REFERENCES

Ahmadi, T., Wang, Z.L., Green, T.C., Henglein, A., and El-Sayed, M.A. (1996). Shape-controlled synthesis of colloidal platinum nanoparticles. Science, 272, 1924.

Avgouropoulos, G., Papavasiliou, J., Tabakova, T., Idakiev, V., and Ioannides, T. (2006). A comparative study of ceria-supported gold and copper oxide catalysts for preferential CO oxidation reaction. Chemical Engineering Journal, 124, 41-45.

Baatz, C., Decker, N., and Prüße, U. (2008). New innovation gold catalysts prepared by an improved incipient wetness method. Journal of Catalysis, 258, 165-169.

Boccuzzi, F., Chiorino, A., Manzoli, M., Lu, P., Akita, T., Ichikawa, S., and Harutay, M. (2001). Au/TiO_2 Nanosized Samples: A Catalytic, TEM, and FTIR Study of the Effect of Calcination Temperature on the CO Oxidation. Journal of Catalysis, 202, 256–267.

Chan, S.C. and Barteau, M.A. (2005). Preparation of Highly Uniform Ag/TiO2 and Au/TiO2 Supported Nanoparticle Catalysts by Photodeposition. Langmuir, 21, 5588–5595.

Chang, L.H., Yeh, Y.L., and Chen, Y.W. (2008). Preferential oxidation of CO in hydrogen stream over nano-gold catalysts prepared by photodeposition method. International Journal of Hydrogen Energy, 33, 1965 – 1974.

Comotti, M., Li, W.C., Spliethoff, B., and Schüth, F. (2006). Support Effect in High Activity Gold Catalysts for CO Oxidation. Journal of the American Chemical Society, 128, 917-924.

Daté, M and Haruta, M. (2001). Moisture Effect on CO Oxidation over Au/TiO_2 Catalyst. Journal of Catalysis, 201, 221–224.

Glaspell, G., Fuoco, L., and El-Shall, M.S. (2005). Microwave Synthesis of Supported Au and Pd Nanoparticle Catalysts for CO Oxidation. Journal of Physical Chemistry B, 109 (37), 17350-17355.

Grisel, R.J.H., Weststrate, C.J., Goossens, A., Crajé, M.W.J., Kraan, A.M., Nieuwenhuys, B.E. (2002). Oxidation of CO over $Au/MO_x/Al_2O_3$ multi-component catalysts in a hydrogen-rich environment. Catalysis Today, 2599, 1–10.

Grunwaldt, J.D., Maciejewski, M., Becker, O.S., Fabrizioli, P., and Baiker, A. (1999). Comparative Study of Au/TiO_2 and Au/ZrO_2 Catalysts for Low-Temperature CO Oxidation. Journal of Catalysis, 186, 458–469.

Gupta, N.M. and Tripathi, A.K. (1999). Microcalorimetry, Adsorption, and Reaction Studies of CO, O_2, and CO+O_2 over Fe_2O_3, Au/ Fe_2O_3, and Polycrystalline Gold Catalysts as a Function of Reduction Treatment. Journal of Catalysis, 187, 343–347.

Haruta, M., Ueda, A., Tsubota, S., Sanchez, R.M.T. (1996). Low temperature catalytic combustion of methanol and its decomposed derivatives over supported gold catalysts. Catalysis Today, 29, 443-447.

Haruta, M., Daté, M. (2001). Advances in the catalysis of Au nanoparticles. Applied Catalysis A: General, 222, 427–437.

Hoflund, G.B., Gardner, S.D., Schryer, D.R., Upchurch, B.T., Kielin, E.J. (1995). Au/MnO, catalytic performance characteristics for low-temperature carbon monoxide oxidation. Applied Catalysis B: Environmental, 6, 117-126.

Horv'ath, D., Toth, L., and Guczi, L. (2000). Gold nanoparticles: effect of treatment on structure and catalytic activity of Au/Fe_2O_3 catalyst prepared by co-precipitation. Catalysis Letters, 67, 117–128.

Iliev, V, Tomova, D., Todorovska, R., Oliver, D., Petrov, L., Todorovsky, D., and Uzunova-Bujnova, M. (2006). Photocatalytic properties of TiO2 modified with gold nanoparticles in the degradation of oxalic acid in aqueous solution. Applied Catalysis A: General, 313, 115–121.

Imai, H., Daté, M., and Tsubota, S. (2008). Preferential Oxidation of CO in H_2-Rich Gas at Low Temperatures over Au Nanoparticles Supported on Metal Oxides. Catalysis Letters, 124, 68–73.

