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ภาคผนวก

ภาคผนวก ก

แฟ้มการเลี้ยวเบนผลึกผง (เฉพาะที่ใช้ในงานวิจัยนี้ [130])

5-522 ★

d	3.27	2.00	1.71	3.27	(ZnSe)8F
I/I_1	100	70	44	100	Zinc Selenide (Stilleite)

Rad. $CuK\alpha_1$ λ 1.5405 Filter Ni Dia.
Cut off I/I_1 Diffractometer I/I cor.
Ref. Swanson and Fuyat, NBS Circular 539, Vol. 3, 23 (1954)

Sys. Cubic S.G. F$\bar{4}$3m (216)
a_0 5.667 b_0 c_0 A C
α β γ Z 4 Dx 5.267
Ref. Ibid.

εα nωβ 2.89 εγ Sign
2V D 5.42 mp Color Yellowish to reddish
Ref. Ibid.

Sample from Mallinckrodt Chem. Works. Spect. anal.:
<0.01% Ba,K,Mo,Na; <0.001% Al,Ca,Fe,Mg,Ni,Pd,Si;
<0.0001% Ag,Bi,Cd,Cu,Mn.
X-ray pattern 25°C.
Also hexagonal form.
Structure: sphalerite.
Merck Index, 8th Ed. p. 1130.

d Å	I/I_1	hkl	d Å	I/I_1	hkl
3.273	100	111			
2.835	<1	200			
2.003	70	220			
1.707	44	311			
1.635	<1	222			
1.416	9	400			
1.299	13	331			
1.267	<1	331			
1.1561	15	422			
1.0901	6	511			
1.0012	4	440			
0.9577	8	531			
.9441	<1	600			
.8958	4	620			
.8642	2	533			
.5545	<1	622			
.8180	2	444			

15-105 MAJOR CORRECTION i

d	3.43	2.00	3.25	3.43	(ZnSe)4H
I/I_1	100	100	90	100	Zinc Selenide

Rad. λ Filter Dia.
Cut off I/I_1 Visual
Ref. Korneeva, Soviet Phys. Cryst. 6 4, 505-6 (1962)

Sys. Hexagonal S.G. P6₃mc (186)
a_0 3.996 b_0 c_0 6.626 A C 1.66
α β γ Z 2 Dx [5.23]
Ref. Ibid.

εα nωβ εγ Sign
2V D mp Color Yellow
Ref. Ibid.

See 5-0522 for pattern of cubic modification.
Wurtzite type obtained by decomposing $ZnSe \cdot N_2H_4$ at 480± 20°C. Vapor grown crystals have a_0=4.003, c_0=6.540, C=1.634.
Reference; Chan and Park, Bull. Am. Phys. Soc. 9 296 (1964).

d Å	I/I_1	hkl	d Å	I/I_1	hkl
3.43	100	100			
3.25	90	002			
3.05	70	101			
2.368	60	102			
1.997	100	110			
1.84	80	103			
1.703	70	112			
1.527	10	202			
1.353	60	203			
1.308	30	120			
1.222	40	105			
1.153	40	300			
1.119	60	213			
1.087	40	302			
1.042	20	205			
1.000	30	220			
0.956	50	116			
.923	20	215			
.878	20	313			
.857	10	401			

27-1402

d	3.14	1.92	1.64	3.14	(Si)8F ★
I/I_1	100	55	30	100	Silicon

Rad. $CuK\alpha_1$ λ 1.5405981 Filter Mono. Dia.
Cut off I/I_1 Diffractometer I/I cor. =4.7
Ref. NBS Monograph 25, Sec. 13, 35 (1976)

Sys. Cubic S.G. Fd3m (227)
a_0 5.43088(4) b_0 c_0 A C
α β γ Z 8 Dx 2.329
Ref. Ibid.

εα nωβ εγ Sign
2V D mp Color Gray
Ref. Ibid.

