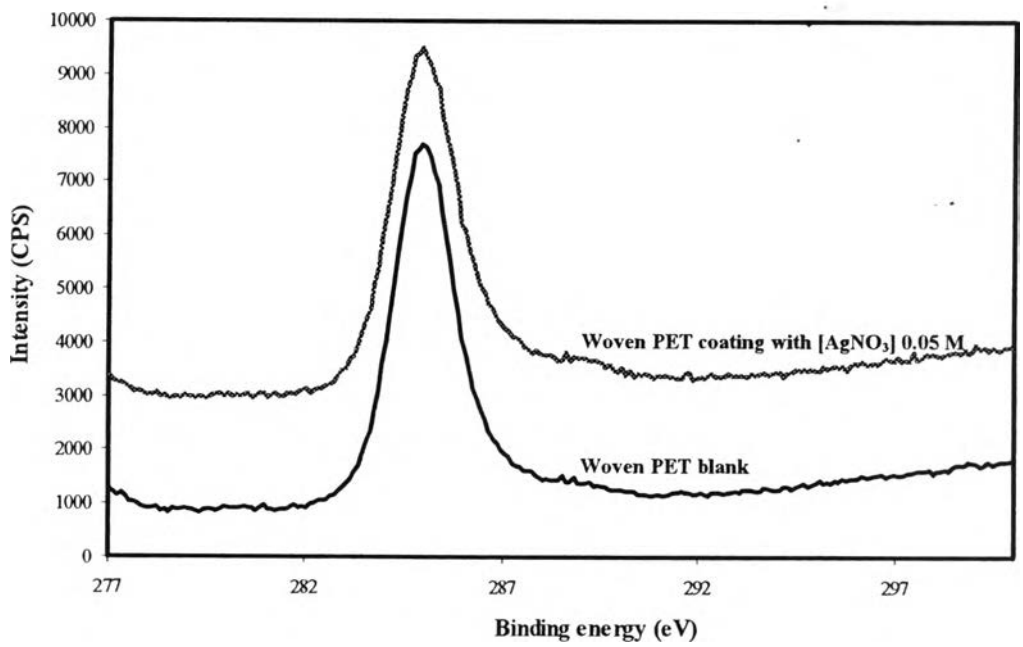


Figure 5 C1s XPS spectra of woven PET with air-plasma treatment

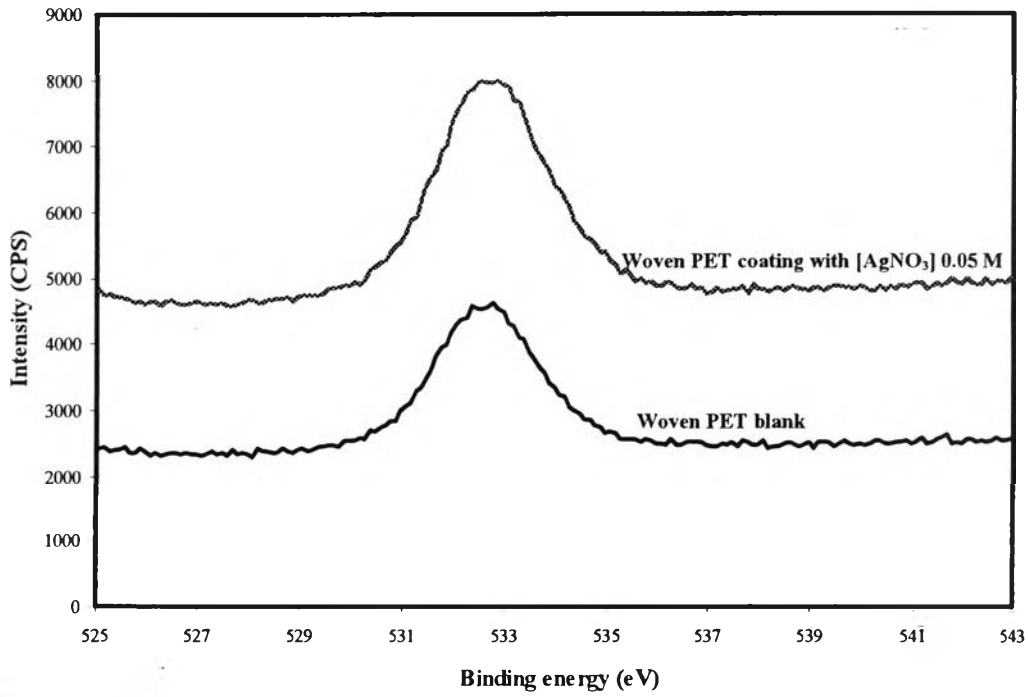


Figure 6 O1s XPS spectra of Woven PET air-plasma treatment

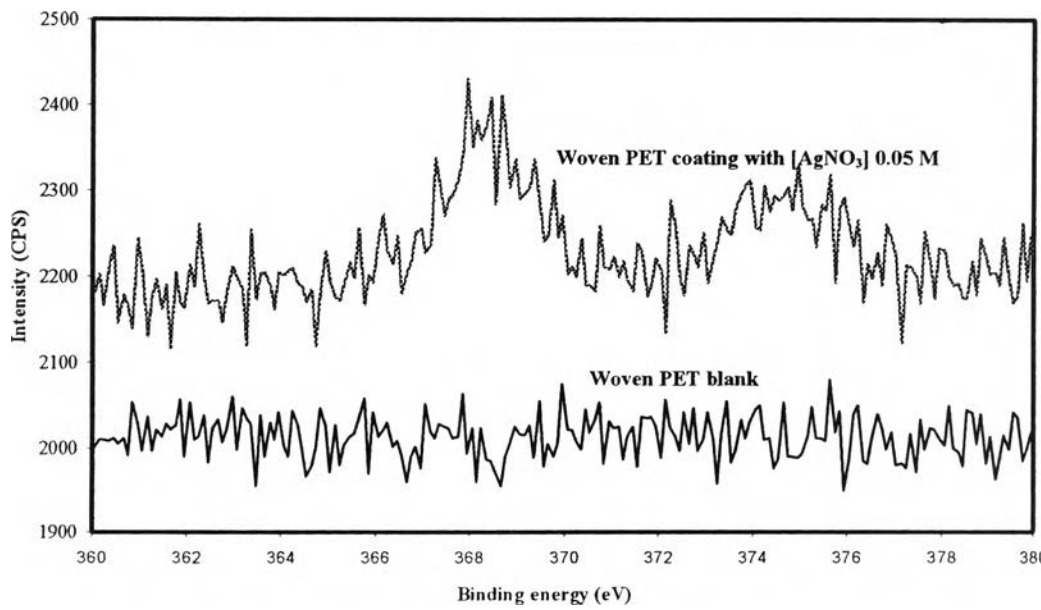


