APPENDICES

APPENDIX A

IMAGES OF INSTRUMENT

A.1. X-ray diffractometer (XRD)

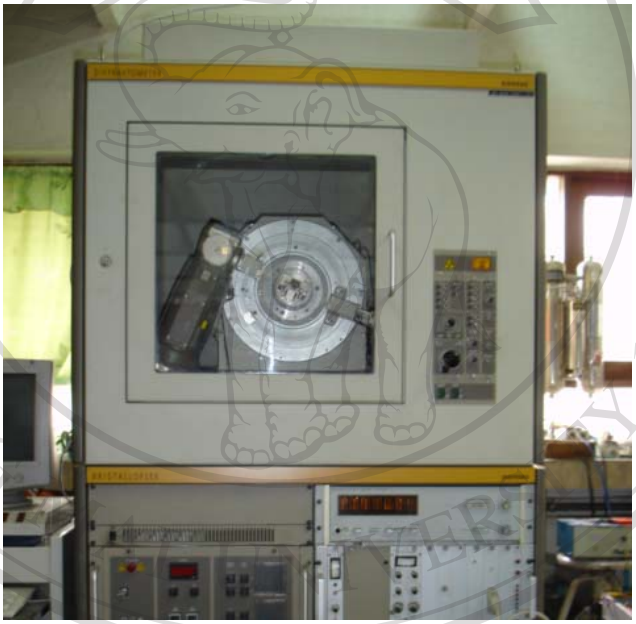


Figure A.1. X-ray diffractometer, Siemens D500

A.2. Scanning Electron Microscopy (SEM)

Figure A.2. Scanning Electron Microscopy, JEOL JSM-6335F

A.3. Transmission Electron Microscopy (TEM)

Figure A.3. Transmission Electron Microscopy, JOEL JSM-2010

A.4. Surface area analyzer (BET)

Figure A.4. Surface area analysis, Quantachrome Autosorb 1 MP

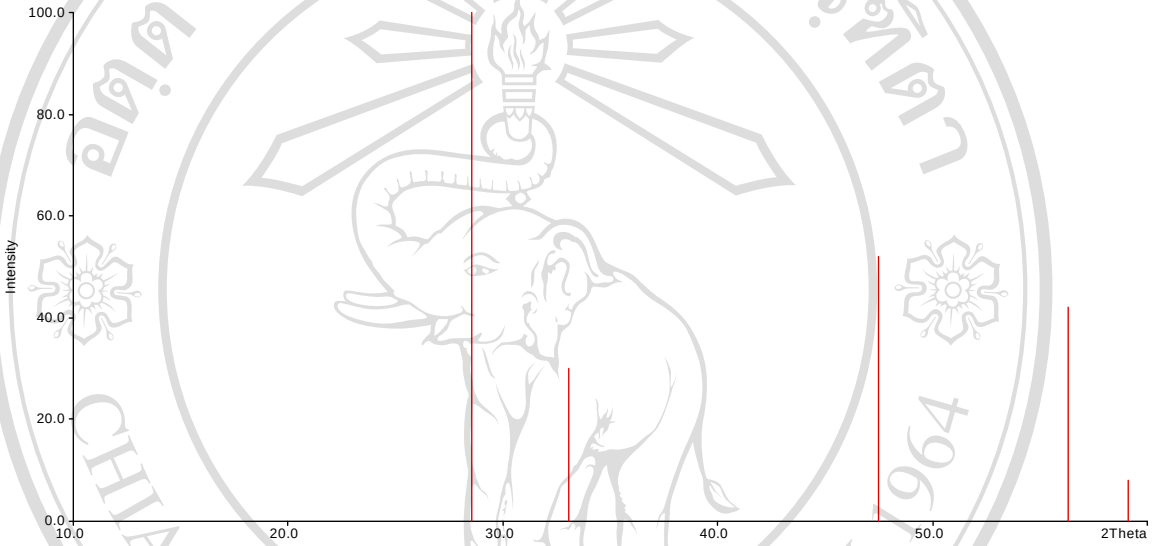
A.5. Spiral photoreactor

Figure A.5. Spiral photoreactor

APPENDIX B

JCPDS INFORMATION

B.1. JCPDS file of cerium oxide(CeO_2)