Pattern at 25±0.1°C.
Internal standard: W.
This sample is NBS Standard Reference Material #640.
d's calculated from precision measurement of a_0.
a_0 uncorrected for refraction.
To replace 26-1481.

d A	I/I_1	hkl	d A	I/I_1	hkl
3.13552	100	111			
1.92011	55	220			
1.63747	30	311			
1.35772	6	400			
1.24593	11	331			
1.10857	12	422			
1.04517	6	511			
0.96005	3	440			
.91799	7	531			
.85870	8	620			
.82820	3	533			

5-664

d	2.48	2.82	2.60	2.82	(ZnO)4H ★
I/I_1	100	71	56	71	Zinc Oxide (Zincite)

Rad. $CuK\alpha_1$ λ 1.5405 Filter Ni Dia.
Cut off I/I_1 Diffractometer I/I cor.
Ref. Swanson and Fuyat, NBS Circular 539, Vol. 2, 25 (1953)

Sys. Hexagonal S.G. $P6_3mc$ (186)
a_0 3.249 b_0 c_0 5.205 A C 1.60
α β γ Z 2 Dx 5.680
Ref. Ibid.

εα nωβ εγ Sign
2V D mp Color Colorless
Ref. Ibid.

Sample from New Jersey Zinc Co.
Spect. analysis: <0.001% each of Mg, Si and Ca.
X-ray pattern at 26°C.
Merck Index, 8th Ed., p. 1129.

d A	I/I_1	hkl	d A	I/I_1	hkl
2.816	71	100	.9069	12	213
2.602	56	002	.8826	6	302
2.476	100	101	.8675	1	006
1.911	29	102	.8369	4	205
1.626	40	110	.8290	2	106
1.477	35	103	.8237	2	214
1.407	6	200	.8125	5	220
1.379	28	112			
1.359	14	201			
1.301	3	004			
1.238	5	202			
1.1812	3	104			
1.0929	10	203			
1.0639	4	210			
1.0422	10	211			
1.0158	5	114			
0.9848	4	212			
.9764	7	105			
.9555	1	204			
.9382	4	300			

6-362

d	3.01	3.78	2.07	3.78	(Se)3H ★
I/I_1	100	55	35	55	Selenium (Selenium)

Rad. $CuK\alpha_1$ λ 1.5405 Filter Ni Dia.
Cut off I/I_1 Diffractometer I/I cor.
Ref. Swanson et al., NBS Circular 539, Vol. 5, 54 (1955)

Sys. Hexagonal S.G. *
a_0 4.3662 b_0 c_0 4.9536 A C 1.1345
α β γ Z 3 Dx 4.809
Ref. Ibid.

εα nωβ 3.0 εγ 4.04 Sign +
2V D 4.80 mp 220°C Color Dark gray powder
Ref. Dana's System Mineralogy, 7th Ed., Vol. 1.

$^{*}P3_121$ (152) or $P3_221$ (154).
Sample from The Mallinckrodt Chem. Wks.
Spect. anal.: <0.01% Al, Si; <0.001% B, Ba, Ca, Cu, Fe; <0.0001% Ag, Bi, Cd, Li.
X-ray pattern at 26°C. Sample annealed at 155°C for 16 hours.
Two other forms, monoclinic and cubic have been reported. Merck Index, 8th Ed., p. 940.

d A	I/I_1	hkl	d A	I/I_1	hkl
3.78	55	100	1.0365	2	204
3.005	100	101	1.0261	2	311
2.184	16	110	0.9593	2	105
2.072	35	102			
1.998	20	111			
1.890	4	200			
1.766	20	201			
1.650	10	003			
1.637	12	112			
1.5127	8	103			
1.5029	10	202			
1.4291	10	210			
1.3727	4	211			
1.3170	6	113			
1.2439	2	203			
1.2387	4	212			
1.2215	4	301			
1.1769	6	104			
1.1232	4	302			
1.0803	6	213			