Figure 7 Ag3d XPS spectra of woven PET air-plasma treatment

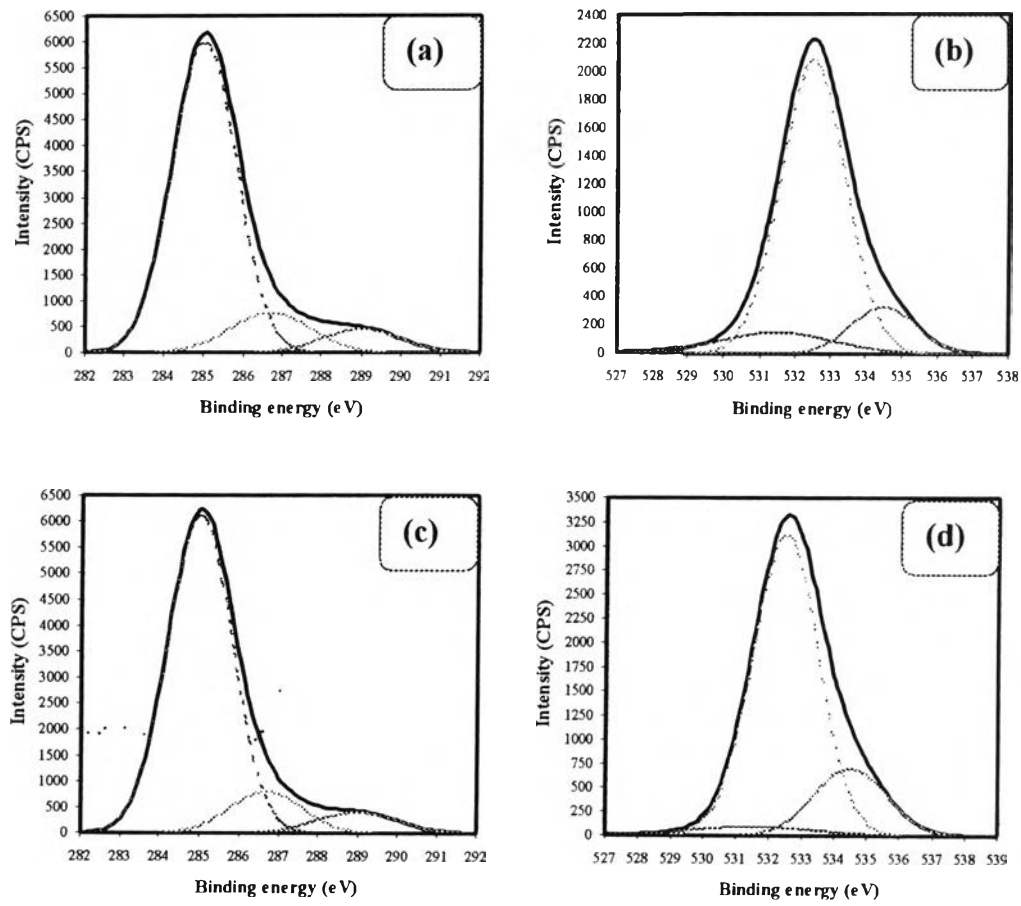


Figure 8 Deconvoltion of XPS spectra of woven PET air-plasma treatment (a) C1s and (b) O1s of Woven PET blank, (c) C1s, and (d) O1s of woven PET coating with [$AgNO_3$] 0.05 M