[34-394] PDF-2 Sets 1-86 Quality: * Wavelength: 1.540598

Cerium Oxide
Cerianite-(Ce), syn
ceria
Ce O2

Rad.: CuKa1 (1.5405981) Filter: Mono. Graph d-sp: Diffractometer
I/Icor.: Cutoff: 22.1 Int.: Diffractometer
Ref.: Natl. Bur. Stand. (U.S.) Monogr. 25, 20, (1983), 38

Sys.: Cubic S.G.: Fm3m (225) V(redu): 39.6
a: 5.41134(12) b: c:
A: B: C: Z: 4 mp:
Dx: 7.215 Dm: SS/FOM: F16= 129.8 (.0077, 16)

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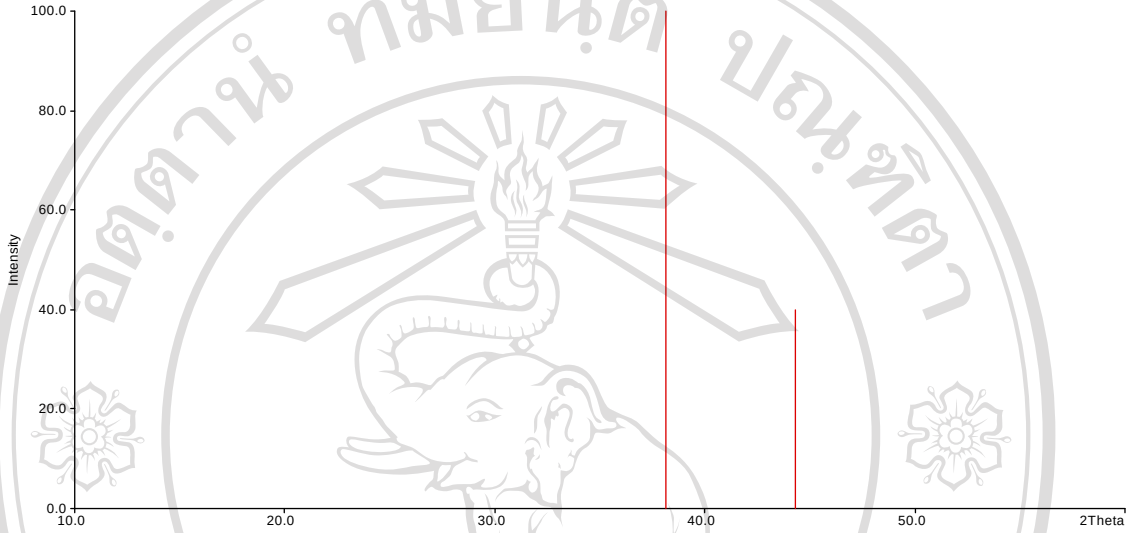
ea: nwB: ey: Sign: 2V:
Color: Light gray, yellowish brown

This yttria stabilized phase was prepared at NBS, Gaithersburg, MD, USA, by Dragoo, Domingues (1982) from co-precipitation of the oxides. The powder was calcined at 620 C and then formed into a billet without binder, isostatically pressed, and then hot-pressed in an alumina die for 30 minutes at 1350 C with an applied stress // of 28 MPa. The structure of fluorite // was determined by Bragg (1914). // Pattern taken at 26(1) C. // To replace 4-593. // See ICSD 28753, 28785 and 29046 (PDF 75-120, 75-151 and 75-390).