11-695 MINOR CORRECTION

d	4.05	2.49	2.84	4.05	$(SiO_2)12I$ ★
I/I₁	100	20	14	100	SILICON OXIDE (CRISTOBALITE, LOW)

Rad. $CuK\alpha_1$ λ 1.5405 Filter Ni Dia.
Cut off I/I₁ DIFFRACTOMETER
Ref. NAT. BUR. STANDARDS CIRC. 539 10 48 (1960)

Sys. TETRAGONAL S.G. $P4_12_12$ (92), $P4_32_12$ (96)
a_0 4.971 b_0 c_0 6.918 A C 1.392
α β γ Z 4 Dx 2.334
Ref. IBID.

εα 1.484 nωβ 1.486 εγ Sign −
2V D mp Color COLORLESS
Ref. IBID.

SAMPLE WAS PREPARED AT NBS AT 1700°C FROM SILICA GEL.
SPEC. ANAL. SHOWED 0.01-0.1% AL, CU; 0.001-0.01% FE, TI; AND 0.0001-0.001% AG, MG, SN.
PATTERN WAS MADE AT 25°C.
MERCK INDEX, 8TH ED., P. 946.

SEE FOLLOWING CARD

d Å	I/I₁	hkl	d Å	I/I₁	hkl
4.05	100	101	1.494	6	302
3.52	4	110	1.431	4	312
3.14	12	111	1.419	4	204
2.841	14	102	1.398	4	223
2.485	20	200	1.379	<2	320
2.465	6	112	1.365	4	214
2.340	2	201	1.352	4	321
2.118	6	211	1.346	<2	303
2.019	4	202	1.333	4	105
1.929	6	113	1.299	4	313
1.870	8	212	1.281	4	322
1.757	<2	220	1.242	<2	400
1.730	2	004	1.233	2	224
1.690	4	203	1.223	4	401
1.634	2	104	1.210	4	205
1.612	6	301	1.206	4	410
1.600	4	213	1.188	2	411
1.571	<2	310	1.183	2	323
1.567	<2	222	1.175	2	215
1.533	4	311	1.172	1	330

d	4.05	2.49	2.84	4.05	$(SiO_2)12I$ ★
I/I₁	100	20	14	100	SILICON OXIDE (CRISTOBALITE, LOW)

Rad. λ Filter Dia.
Cut off I/I₁ I/I cor.
Ref.

Sys. S.G.
a_0 b_0 c_0 A C
α β γ Z Dx
Ref.

εα nωβ εγ Sign
2V D mp Color
Ref.

SEE PRECEDING CARD

d Å	I/I₁	hkl	d Å	I/I₁	hkl
1.163	<1	314	0.9350	<1	424
1.155	<1	331	.9298	<1	316
1.138	<1	412	.9244	<1	405
1.110	<1	332	.9185	<1	207
1.097	3	421	.9129	<1	503
1.095	3	116	.9032	1	217
1.086	<1	225	.8979	<1	513
1.0776	<1	324	.8919	<1	522
1.0687	<1	413	.8845	<1	326
1.0582	<1	422	.8664	<1	425
1.0445	<1	333	.8618	<1	504
1.0384	<1	315	.8569	<1	523
1.0015	<1	423	.8524	<1	530
0.9941	<1	430	.8518	<1	442
.9890	1	414	.8463	<1	531
.9841	<1	501	.8366	<1	317
.9696	<1	334,107	.8226	<1	601
.9654	<1	511	.8172	<1	610
.9555	<1	502	.8072	<1	505
.9467	<1	306	4 REFLECTIONS TO .7809		

ภาคผนวก ข

ความสัมพันธ์กันระหว่างระนาบในผลึกลูกบาศก์

มุม (องศา) ระหว่างระนาบผลึกลูกบาศก์ [131]