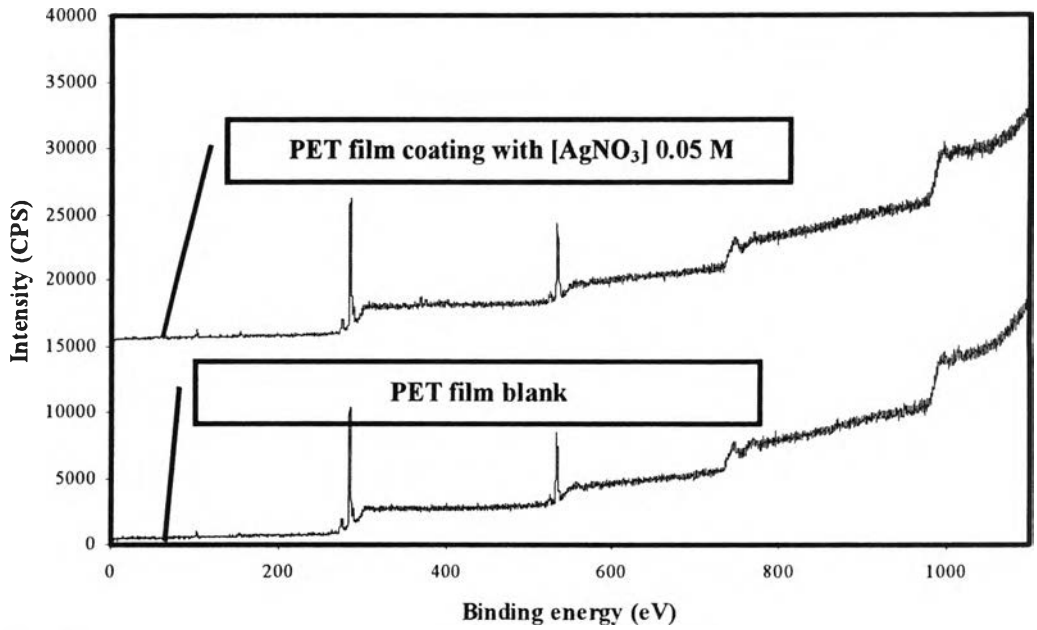


Figure 9 Wide range XPS survey of PET film with air-plasma treatment

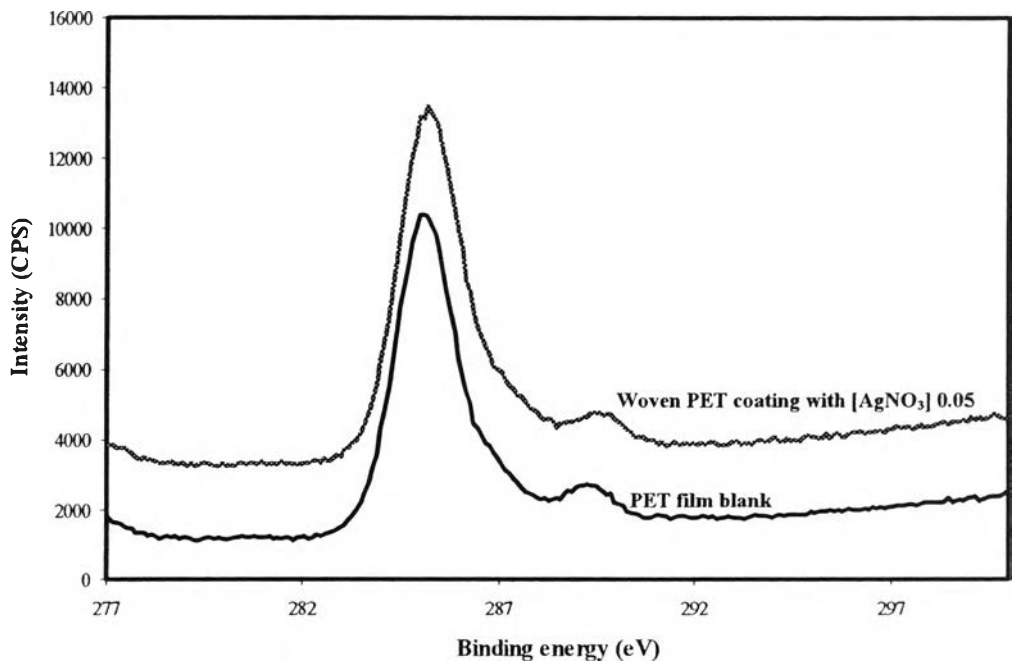


Figure 10 C1s XPS spectra of PET film with air-plasma treatment

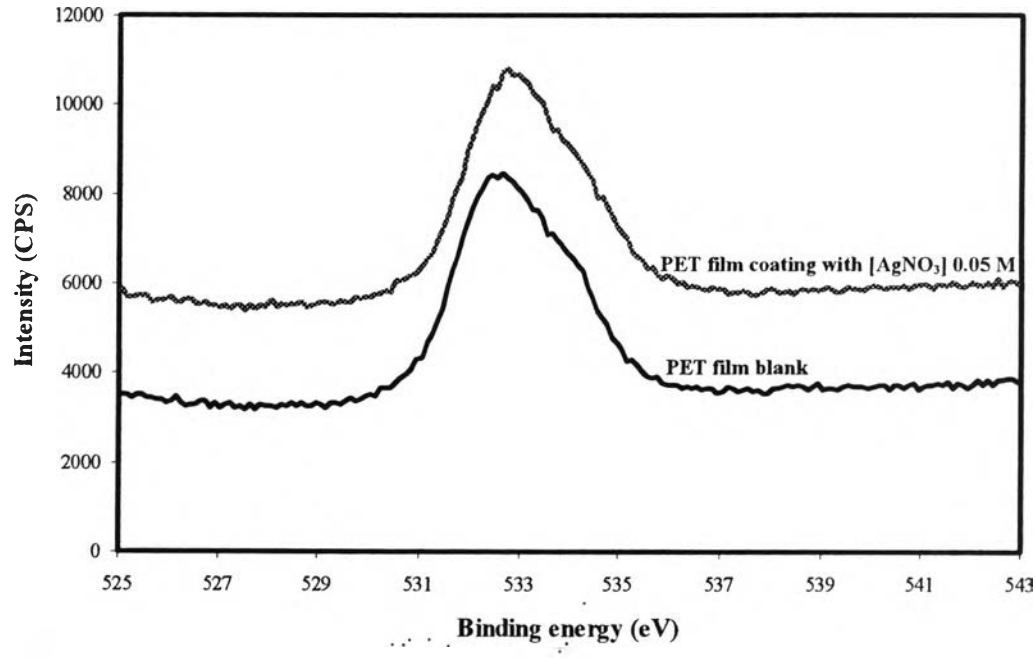