Lee, W.S., Wan, B.Z., Kuo, C.N., Lee, W.C., and Cheng, S. (2007). Maintaining Catalytic Activity of Au/TiO_2 during the Storage at Room Temperature. Catalysis Communication, 8, 1604-1608.

Logunov, S.L., Ahmadi, T.S., El-Sayed, M.A., Khoury, J.T., and Whetten, R.L. (1997). Electron dynamics of passivated gold nanocrystals probed by subpicosecond transient absorption spectroscopy. Journal of Physical Chemistry B, 101, 3713-3719.

Mavrikakis, M., Stoltze, P., and Nørskov, J.K. (2000). Making gold less noble. Catalysis Letters, 64, 101–106.

Mohamed, M.M., Salama, T.M., Ohnishi, R., and Ichikawa, M. (2001). Characterization of gold(I) in dealuminated H-mordenite zeolite. Langmuir, 17, 5678-5684.

Neri, G., Bonavita, A., Rizzo, G., Galvagno, S., Donato, N., and Caputi, L.S. (2004). A study of water influence on CO response on gold-doped iron oxide sensors. Sensors and Actuators B, 101, 90-96.

Oh, H.S., Yang, J.H., Costello, C.K., Wang, Y.M., Bare, S.R., Kung, H.H., and Kung, M.C. (2002). Selective Catalytic Oxidation of CO: Effect of Chloride on Supported Au Catalysts. Journal of Catalysis, 210, 375–386.

Panzera, G., Modafferi, V., Candamano, S., Donato, A., Frusteri, F., Antonucci, P.L. (2004). CO selective oxidation on ceria-supported Au catalysts for fuel cell application. Journal of Power Sources, 135, 177-183.

Park, E.D. and Lee, J.S. (1999). Effects of Pretreatment Conditions on CO Oxidation over Supported Au Catalysts. Journal of Catalysis, 186, 1–11.

Park, S., Yoo, K., Park, H.J., Lee, J.C., and Lee, J.H. (2006). Rapid gold ion recovery from wastewater by photocatalytic ZnO nanopowders. Journal of Electroceramics, 17, 831-834.

Qian, K., Huang, W., Fang, J., Lv, S., He, B., Jiang, Z., and Wei, S. (2008). Low-temperature CO oxidation over Au/ZnO/SiO2 catalysts: Some mechanism insights. Journal of Catalysis, 255, 269–278.

Rossignol, C., Arrii, S., Morfin, F., Piccolo, L., Caps, V., and Rousset, J.L. (2005). Selective oxidation of CO over model gold-based catalysts in the presence of H_2. Journal of Catalysis, 230, 476–483.

Sandoval, A., Gómez-Cortés, A., Zanella, R., Díaz, G., and Saniger, J.M. (2007). Gold nanoparticles: Support effects for the WGS reaction. Journal of Molecular Catalysis A: Chemical, 278, 200-2008.

Schubert, M.M., Plzak, V., Garche, J., and Behm R.J. (2001). Activity, Selectivity, and Long-Term Stability of Different Metal Oxide Supported Gold Catalysts for the Preferential CO Oxidation in H_2-rich Gas. Catalysis Letters, 76, 143-150.

Schumacher, B., Plzak, V., Kinne, M., and Behm, R.J. (2003). Highly active Au/TiO_2 catalysts for low-temperature CO oxidation: preparation, conditioning and stability. Catalysis Letters, 89, 109-114.

Shen, L., Bao, N., Yanagisawa, K., Zheng, Y., Domen, K., Gupta, A., and Grimes, C. (2007). Direct growth of comet-like superstructures of Au–ZnO submicron rod arrays by solvothermal soft chemistry process. Journal of Solid State Chemistry, 180, 213-220.

Tabakova, T., Idakiev, V., Andreeva, D., Mitov, I. (2000). Influence of the microscopic properties of the support on the catalytic activity of Au/ZnO, Au/ZrO_2, Au/Fe_2O_3, Au/Fe_2O_3–ZnO, Au/Fe_2O_3–ZrO_2 catalysts for the WGS reaction. Applied Catalysis A: General, 202, 91–97.

Tabakova, T., Idakiev, V., Tenchev, K., Boccuzzi, F., Manzoli, M., and Chiorino, A. (2006). Pure hydrogen production on a new gold–thoria catalyst for fuel cell applications. Applied Catalysis B: Environmental, 63, 94–103.

Tripathi, A.K., Kamble, V. S., and Gupta, N.M. (1999). Microcalorimetry, Adsorption, and Reaction Studies of CO, O_2, and $CO+O_2$ over Au/Fe_2O_3, Fe_2O_3, and Polycrystalline Gold Catalysts. Journal of Catalysis, 187, 332–342.