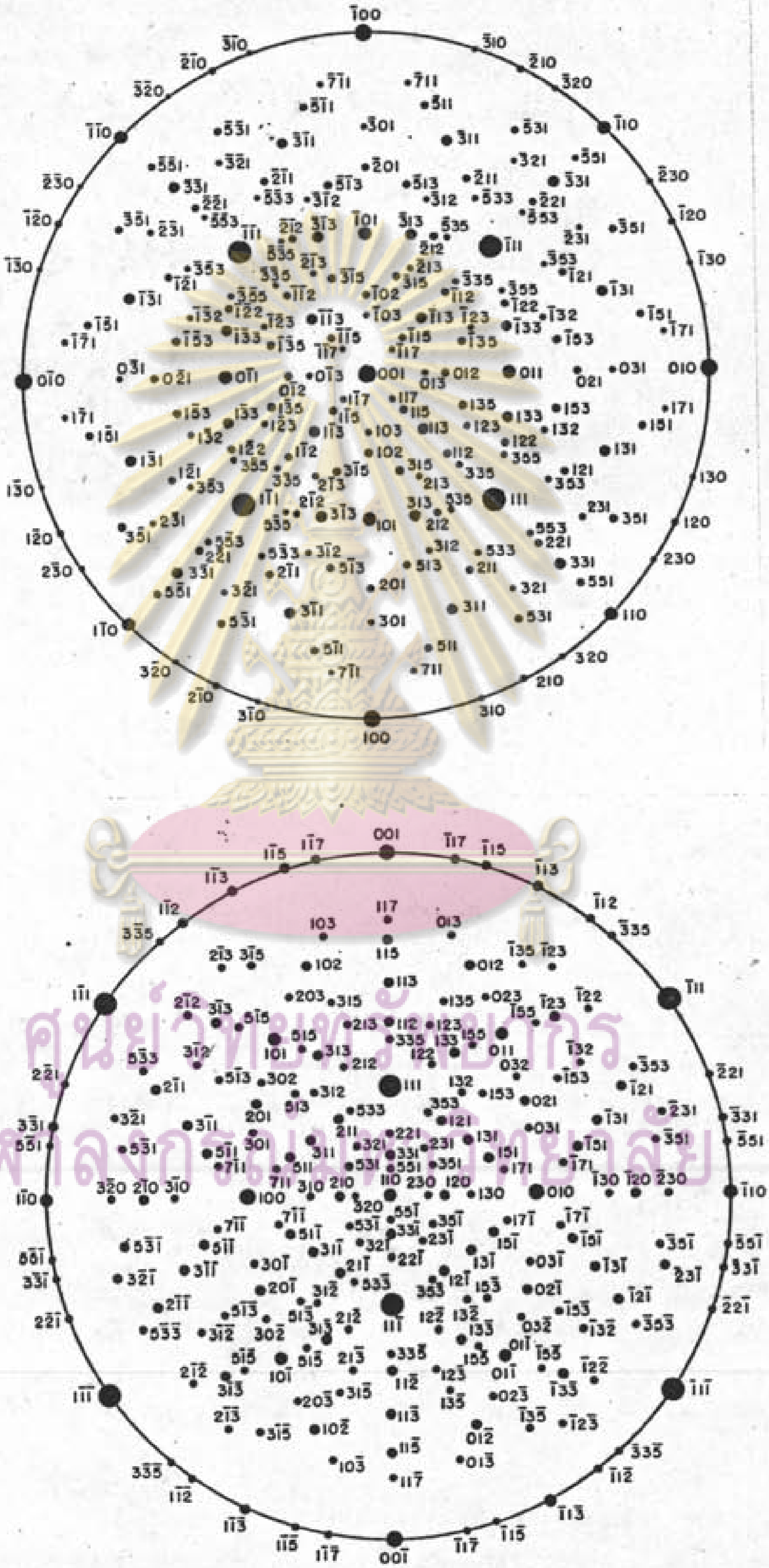
HKL	*hkl*			
100	100	0.00	90.00	
	110	45.00	90.00	
	111	54.74		
	210	26.56	63.43	90.00
	211	35.26	65.90	
	221	48.19	70.53	
	310	18.43	71.56	90.00
	311	24.24	72.45	
	320	33.69	56.31	90.00
	321	36.70	57.69	74.50
	322	43.31	60.98	
	331	46.51	76.74	
	332	50.24	64.76	
	410	14.04	75.96	90.00
	411	19.47	76.37	
	421	29.20	64.12	77.40
	430	36.87	53.13	90.00
	431	38.33	53.96	78.69
	432	42.03	56.14	68.20
	433	46.69	59.04	
	441	45.87	79.98	
	443	51.34	62.06	
	510	11.31	78.69	90.00
	511	15.79	78.90	
	520	21.80	68.20	90.00
	521	24.09	68.58	79.48
	522	29.50	69.62	
	530	30.96	59.04	90.00
	531	32.31	59.53	80.27
	532	35.80	60.88	71.07
	533	40.32	62.77	
	540	38.66	51.34	90.00
	541	39.51	51.89	81.12
	542	41.81	53.40	72.65
	543	45.00	55.55	64.90
	544	48.53	58.01	
	551	45.56	81.95	
	552	47.12	74.21	
	553	49.39	67.01	
	554	52.01	60.50	