Figure 11 O1s XPS spectra of PET film air-plasma treatment

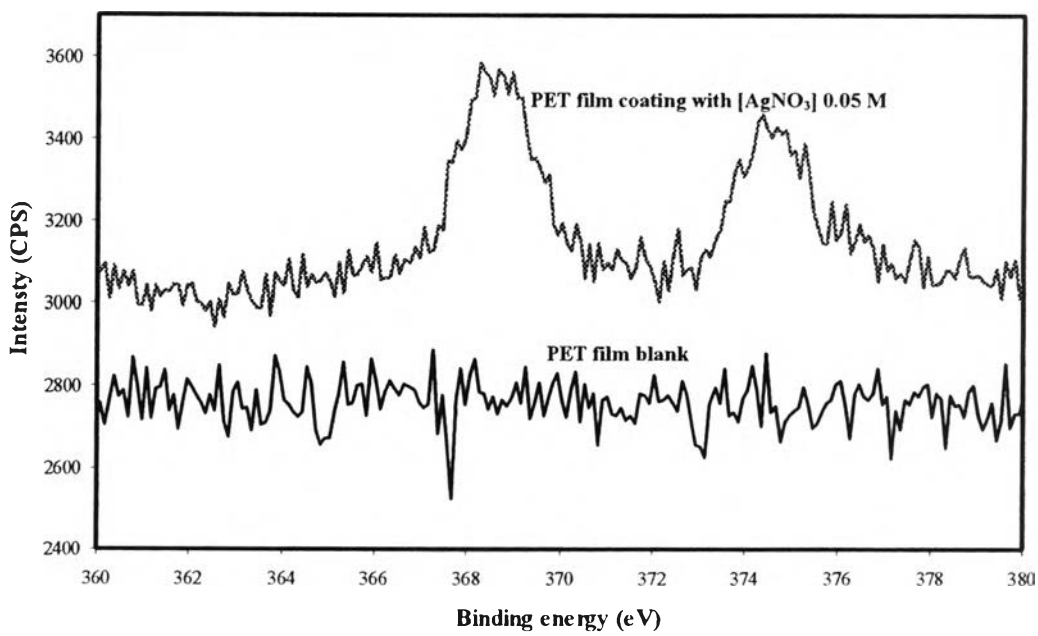


Figure 12 Ag3d XPS spectra of woven PET air-plasma treatment

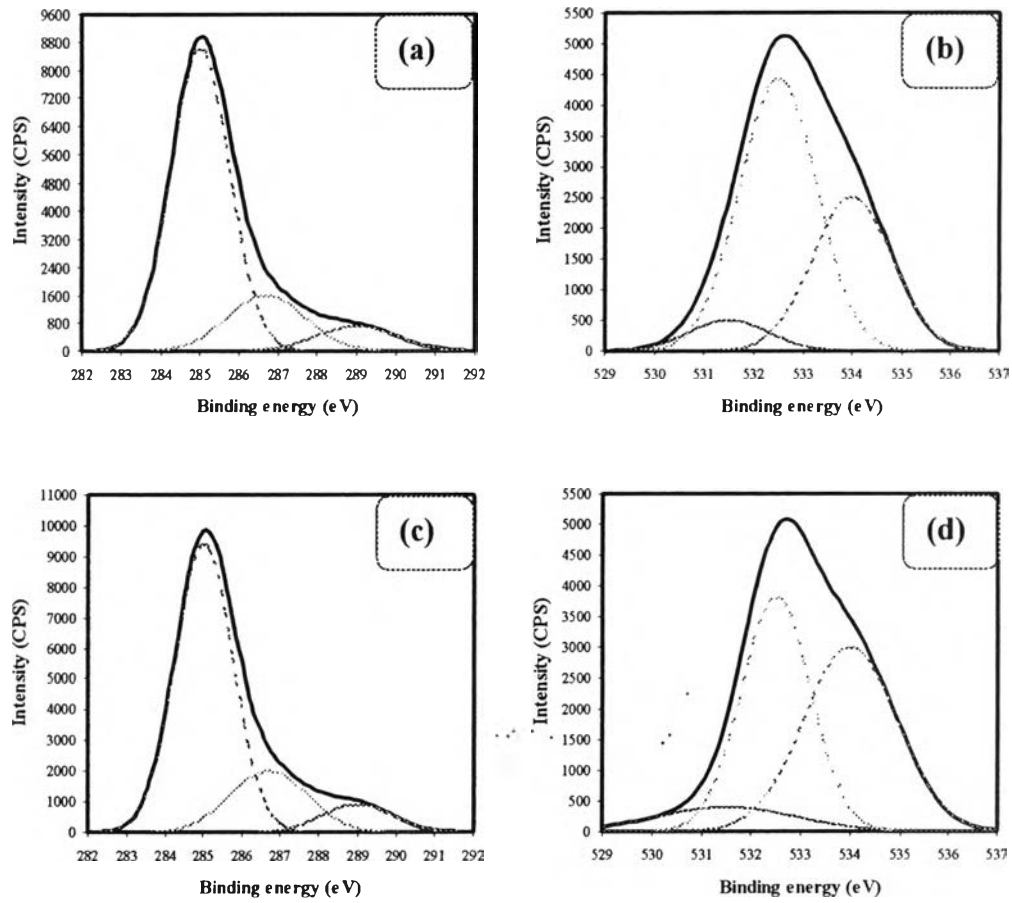
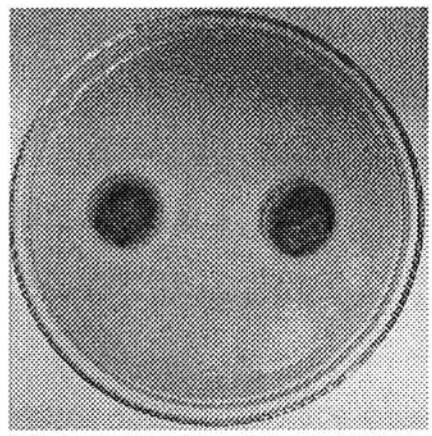