Hanawalt: 3.12/X 1.91/5 1.63/4 2.71/3 1.24/1 1.10/1 0.91/1 1.04/1 0.86/1 1.56/1
Max-d: 3.12/X 2.71/3 1.91/5 1.63/4 1.56/1 1.35/1 1.24/1 1.21/1 1.10/1 1.04/1

d[A]	2Theta	Int.	h k l	d[A]	2Theta	Int.	h k l
3.1234	28.555	100	1 1 1	0.9566	107.265	4	4 4 0
2.7056	33.082	30	2 0 0	0.9147	114.730	13	5 3 1
1.9134	47.479	52	2 2 0	0.9019	117.318	6	6 0 0
1.6318	56.335	42	3 1 1	0.8556	128.393	9	6 2 0
1.5622	59.087	8	2 2 2	0.8252	137.972	6	5 3 3
1.3531	69.402	8	4 0 0	0.8158	141.568	5	6 2 2
1.2415	76.700	14	3 3 1				
1.2101	79.070	8	4 2 0				
1.1048	88.412	14	4 2 2				
1.0415	95.397	11	5 1 1				

B.2. JCPDS file of silver(Ag)



[4-783] PDF-2 Sets 1-86 Quality: I Wavelength: 1.540598

Silver
Silver-3C, syn
Ag

Rad.: CuKa1 (1.54056) Filter: Beta Ni d-sp:
I/Icor.:5.20 Cutoff: Int.: Diffractometer
Ref.: Swanson, Tatge., Natl. Bur. Stand. (U.S.), Circ. 539, I, (1953), 23

Sys.: Cubic S.G.: Fm3m (225) V(redu): 17.0
a: 4.0862 b: c:
A: B: C: Z: 4 mp: 960.6deg
Dx: 10.500 Dm: 10.500 SS/FOM: F 9= 65.3 (.0153, 9)

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ea: nwB: 0.181 ey: Sign: 2V:
Color: Light gray metallic
Ref.: Winchell., Elements of Optical Mineralogy, II, 17

Sample obtained from Johnson Matthey Company, Ltd. // Purity >99.999%. // Spectrographic analysis indicated faint traces of Ca, Fe and Cu. // Pattern taken at 27 C. Opaque mineral optical data on specimen from Great Bear Lake, Canada: RR2Re=94.1, Disp.=16, VHN100=55-63, Color values .314, // .321, 94.2, Ref.: IMA Commission on Ore Microscopy QDF.

Hanawalt: 2.36/X 2.04/4 1.23/3 1.45/3 0.94/2 0.83/1 1.18/1 0.91/1 1.02/1 0.00/1
Max-d: 2.36/X 2.04/4 1.45/3 1.23/3 1.18/1 1.02/1 0.94/2 0.91/1 0.83/1 0.00/1

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d[A]	2Theta	Int.	h k l	d[A]	2Theta	Int.	h k l
2.3590	38.117	100	1 1 1	1.0215	97.891	4	4 0 0
2.0440	44.278	40	2 0 0	0.9375	110.501	15	3 3 1
1.4450	64.427	25	2 2 0	0.9137	114.928	12	4 2 0
1.2310	77.475	26	3 1 1	0.8341	134.889	13	4 2 2
1.1796	81.539	12	2 2 2				

APPENDIX C

CALCULATION OF PARTICLE SIZE

The particle diameters of pure CeO_2 and Ag-doped CeO_2 nanoparticles were calculated from specific surface areas and density of Ag and CeO_2 as

$$d_{BET} = \frac{6}{SSA_{BET}\rho_{sample}}$$

or $$d_{BET} = \frac{6}{[(SSA_{CeO_2} \times \rho_{CeO_2} \times (\text{mol\% of } CeO_2)) + (SSA_{Ag} \times \rho_{Ag} \times (\text{mol\% of Ag}))]}$$

Where:

SSA_{BET} is specific surface area

ρ_{sample} is the density of sample

(ρ_{CeO_2} = 7.65 g/cm^3 , ρ_{Ag}= 10.49 g/cm^3)