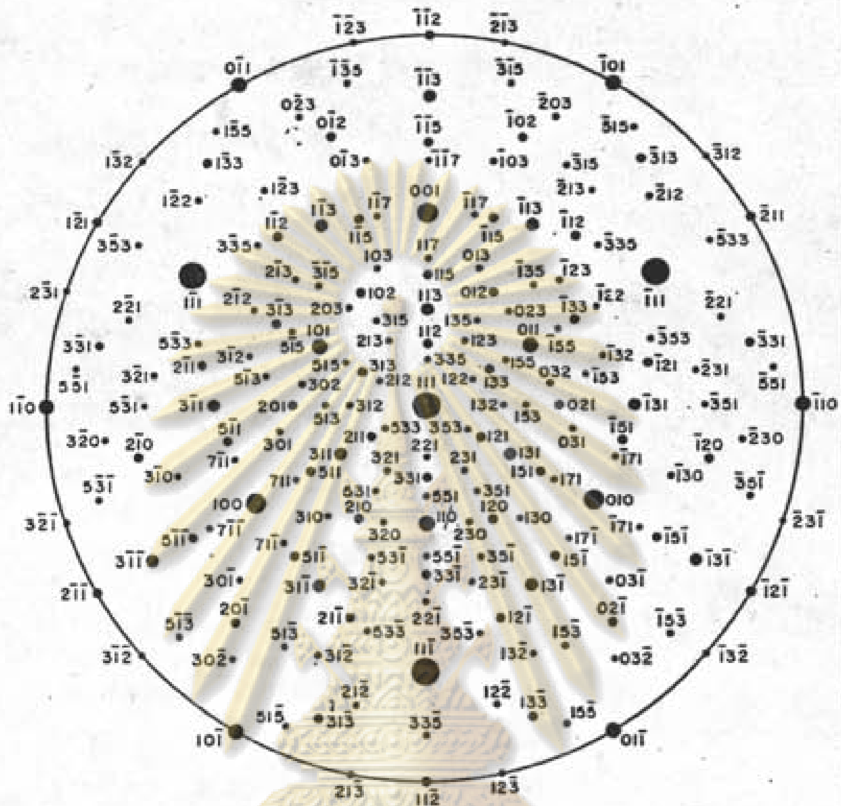
HKL	*hkl*						
110	110	0.00	60.00	90.00			
	111	35.26	90.00				
	210	18.43	50.77	71.56			
	211	30.00	54.74	73.22	90.00		
	221	19.47	45.00	76.37	90.00		
	310	26.56	47.87	63.43	77.08		
	311	31.48	64.76	90.00			
	320	11.31	53.96	66.91	78.69		
	321	19.11	40.89	55.46	67.79	79.11	
	322	30.96	46.69	80.12	90.00		
	331	13.26	49.54	71.07	90.00		
	332	25.24	41.08	81.33	90.00		
	410	30.96	46.69	59.04	80.12		
	411	33.56	60.00	70.53	90.00		
	421	22.21	39.51	62.42	72.02	81.12	
	430	8.13	55.55	64.90	81.87		
	431	13.90	46.10	56.31	65.42	73.90	82.03
	432	23.20	38.02	48.96	74.77	82.45	
	433	31.91	43.31	83.03	90.00		
	441	10.02	52.01	68.33	90.00		
	443	27.94	39.37	83.66	90.00		
	510	33.69	46.10	56.31	82.03		
	511	35.26	57.02	74.21	90.00		
	520	23.20	48.96	66.80	74.77		
	521	25.35	39.23	58.91	67.21	82.58	
	522	30.50	60.50	68.33	90.00		
	530	14.04	52.67	68.67	75.96		
	531	17.02	44.18	61.44	76.17		
	532	23.41	36.59	55.00	69.87	76.74	83.41
	533	30.38	49.68	77.54	90.00		
	540	6.34	56.48	63.78	83.66		
	541	10.89	49.11	56.94	64.12	70.89	83.74
	542	18.43	42.45	50.77	71.56	77.83	83.95
	543	25.84	36.87	45.57	78.46	84.26	
	544	32.55	41.47	84.62	90.00		
	551	8.05	53.55	66.67	90.00		
	552	15.79	47.66	73.22	90.00		
	553	22.99	42.57	79.39	90.00		
	554	29.50	38.43	85.01	90.00		
111	111	0.00	70.53				
	210	39.23	75.04				
	211	19.47	61.87	90.00			
	221	15.79	54.74	78.90			
	310	43.09	68.58				
	311	29.50	58.52	79.98			
	320	36.81	80.78				
	321	22.21	51.89	72.02	90.00		
	322	11.42	65.16	81.95			
	331	22.00	48.53	82.39			
	332	10.02	60.50	75.75			
	410	45.56	65.16				
	411	35.26	57.02	74.21			
	421	28.12	50.95	67.79	82.76		
	430	36.07	83.37				
	431	25.06	47.20	76.91	90.00		
	432	15.22	57.58	71.24	83.84		
	433	8.05	66.67	78.58			
	441	25.24	45.29	84.23			
	443	7.33	63.20	74.30			