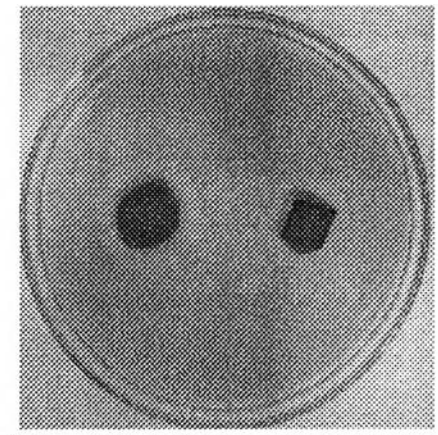


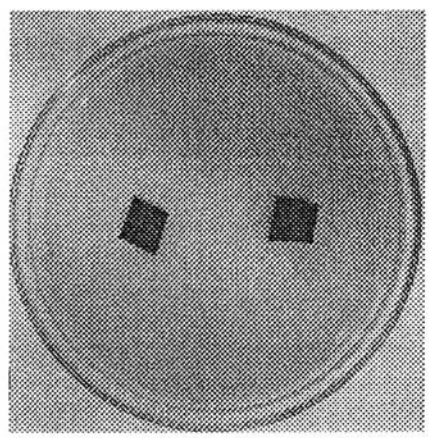
Figure 13 Deconvoltion of XPS spectra of PET film air-plasma treatment (a) C1s and (b) O1s of PET film blank (c) C1s, and (d) O1s of PET film coating with [$AgNO_3$] 0.05 M



