

APPENDIX

Table 5.1 JCPDS Cards (Joint Committee on Powder Diffraction Standards Cards) of Ag₂Se (024-1041)

Ag ₂ Se Silver selenide	2-theta (degree)	Intensity	d-spacing (°A)	h	k	l
Crystal system:	22.920	6.0	3.87700	0	0	2
Orthorombic	23.523	2.0	3.77900	1	0	1
Space group: P212121	24.059	1.0	3.69600	1	1	0
Space group number: 19	25.245	1.0	3.52500	0	2	0
a : 4.3330	26.725	7.0	3.33300	1	1	1
b : 7.0620	30.906	16.0	2.89100	1	0	2
c : 7.7640	32.692	20.0	2.73700	1	2	0
Alpha : 90.0000	33.498	100.0	2.67300	1	1	2
Beta : 90.0000	34.729	85.0	2.58100	1	2	1
Gamma : 90.0000	36.978	31.0	2.42900	0	1	3
Measured density(g/cm ³) :	39.967	33.0	2.25400	1	0	3
7.00	40.265	17.0	2.2380	1	2	2
Volume of cell (10 ⁶ pm ³) :	41.664	3.0	2.16600	2	0	0
237.58	42.633	34.0	2.11900	1	1	3
Z : 4	43.473	35.0	2.08000	2	0	1
	43.760	12.0	2.06700	1	3	0
	44.974	25.0	2.01400	0	3	2
	45.282	15.0	2.00100	2	1	1
	46.789	7.0	1.94000	0	0	4
	48.349	23.0	1.88100	1	2	3
	48.596	23.0	1.87200	0	1	4
	49.298	4.0	1.84700	2	2	0
	49.874	10.0	1.82700	2	1	2

50.795	4.0	1.79600	2	2	1
51.627	3.0	1.76900	1	0	4
53.245	6.0	1.71900	1	1	4
54.972	2.0	1.66900	2	2	2
56.216	1.0	1.63500	1	4	0
56.898	9.0	1.61700	2	1	3
57.285	5.0	1.60700	0	4	2
57.796	6.0	1.59400	2	3	0
59.096	6.0	1.56200	3	3	1
61.662	2.0	1.50300	2	2	3
62.965	4.0	1.47500	2	3	2
63.736	3.0	1.45900	0	4	3
64.478	2.0	1.44400	2	0	4
65.703	9.0	1.42000	3	0	1
65.912	5.0	1.41600	2	1	4

Table 5.2 JCPDS Cards (Joint Committee on Powder Diffraction Standards Cards) of Se (001-0848)

Se selenium	2-theta (degree)	Intensity	d-spacing (°Å)	h	k	l
Crystal system: Hexagonal	23.517	33.0	3.78000	1	0	0
Space group: P3121	29.555	100.0	3.02000	1	0	1
Space group number: 152	41.385	27.0	2.18000	1	1	0
a : 4.3400	43.694	40.0	2.07000	1	0	2
b : 4.3400	45.306	33.0	2.00000	1	1	1
c : 4.9500	51.596	27.0	1.77000	2	0	1
Alpha : 90.0000	56.029	20.0	1.64000	1	1	2
Beta : 90.0000	61.345	27.0	1.51000	1	0	3
Gamma : 120.0000	65.186	20.0	1.43000	2	1	0

Measured density (g/cm ³) :	71.403	13.0	1.32000	1	1	3
4.81	76.809	7.0	1.24000	2	0	3
Volume of cell (10 ⁶ pm ³) :	81.506	7.0	1.18000	1	0	4
80.74	85.950	7.0	1.13000	3	0	2
Z: 3.0	90.998	13.0	1.08000	2	1	3
	95.578	7.0	1.04000	3	1	0

Table 5.3 JCPDS Cards (Joint Committee on Powder Diffraction Standards Cards) of In(OH)₃ (076-1464)