HKL	*hkl*								
111	510	47.20	63.07						
	511	38.94	56.25	70.53					
	520	41.37	71.24						
	521	32.51	50.77	65.06	77.83				
	522	25.24	59.83	84.23					
	530	37.62	78.58						
	531	28.56	46.91	72.98	84.40				
	532	20.51	55.81	68.00	90.00				
	533	14.42	63.88	84.95					
	540	35.76	84.83						
	541	27.02	44.54	79.74	90.00				
	542	18.78	52.95	75.04	85.06				
	543	11.54	60.67	70.94	80.60				
	544	6.21	67.52	76.74					
	551	27.21	43.31	85.36					
	552	19.47	51.06	80.96					
	553	12.27	58.25	76.97					
	554	5.76	64.76	73.48					
210	210	0.00	36.87	53.13	66.42	78.46	90.00		
	211	24.09	43.09	56.79	79.48	90.00			
	221	26.56	41.81	53.40	63.43	72.65	90.00		
	310	8.13	31.95	45.00	64.90	73.57	81.87		
	311	19.29	47.61	66.14	82.25				
	320	7.12	29.74	41.91	60.25	68.15	75.64	82.87	
	321	17.02	33.21	53.30	61.44	68.99	83.14		
		90.00							
	322	29.80	40.60	49.40	64.29	77.47	83.77		
	331	22.57	44.10	59.14	72.07	84.11			
	332	30.89	40.29	48.13	67.58	73.38	84.53		
	410	12.53	29.80	40.60	49.40	64.29	77.47	83.77	
211	211	0.00	33.56	48.19	60.00	70.53	80.40		
	221	17.72	35.26	47.12	65.90	74.21	82.18		
	310	25.35	40.21	58.91	75.04	82.58			
	311	10.02	42.39	60.50	75.75	90.00			
	320	25.06	37.57	55.52	63.07	83.50			
	321	10.89	29.20	40.20	49.11	56.94	70.89	77.40	83.74
		90.00							
	322	8.05	26.98	53.55	60.32	72.72	78.58	84.32	
	331	20.51	41.47	68.00	79.20				
	332	16.78	29.50	52.46	64.20	69.62	79.98	85.01	
	410	26.98	46.12	53.55	60.32	72.72	78.58		
221	221	0.00	27.27	38.94	63.61	83.62	90.00		
	310	32.51	42.45	58.19	65.06	83.95			
	311	25.24	45.29	59.83	72.45	84.23			
	320	22.41	42.30	49.67	68.30	79.34	84.70		
	321	11.49	27.02	36.70	57.69	63.55	74.50	79.74	84.89
	322	14.04	27.21	49.70	66.16	71.13	75.96	90.00	
	331	6.21	32.73	57.64	67.52	85.61			
	332	5.77	22.50	44.71	60.17	69.19	81.83	85.92	
	410	36.06	43.31	55.53	60.98	80.69			
310	310	0.00	25.84	36.87	53.13	72.54	84.26		
	311	17.55	40.29	55.10	67.58	79.01	90.00		
	320	15.26	37.87	52.12	58.25	74.74	79.90		
	321	21.62	32.31	40.48	47.46	53.73	59.53	65.00	75.31
		85.15	90.00						
	322	32.47	46.35	52.15	57.53	72.13	76.70		
	331	29.47	43.49	54.52	64.20	90.00			
	332	36.00	42.13	52.64	61.84	66.14	78.33		
	410	4.40	23.02	32.47	57.53	72.13	76.70	85.60	