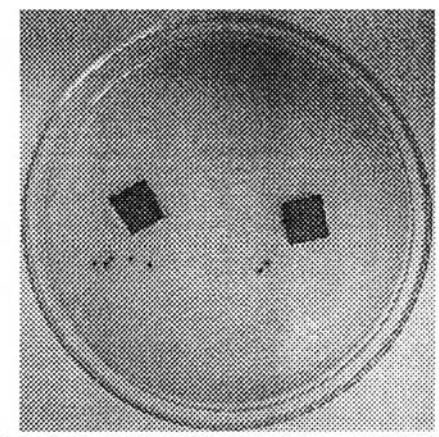
(a) $AgNO_3$ 1 M, without $NaBH_4$



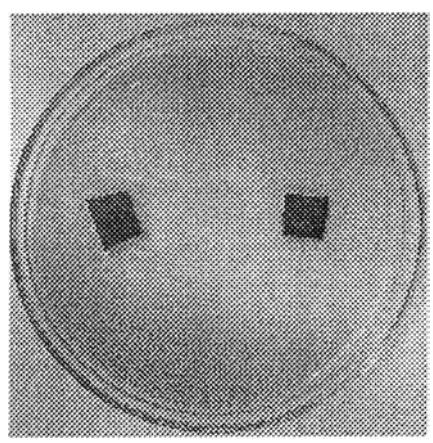
(b) $AgNO_3$ 0.5 M, without $NaBH_4$



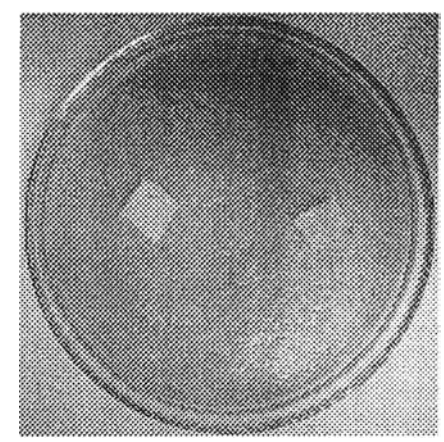
(c) $AgNO_3$ 0.1 M, without $NaBH_4$



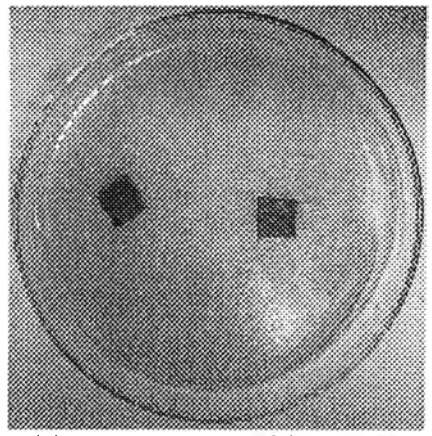
(d) $AgNO_3$ 0.05 M, without $NaBH_4$



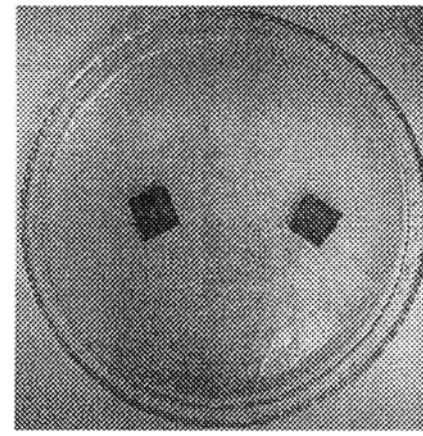
((e) $AgNO_3$ 0.01 M, without $NaBH_4$



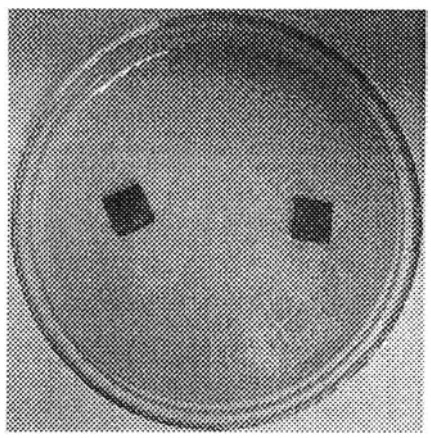
(f) $AgNO_3$ 0.001 M, without $NaBH_4$



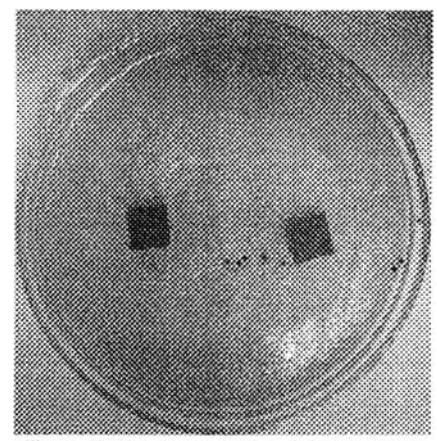
(g) $AgNO_3$ 1 M, with $NaBH_4$



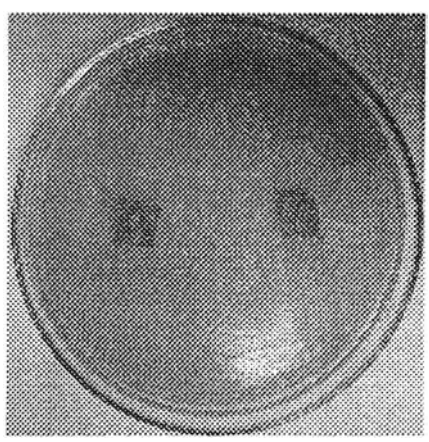
(h) $AgNO_3$ 0.5 M, with $NaBH_4$



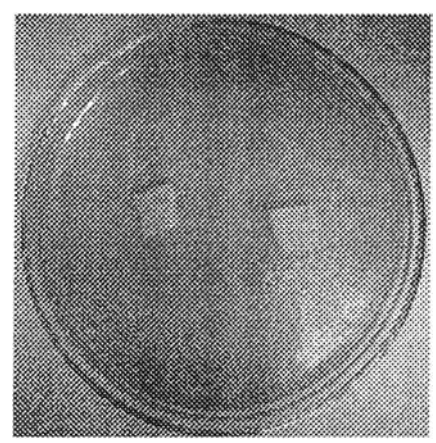
(i) $AgNO_3$ 0.1 M, with $NaBH_4$



(j) $AgNO_3$ 0.05 M, with $NaBH_4$

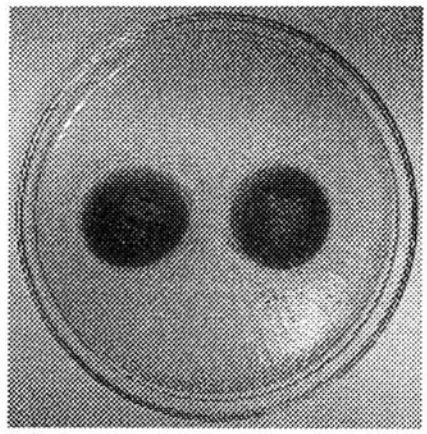


(k) $AgNO_3$ 0.01 M, with $NaBH_4$

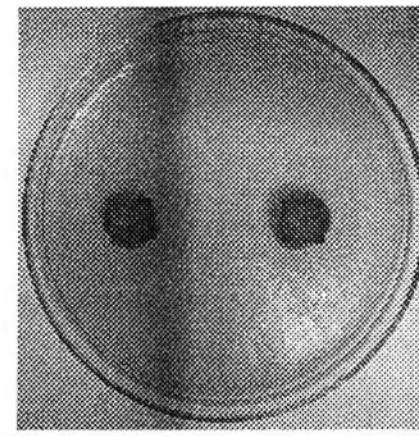


(l) $AgNO_3$ 0.001 M, with $NaBH_4$

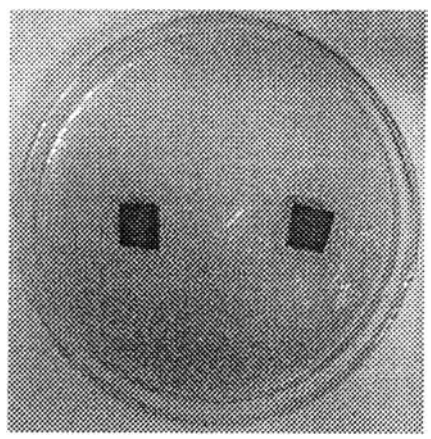
Figure 14 Effect of $AgNO_3$ concentration on clear zone distance for *S. aureus*. For a. to f., the woven PET is submerged only in $AgNO_3$ solution and in g. to l. the woven PET is submerged in $AgNO_3$ solution and, after that, in [$NaBH_4$] 0.1 M.