In(OH) ₃ Indium hydroxide	2-theta (degree)	Intensity	d-spacing (°A)	h	k	l
Crystal system : Cubic	15.703	0.4	5.63868	1	1	0
Space group : Im3	22.279	100.0	3.98715	2	0	0
Space group number : 204	27.374	0.3	3.25549	2	1	1
a : 7.9743	31.712	54.9	2.81934	2	2	0
b : 7.9743	35.573	4.9	2.52170	0	1	3
c : 7.9743	39.099	19.6	2.30198	2	2	2
Alpha : 90.0000	42.377	1.0	3.13122	3	2	1
Beta : 90.0000	45.460	13.5	1.993581	4	0	0
Gamma : 90.0000	48.388	0.3	.87956	4	1	1
Calculated density	51.189	37.1	1.78311	4	2	0
(g/cm ³) : 4.34	53.883	0.1	1.70013	3	3	2
Volume of cell (10 ⁶ pm ³) :	56.488	12.8	1.62775	4	2	2
507.08	59.017	0.1	1.56389	0	1	5
Z: 8.00	63.888	0.1	1.45590	1	2	5
	66.246	5.6	1.40967	4	4	0
	68.563	0.5	1.36758	5	3	0
	70.843	5.7	1.32905	4	4	2

	73.092	0.1	1.29360	2	3	5
	75.315	7.4	1.26085	6	2	0
	77.515	0.1	1.23046	1	4	5
	79.697	3.7	1.20217	6	2	2

Table 5.4 JCPDS Cards (Joint Committee on Powder Diffraction Standards Cards) of H_3BO_3 (001-0767)

H_3BO_3 Boric oxide	2-theta (degree)	Intensity	d-spacing (°Å)	h	k	l
Crystal system: Anorthic	15.004	28.0	5.90000	1	0	0
Space group: P-1	28.218	100.0	3.16000	0	0	2
Space group number: 2	30.808	3.0	2.90000	0	-2	1
a : 7.0400	31.820	2.0	2.81000	2	-1	1
b : 7.0400	34.196	6.0	2.62000	0	1	2
c : 6.5600	35.165	2.0	2.55000	1	0	2
Alpha : 92.5000	36.041	2.0	2.49000	-2	0	2
Beta : 101.1700	40.416	13.0	2.23000	2	1	0
Gamma : 120.0000	41.786	3.0	2.16000	2	-3	1
Measured density	43.473	6.0	2.08000	-2	-1	2
(g/cm ³): 1.48	44.833	3.0	2.02000	0	2	2
Volume of cell (10 ⁶ pm ³):	54.582	3.0	1.68000	-1	4	0
272.43	56.403	2.0	1.63000	-3	-1	2
Z : 4.00	58.357	3.0	1.58000	-1	4	1

Table 5.5 JCPDS Cards (Joint Committee on Powder Diffraction Standards Cards) of In_2O_3 (044-1087)

In_2O_3 Indium oxide	2-theta (degree)	Intensity	d-spacing (°Å)	h	k	l
Crystal system : Cubic	12.361	1.0	7.15500	1	1	0
Space group : I213	17.516	1.0	5.05900	2	0	0
Space group number : 199	21.493	2.0	4.13100	2	1	1
a : 10.1180	27.858	1.0	3.20000	3	1	0
b : 10.1180	30.581	100.0	2.92100	2	2	2
c : 10.1180	33.103	5.0	2.70400	3	2	1
Alpha : 90.0000	35.452	28.0	2.53000	4	0	0
Beta : 90.0000	37.689	3.0	2.38480	4	1	1
Gamma : 90.0000	39.810	1.0	2.26250	4	2	0
Calculated density (g/cm ³):	41.842	1.0	2.15720	3	3	2
7.12	43.798	1.0	2.06530	4	2	2
Volume of cell (10 ⁶ pm ³):	45.685	3.0	1.98430	4	3	1
1035.82	49.289	2.0	1.84730	5	2	1
Z: 16.00	51.020	35.0	1.78860	4	4	0
	52.709	1.0	1.73520	4	3	3
	54.361	1.0	1.68630	6	0	0
	55.977	2.0	1.64140	6	1	1
	57.567	1.0	1.59980	6	2	0
	59.129	1.0	1.56120	5	4	1
	60.665	11.0	1.52530	6	2	2
	62.172	1.0	1.49180	6	3	1
	63.668	4.0	1.46040	4	4	4
	65.140	1.0	1.43090	5	4	3
	66.597	1.0	1.40310	0	4	6
	68.035	1.0	1.37690	6	3	3
	69.460	1.0	1.35210	6	4	2