Viswanatha, R., Sapra, S., Satpati, B., Satyam, P.V., Dev, B.N., and Sarma, D.D. (2003). Understanding the quantum size effects in ZnO nanocrystals. Journal of Materials Chemistry, 14, 661-668.

Xu, X., Caswell, K.K., Tucker, E., Kabisatpathy, S., Brodhacker, K.L., and Scrivens, W.A. (2007). Size and shape separation of gold nanoparticles with preparative gel electrophoresis. Journal of Chromatography A, 1167, 35-41.

Zenella, R., Giorgio, S., Shin, C.H., Henry, C.R., and Louis, C. (2004). Characterization and reactivity in CO oxidation of gold nanoparticles supported on TiO_2 prepared by deposition-precipitation with NaOH and urea. Journal of Catalysis, 222, 357-367.

APPENDICES

Appendix A Series of Au/ZnO catalysts prepared by photodeposition

Irradiation Time (minutes)		Precipitating Concentration, Na_2CO_3 (mol/dm^3)		Denoted as
		Support Preparation	Au Loading Procedure	
30	Without Calcination	0.1	0.1	Uncalcined Au(0.1)/ZnO(0.1)-30
90		0.1	0.1	Uncalcined Au(0.1)/ZnO(0.1)-90
120		0.1	0.1	Uncalcined Au(0.1)/ZnO(0.1)-120
240		0.1	0.1	Uncalcined Au(0.1)/ZnO(0.1)-240
		0.05	0.1	Uncalcined Au(0.05)/ZnO(0.1)-240
		0.1	0.05	Uncalcined Au(0.1)/ZnO(0.05)-240
		0.05	0.05	Uncalcined Au(0.05)/ZnO(0.05)-240
	With Calcination	0.1	0.1	Calcined Au(0.1)/ZnO(0.1)-240
		0.05	0.1	Calcined Au(0.05)/ZnO(0.1)-240
		0.1	0.05	Calcined Au(0.1)/ZnO(0.05)-240
		0.05	0.05	Calcined Au(0.05)/ZnO(0.05)-240

Appendix B Influence of Irradiation Time

Table B1 Actual Au loading of the uncalcined Au(0.1)/ZnO(0.1) with different irradiation times

Irradiation time (minutes)	Actual Au loading (% atom)
30	0.56
90	0.56
120	0.56
240	0.56

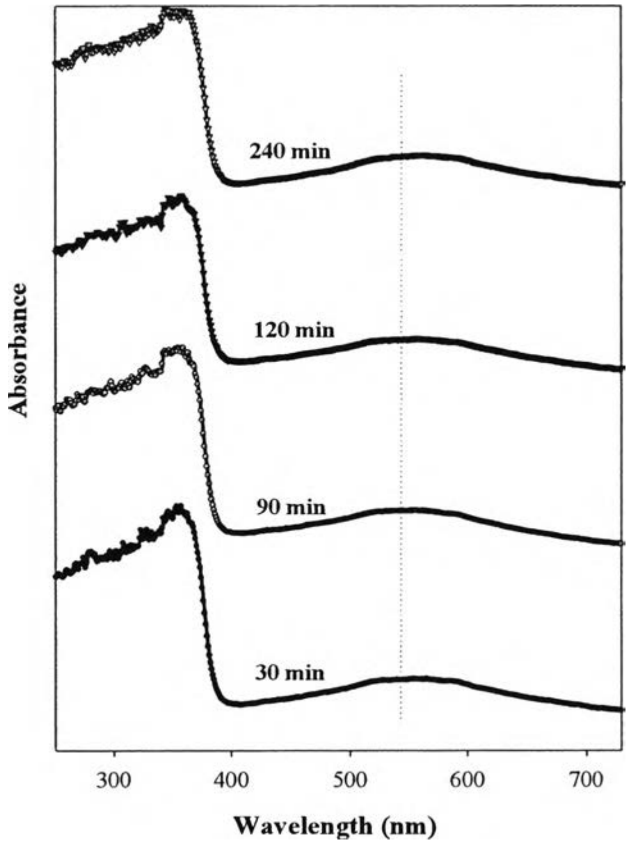

Figure B1 UV-vis spectra of the uncalcined Au(0.1)/ZnO(0.1) with different irradiation times.