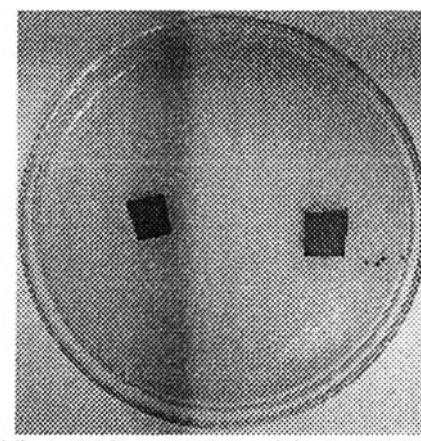
(a) $AgNO_3$ 1 M, without $NaBH_4$



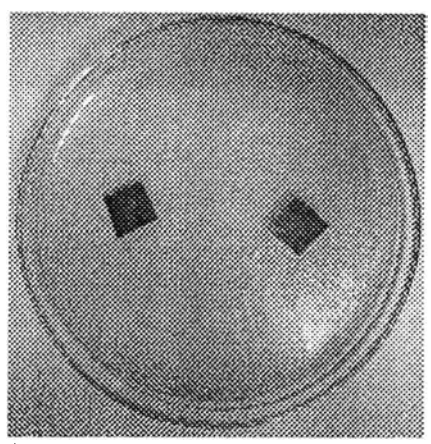
(b) $AgNO_3$ 0.5 M, without $NaBH_4$



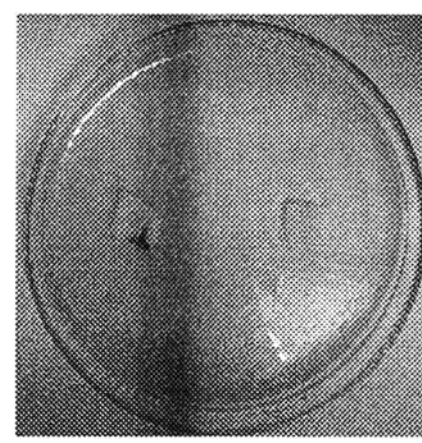
(c) $AgNO_3$ 0.1 M, without $NaBH_4$



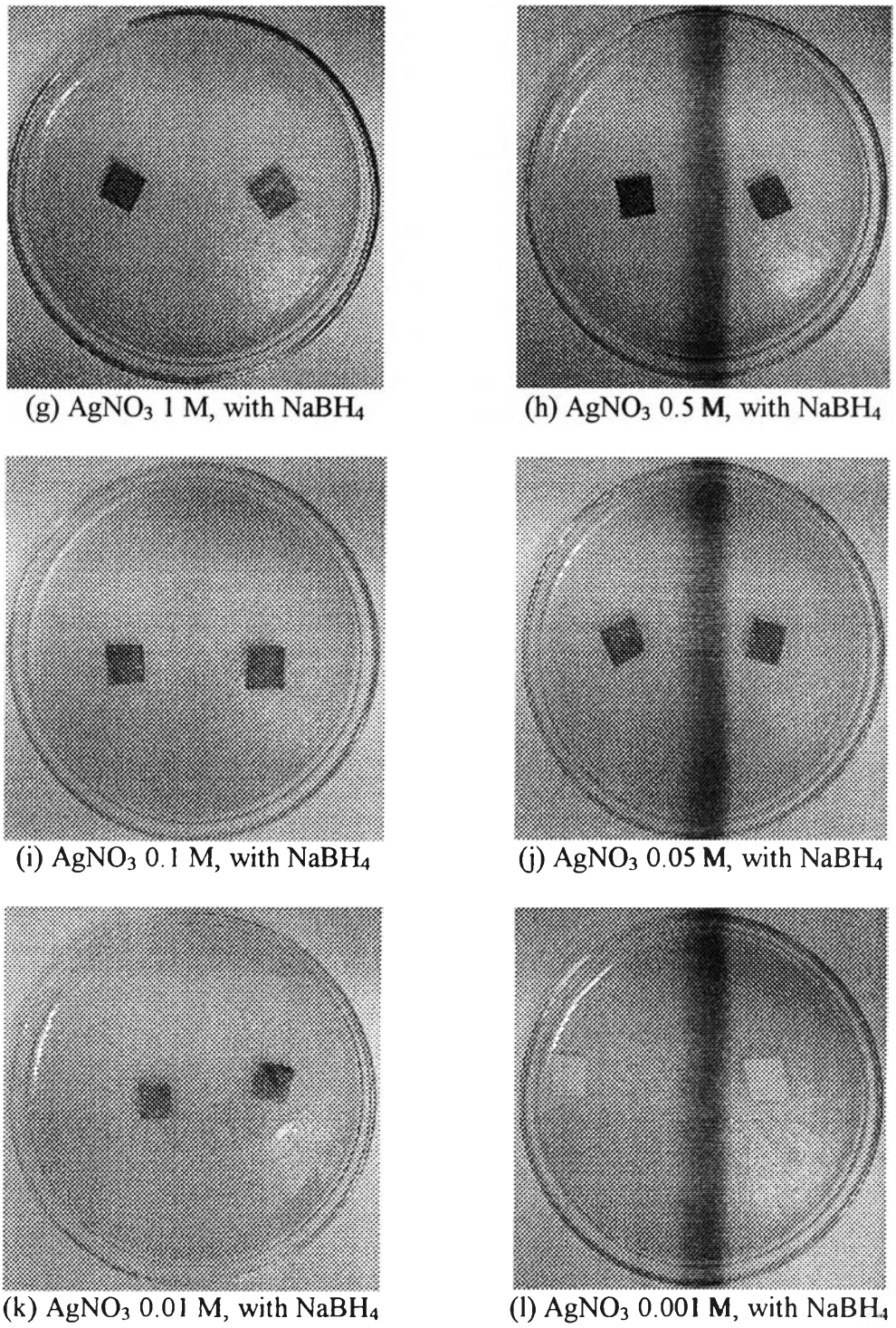
(d) $AgNO_3$ 0.05 M, without $NaBH_4$



(e) $AgNO_3$ 0.01 M, without $NaBH_4$



(f) $AgNO_3$ 0.001 M, without $NaBH_4$



(g) $AgNO_3$ 1 M, with $NaBH_4$ (h) $AgNO_3$ 0.5 M, with $NaBH_4$

(i) $AgNO_3$ 0.1 M, with $NaBH_4$ (j) $AgNO_3$ 0.05 M, with $NaBH_4$

(k) $AgNO_3$ 0.01 M, with $NaBH_4$ (l) $AgNO_3$ 0.001 M, with $NaBH_4$

Figure 15 Effect of $AgNO_3$ concentration on clear zone distance for *E. coli*. For a. to f., the woven PET is submerged only in $AgNO_3$ solution and in g. to l. the woven PET is submerged in $AgNO_3$ solution and, after that, in [$NaBH_4$] 0.1 M.

Table 1 Effect of the number of washing cycle on amount of silver on woven PET

[$AgNO_3$] (M)	Number of washing cycle (Times)	Amount of silver on woven PET (wt.%)
0.05	0	0.160
	1	0.148
	2	0.147
	3	0.146
	4	0.145
	5	0.146
1	0	0.31
	1	0.291
	2	0.287
	3	0.284
	4	0.285
	5	0.285
3	0	0.550
	1	0.450
	2	0.440
	3	0.420
	4	0.410
	5	0.409

Table 2 Amount of silver on woven PET at various $AgNO_3$ concentration.