Table 5.6 JCPDS Cards (Joint Committee on Powder Diffraction Standards Cards) of Cu₂O (001-1142)

Cu ₂ O Copper oxide	2-theta (degree)	Intensity	d-spacing (°A)	h	k	l
Crystal system: Cubic	29.757	3.0	3.00000	1	1	0
Space group: Pn3m	36.650	100.0	2.45000	1	1	1
Space group number: 24	42.612	31.0	2.12000	2	0	0
a : 4.2520	61.345	44.0	1.51000	2	2	0
b : 4.2520	73.997	31.0	1.28000	3	1	1
c : 4.2520	77.549	5.0	1.23000	2	2	2
Alpha : 90.0000	92.094	3.0	1.07000	4	0	0
Beta : 90.0000						
Gamma : 90.0000						
Measured density (g/cm ³): 6.14						
Volume of cell (10 ⁶ pm ³):76.87						
Z: 2.00						

Table 5.7 JCPDS Cards (Joint Committee on Powder Diffraction Standards Cards) of Ag₂O (019-1155)

Ag ₂ O Silver oxide	2-theta (degree)	Intensity	d-spacing (°A)	h	k	l
Crystal system:	33.929	4.0	2.64000	1	0	0
	36.496	4.0	2.46000	0	0	2
	38.610	100.0	2.33000	1	0	1

	50.375	25.0	1.81000	1	0	2
	56.029	2.0	1.64000	0	0	3
	60.459	10.0	1.53000	1	1	0
	66.763	25.0	1.40000	1	0	3
	70.785	2.0	1.33000	2	0	0
Space group: P-3m1						
Space group number: 164						
a : 3.0720						
b : 3.0720						
c : 4.9410						
Alpha : 90.0000						
Beta : 90.0000						
Gamma : 120.0000						
Calculated density						
(g/cm ³): 9.53						
Measured density						
(g/cm ³): 9.50						
Volume of cell (10 ⁶ pm ³):						
40.38						
Z: 1.00						

CURRICULUM VITAE

Name

Miss Pathinee Rattaniламorn

Date of Birth

10th May 1985

Institution attended

- High School (Science and Mathematics Programme), Wattanothaipayap school, Chiang Mai, Thailand, 2002.
- B.S. (Chemistry), Department of Chemistry, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand, 2006.
- M.S. (Chemistry), Department of Chemistry, Faculty of Science, Chiang Mai University, 2011.

Scholarships

- Center of Excellent for Innovation in Chemistry (PERCH-CIC), Chiang Mai University, Chiang Mai, Thailand
- National Metal and Materials Technology Center (MTEC)

Grant

- Graduate School of Chiang Mai University, Chiang Mai, Thailand

International Conferences

- **Poster Presentation:** Pathinee Rattananil-a-morn, Thapanee Sarakonsri, “Preparation of $\text{Cu}_{0.5}\text{Ag}_{1.5}\text{InSe}_3$ (CAIS) p-Type Semiconductor for Thermoelectric Applications by Sol-gel Method” , *The International Congress for Innovation in Chemistry (PERCH-CIC Congress VI)*, 3rd-6th May 2009, Jomtien Palm Beach Hotel&Resort, Chonburi, Thailand.
- **Poster Presentation:** Pathinee Rattananil-a-morn, Thapanee Sarakonsri and Chanchana Thanachayanont, “Preparation of $\text{Cu}_{0.5}\text{Ag}_{1.5}\text{InSe}_3$ (CAIS) p-Type Semiconductor for Thermoelectric Applications by Sol-gel Method.” , *Poster presentation at The 3rd International Symposium on Functional Materials (ISFM2009)*, 15th-18th June, 2009, Jinju, Korea
- , Le Meridien Chiang Rai Resort, Chiang Rai, Thailand.
- **Poster Presentation:** Pathinee Rattananil-a-morn, Thapanee Sarakonsri and Chanchana Thanachayanont, “Preparation of $\text{Cu}_{0.5}\text{Ag}_{1.5}\text{InSe}_3$ (CAIS) p-Type Semiconductor for Thermoelectric Applications by Sol-gel Method.” , *International Conference on Green and Sustainable Innovation 2009(ICGSI 2009)*, 2nd - 4th December 2009, Le Meridien Chiang Rai Resort, Chiang Rai, Thailand.