Appendix C Influence of Precipitant Concentration

Table C1 Nitrogen Sorption Analysis (BET) of the prepared catalysts

Catalysts	Surface Area (m^2/g)
0.05 ZnO	49.24
Uncalcined Au(0.05)/ZnO(0.05)-240	64.21
Uncalcined Au(0.1)/ZnO(0.05)-240	54.74
0.1 ZnO	45.49
Uncalcined Au(0.1)/ZnO(0.1)-240	39.19
Calcined Au(0.1)/ZnO(0.1)-240	51.68
Uncalcined Au(0.05)/ZnO(0.1)-240	53.82

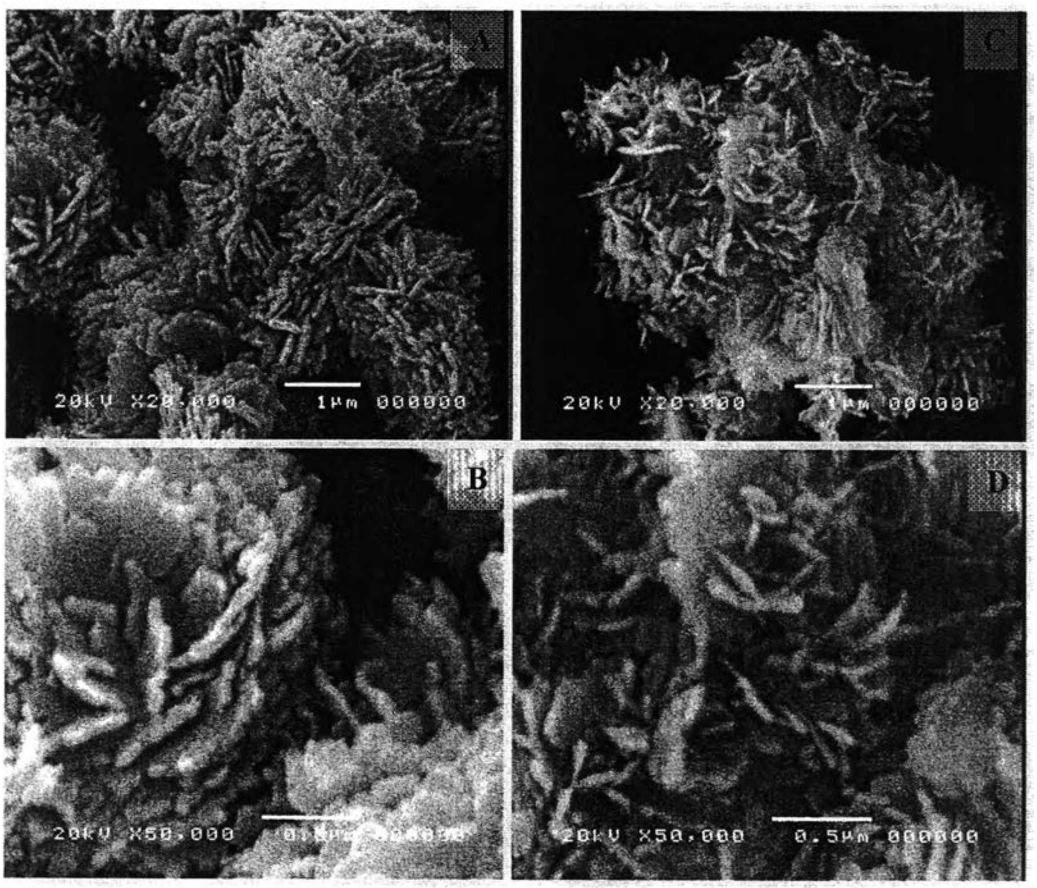

Figure C1 SEM images with different magnifications of ZnO, prepared by using different concentration of Na_2CO_3; 0.1 M (A and B), and 0.05 M (C and D).