[$AgNO_3$] (M)	**[$AgNO_3$] after digestion (ppm)**	**[$AgNO_3$] on woven PET (wt.%)**
0.01	2.160	0.060
0.05	5.220	0.146
0.1	5.455	0.151
0.5	6.776	0.190
1	10.239	0.285
3	15.260	0.409
4	15.121	0.413
5	15.314	0.413

CURRICULUM VITAE

Name: Mr. Surakerk Onsuratoom

Date of Birth: June 5, 1982

Nationality: Thai

University Education:

2002-2006 Bachelor Degree of Engineering, Faculty of Engineering, King Mongkut's Institute of Technology North Bangkok, Bangkok, Thailand

Working Experience:

2005 Position: Student Internship in Department of Project Engineer
Company name: Foster Wheeler International Corporation.

Presentations:

1. Onsuratoom, S., Rujiravanit, R., Sreethawong, T., Chavadej, S., and Tokura, S. (2007, July 31st- August 3rd), Surface Modification of Woven PET by Silver Coating Using DBD plasma Technique for Antimicrobial Property Improvement. Paper presented at The International Symposium in Science and Technology, Osaka, Japan.
2. Onsuratoom, S., Rujiravanit, R., Sreethawong, T., Chavadej, S., and Tokura, S. (2008, April 23) Silver Coating on Woven PET Surface Modified by Using DBD Plasma Technique for Antimicrobial Property Improvement. Paper presented at The 14th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.