HKL	*hkl*								
311	311	0.00	35.10	50.48	62.96	84.78			
	320	23.09	41.18	54.17	65.28	75.47	85.20		
	321	14.76	36.31	49.86	61.09	71.20	80.72		
	322	18.07	36.45	48.84	59.21	68.55	85.81		
	331	25.94	40.46	51.50	61.04	69.76	78.02		
	332	25.85	39.52	50.00	59.05	67.31	75.10	90.00	
	410	18.07	36.45	59.21	68.55	77.33	85.81		
320	320	0.00	22.62	46.19	62.51	67.38	72.08		
	321	15.50	27.19	35.38	48.15	53.63	58.74	68.24	72.75
		77.15	85.75	90.00					
	322	29.02	36.18	47.73	70.35	82.27	90.00		
	331	17.36	45.58	55.06	63.55	79.00			
	332	27.50	39.76	44.80	72.80	79.78	90.00		
	410	19.65	36.18	42.27	47.73	57.44	70.35	78.36	82.27
321	321	0.00	21.79	31.00	38.21	44.41	49.99	64.62	69.07
		73.40	85.90						
	322	13.51	24.84	32.57	44.52	49.59	63.01	71.09	78.79
		82.55	86.28						
	331	11.19	30.85	42.63	52.18	60.63	68.42	75.80	82.96
		90.00							
	332	14.38	24.26	31.27	42.20	55.26	59.15	62.88	73.45
		80.16	83.46	86.73					
	410	24.84	32.57	44.52	49.59	54.31	63.01	67.11	71.09
		82.55	86.28						
322	322	0.00	19.75	58.03	61.93	76.39	86.63		
	331	18.93	33.42	43.67	59.95	73.85	80.97	86.81	
	332	10.74	21.45	55.33	68.78	71.92	87.04		
	410	34.57	49.68	53.97	69.33	72.90			
331	331	0.00	26.52	37.86	61.73	80.91	86.98		
	332	11.98	28.31	38.50	54.06	72.93	84.39	90.00	
	410	33.42	43.67	52.26	59.95	67.08	86.81		
332	332	0.00	17.34	50.48	65.85	79.52	82.16		
	410	39.14	43.62	55.33	58.86	62.26	75.02		
410	410	0.00	19.75	28.07	61.93	76.39	86.63	90.00	