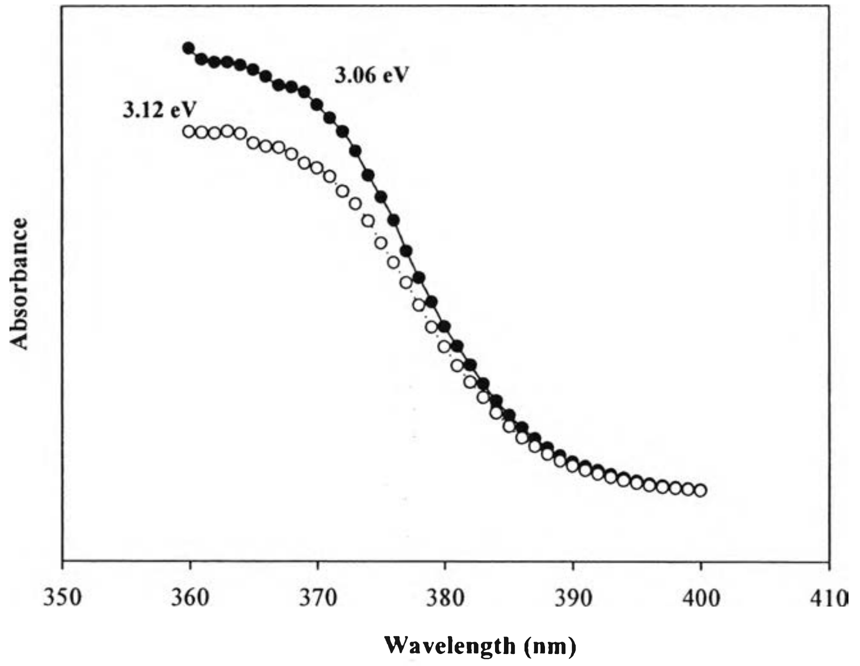

Figure C2 UV-vis spectra of the (○) 0.05 and (●) 0.1 ZnO. The absorption edges of them are extrapolated and correspond to 3.12 and 3.06 eV, respectively.

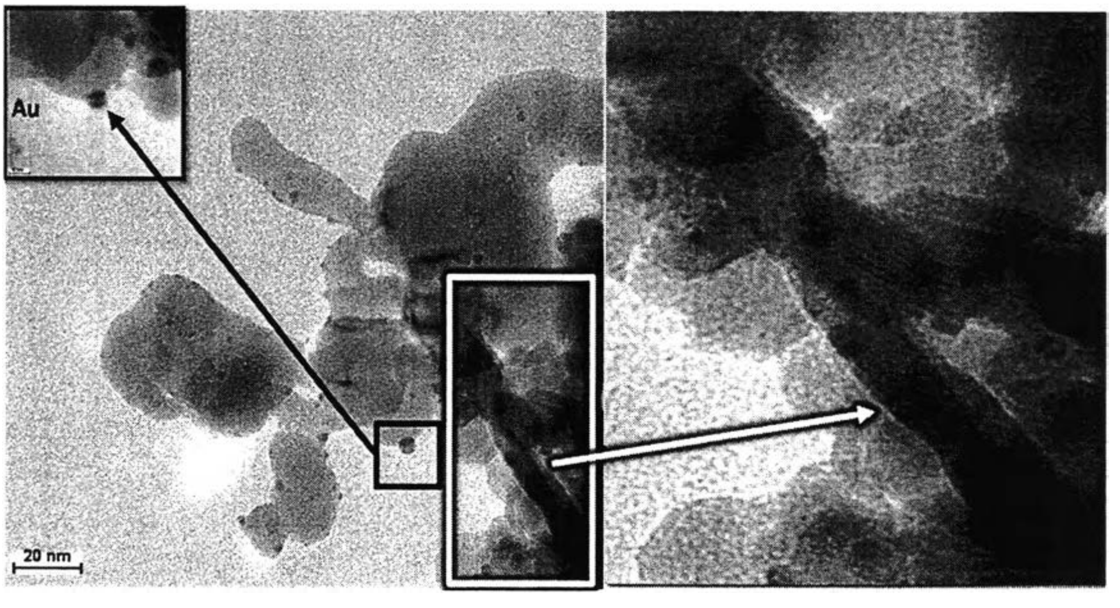

Figure C3 TEM image of the uncalcined Au(0.1)/ZnO(0.1)-240 shown some nanorod ZnO shapes.

Formula C1 Calculation of an average Au particle sizes (D_{avg}) as follows:

$$Davg = \frac{\sum nidi}{\sum ni}$$

where n_i is the number of particles of diameter d_i.