1. Pure CeO_2 nanoparticles

The specific surface area of pure CeO_2 = 109.40 m^2/g

$$d_{BET} = \frac{6}{(109.40\ m^2/g\ x\ 7.65x10^3\ kg/m^3)}$$

= 7.2 nm

2. 0.10 mol% Ag-doped CeO_2 nanoparticles

The specific surface area of 0.10 mol% Ag-doped CeO_2 nanoparticles = 82.37 m^2/g

$$d_{BET} = \frac{6}{\left(82.37\ m^2/g\ x\ 7.65x10^3\ kg/m^3 x\frac{99.9}{100}\right) + \left(82.37\ m^2/g\ x\ 10.49x10^3\ kg/m^3 x\frac{0.1}{100}\right)}$$

= 9.5 nm

3. 0.25 mol% Ag-doped CeO_2 nanoparticles

The specific surface area of 0.25 mol% Ag-doped CeO_2 nanoparticles = 110.80 m^2/g

$$d_{BET} = \frac{6}{\left(110.80\, m^2/g\ x\ 7.65\, x\, 10^3\ kg/m^3 x \frac{99.75}{100}\right) + \left(110.80\, m^2/g\ x\, 10.49\, x\, 10^3\ kg/m^3 x \frac{0.25}{100}\right)}$$

= 7.1 nm

4. 0.50 mol% Ag-doped CeO_2 nanoparticles

The specific surface area of 0.50 mol% Ag-doped CeO_2 nanoparticles = 77.99 m^2/g

$$d_{BET} = \frac{6}{\left(77.99\, m^2/g\ x\ 7.65\, x\, 10^3\ kg/m^3 x \frac{99.5}{100}\right) + \left(77.99\, m^2/g\ x\, 10.49\, x\, 10^3\ kg/m^3 x \frac{0.5}{100}\right)}$$

= 10.0 nm

5. 0.75 mol% Ag-doped CeO_2 nanoparticles

The specific surface area of 0.75 mol% Ag-doped CeO_2 nanoparticles = 114.47 m^2/g

$$d_{BET} = \frac{6}{\left(114.47\, m^2/g\ x\ 7.65\, x\, 10^3\ kg/m^3 x \frac{99.25}{100}\right) + \left(114.47\, m^2/g\ x\, 10.49\, x\, 10^3\ kg/m^3 x \frac{0.75}{100}\right)}$$

= 6.8 nm

6. 1.00 mol% Ag-doped CeO_2 nanoparticles

The specific surface area of 1.00 mol% Ag-doped CeO_2 nanoparticles = 96.93 m^2/g

$$d_{BET} = \frac{6}{\left(96.93\, m^2/g\ x\ 7.65\, x\, 10^3\ kg/m^3 x \frac{99}{100}\right) + \left(96.93\, m^2/g\ x\, 10.49\, x\, 10^3\ kg/m^3 x \frac{1}{100}\right)}$$

= 8.1 nm

CURRICULUM VITAE

Name Miss Chanjira Kitiwiang

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Education Background B.Sc. (Chemistry), Department of Chemistry, Faculty of Science, Chiang Mai University, Thailand, 2003-2006.

M.S. (Chemistry), Department of Chemistry, Faculty of Science, Chiang Mai University, Thailand, 2007-2008.

Scholarship The Center for Innovation in Chemistry: Postgraduate Education and Research Program in Chemistry, (PERCH-CIC), Thailand, 2007-2008

Working experience Work as a teaching assistant in the Chemistry Laboratory courses, Department of Chemistry, Faculty of Science, Chiang Mai University, Thailand, 2007.

Publications and Presentations Journal Article

Kitiwiang Ch., Phanichphant S., Synthesis of Silver-doped Cerium Dioxide Nanoparticles by the Homogeneous Precipitation, J. Microscopy Society of Thailand, Accepted for Publication.

Conference papers/Presentations

Kitiwiang Ch., Phanichphant S., Synthesis of Silver-doped Cerium Dioxide Nanoparticles by the Homogeneous Precipitation., Poster Presentation, The 26nd Annual Conference of Microscopy Society of Thailand, 28-30 January 2009, Empress Hotel, Chiang Mai, Thailand.