ภาพฉายมาตรฐานของผลึกเฟซเซนเตอร์คิวบิกที่หน้าผลึกต่าง ๆ [131]





ภาคผนวก ค

การกัดผิวผลึกด้วยสารเคมี

ขบวนการล้างทำความสะอาดผิวผลึก [82]

1. ต้มใน TCE (trichloroethylene, C_2HCl_3) เดือดนานประมาณ 5 นาที เพื่อล้างคราบไขมันที่ติดอยู่
2. ต้มในอะซีโตนเดือดประมาณ 5 นาที เพื่อละลาย TCE ออก
3. ต้มในเมธานอลเดือดประมาณ 5 นาที
4. ชะด้วยน้ำ DI หลาย ๆ ครั้ง
5. เป่าให้แห้งอย่างเร็วด้วยแก๊สไนโตรเจนบริสุทธิ์ เพื่อกันสิ่งสกปรกแห้งแข็งจับติดเป็นคราบ

ขบวนการกัดผิวผลึกด้วยสารเคมี

1. ล้างทำความสะอาดผิวผลึกดังกล่าวข้างต้น เพื่อมิให้ชั้นไขมันหรือสิ่งสกปรกปิดกั้นการกัดผิวด้วยสารเคมีต่อไป
2. วางผลึกบนฐานเทฟลอนเอียงประมาณ 45 องศาใน 0.1% Br-methanol นาน 30 วินาที Br-methanol จะกัดชั้นผิวหน้าผลึกบาง ๆ ออก ซึ่งจะทำให้ชั้นออกไซด์และสิ่งพร่องบนผิวถูกกัดออก
3. ริน methanol เติมใน Br-methanol เพื่อให้สารละลายเจือจางลง
4. ชะผลึกด้วย methanol เป็นจำนวนมาก เพื่อให้แน่ใจว่าสิ่งที่หลุดออกจากผิวจะไม่ยังคงติดอยู่ที่ผิวผลึก
5. ชะผลึกด้วยน้ำ DI เป็นจำนวนมาก
6. เป่าให้แห้งอย่างรวดเร็วด้วยแก๊สไนโตรเจนบริสุทธิ์

อนึ่งในการเปลี่ยนสารละลายเพื่อดำเนินขั้นตอนในขั้นถัดไป จะใช้วิธีทำให้สารละลายในขณะเจือจางด้วยสารในขั้นถัดไป ในระหว่างขบวนการจะพยายามไม่ให้ผลึกสัมผัสกับอากาศโดยตรง การล้างผิวผลึกจะล้างตามขบวนการข้างต้นสองรอบ การกัดผิวผลึกที่ดีจะสามารถลบรอยขีดข่วนจากการขัด แต่จะไม่ให้กัดมากจนสามารถสังเกตเห็นเกรนหรือทวินได้

ประวัติผู้เขียน

นาย ธนากร โอสถจันทร์ เกิดเมื่อวันที่ 22 พฤศจิกายน พ.ศ.2508 ที่กรุงเทพมหานคร สำเร็จการศึกษาปริญญาวิทยาศาสตรบัณฑิตจากมหาวิทยาลัยเกษตรศาสตร์ เมื่อ พ.ศ. 2529 จากนั้นได้เข้าศึกษาต่อในระดับปริญญามหาบัณฑิต