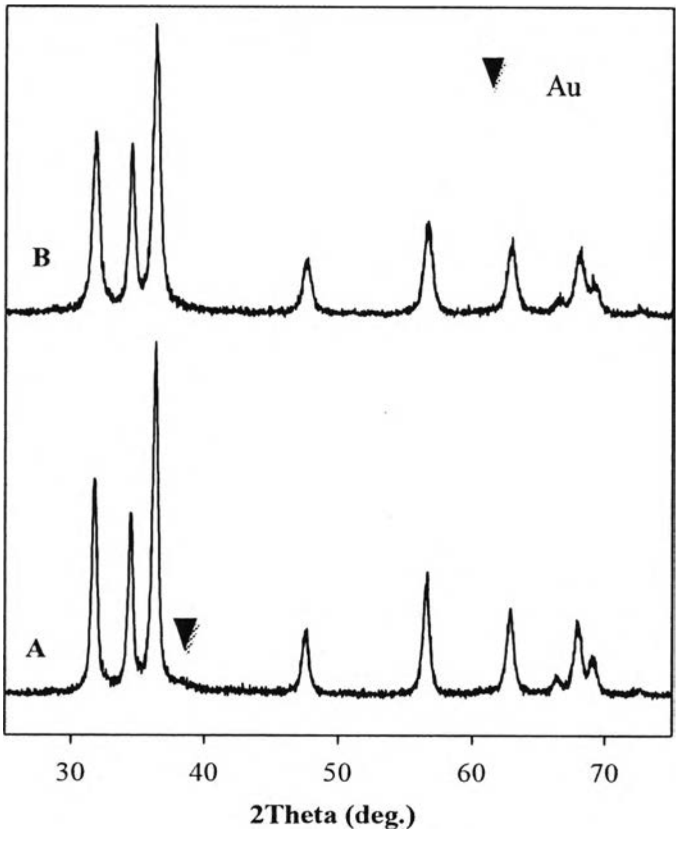

Figure C4 XRD patterns of the (A) uncalcined Au(0.1)/ZnO(0.1)-240 and (B) uncalcined Au(0.05)/ZnO(0.05)-240.

Appendix D Influence of Storage Conditions

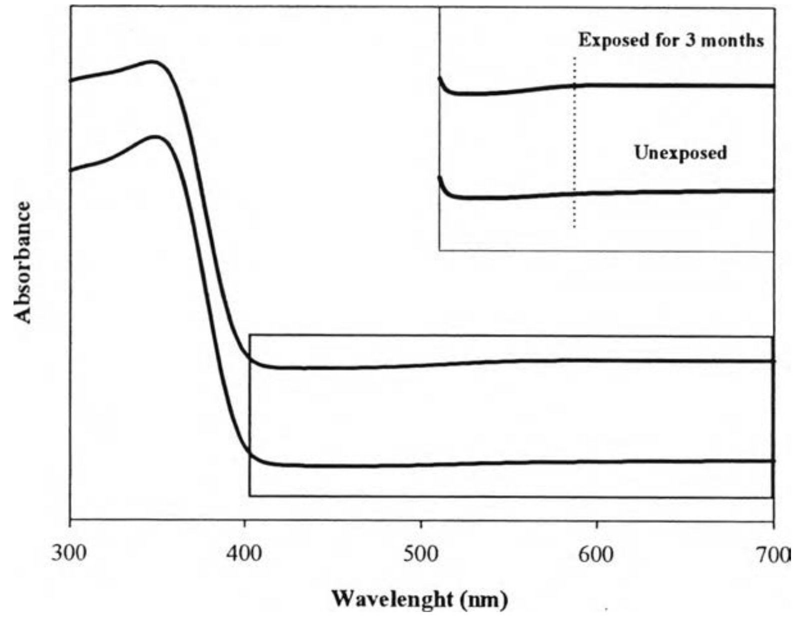

Figure D1 Au particle size distributions and Au averaged sizes of the Au(0.05)/ZnO(0.05) unexposed and exposed to light for 3 months.

Appendix E Stability Testing

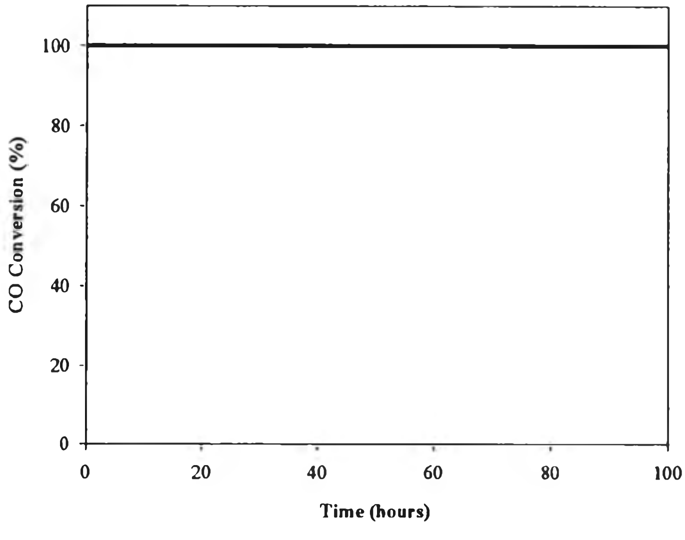

Figure E1 Stability testing of the uncalcined Au(0.05)/ZnO(0.05)-240 for 100 hours.

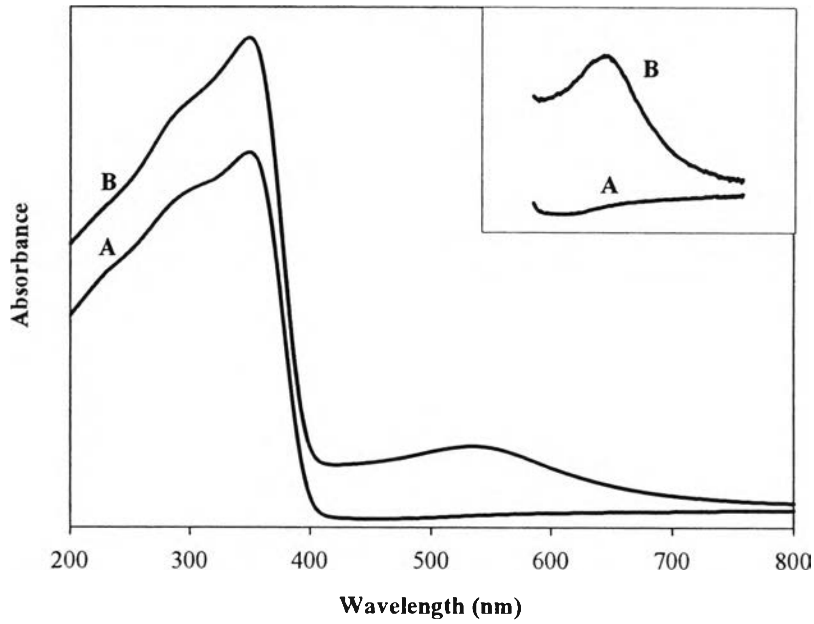

Figure E2 UV-vis absorption spectra of the uncalcined Au(0.05)/ZnO(0.05)-240 (A) before and (B) after reaction.

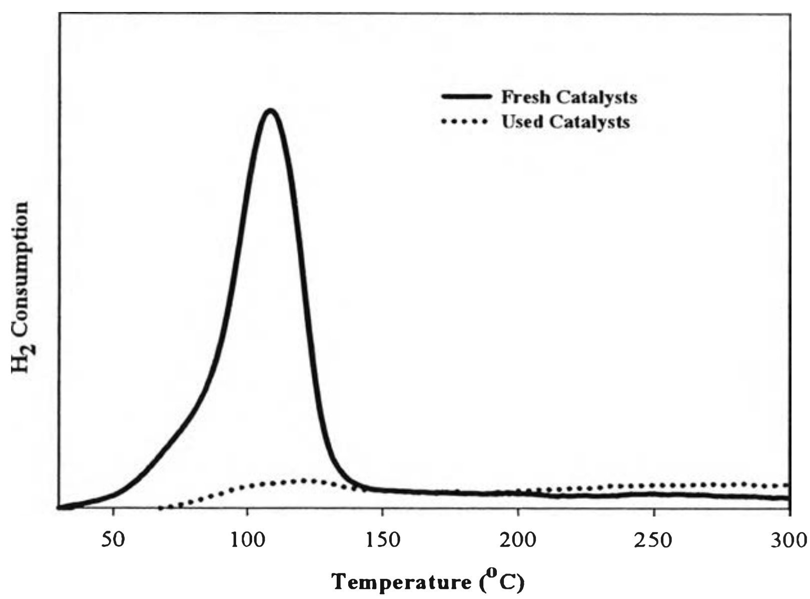

Figure E3 TPR profiles of the fresh and spent uncalcined Au(0.05)/ZnO(0.05)-240.

Appendix F Influence of water

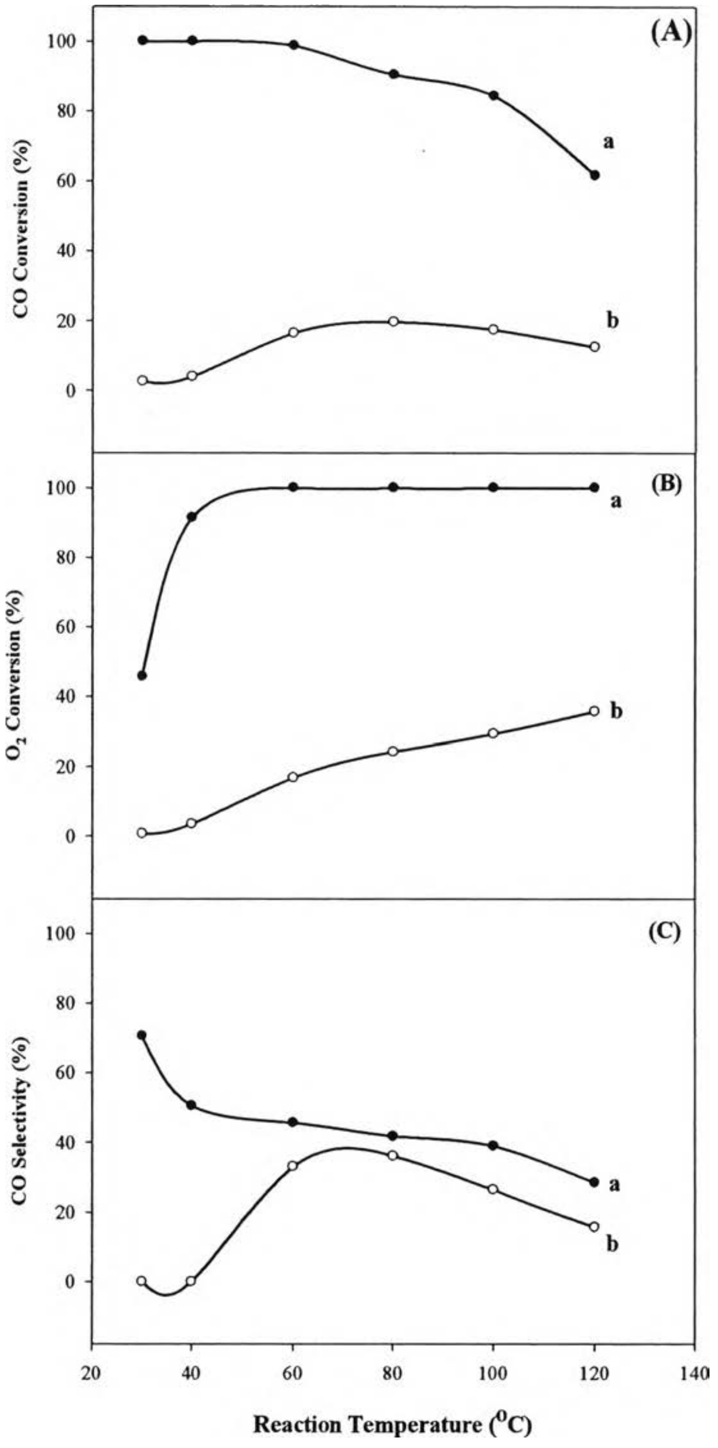

Figure F1 Catalytic activity of the uncalcined Au(0.05)/ZnO(0.05)-240 (a) 0% H_2O and (b) 10% H_2O —(A) CO conversion, (B) O_2 conversion, and (C) CO selectivity.

Appendix G Color Observation

Table G1 Color of the fresh and spent catalysts

Catalysts	Color	
	Before Reaction	After Reaction
Uncalcined Au(0.1)/ZnO(0.1)-30	Dark Purple	Dark Purple
Calcined Au(0.1)/ZnO(0.1)-30	Dark Purple	Dark Purple
Uncalcined Au(0.1)/ZnO(0.1)-90	Dark Purple	Dark Purple
Uncalcined Au(0.1)/ZnO(0.1)-120	Dark Purple	Dark Purple
Uncalcined Au(0.1)/ZnO(0.1)-240	Dark Purple	Dark Purple
Calcined Au(0.1)/ZnO(0.1)-240	Dark Purple	Dark Purple
Uncalcined Au(0.1)/ZnO(0.05)-240	Pale Blue	Pale Purple
Calcined Au(0.1)/ZnO(0.05)-240	Pale Purple	Dark Purple
Uncalcined Au(0.05)/ZnO(0.1)-240	Pale Blue	Pale Purple
Calcined Au(0.05)/ZnO(0.1)-240	Pale Purple	Dark Purple
Uncalcined Au(0.05)/ZnO(0.05)-240	Pale Blue	Pale Purple
Calcined Au(0.05)/ZnO(0.05)-240	Pale Purple	Dark Purple

CURRICULUM VITAE

Name: Ms. Siriwan Dulnee

Date of Birth: May 17, 1984

Nationality: Thai

University Education:

2003-2007 Bachelor Degree of Industrial Chemistry, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand

Working Experience:

2006-2006 Position: LRD intern

Company name: Bangchak Petroleum Company Limited

Presentations:

1. Dulnee, S., and Luengnaruemitchai, A. (2009, April 7-9) Activity of Different Metal Oxide Supported Gold Catalysts Prepared by Photodeposition for the Preferential CO Oxidation in a H_2-rich Gas. Oral presentation at The SDSE2008 Conference, Millennium Hilton Bangkok Hotel, Bangkok, Thailand.
2. Dulnee, S., and Luengnaruemitchai, A. (2009, April 22) Activity of Au/ZnO Catalysts Prepared by Photodeposition for the Preferential CO Oxidation in a H_2-rich Gas. Poster presented at the 15th PPC Symposium on Petroleum, Petrochems, and Polymers, Bangkok, Thailand.