Appendix

PDF#22-0663: QM=Indexed; d=(Unknown); I=Diffractometer — **PDF Card**

Lead Niobium Zinc Oxide
Pb (Nb0.66 Zn0.33) O3

Radiation=CuKa Lambda=1.5418 Filter=Ni
Calibration= d-Cutoff= I/Ic(RIR)=
Ref= Matsuo et al.
Private Communication

Rhombohedral - Powder Diffraction, R3m (160) Z=3 mp=
Cell=5.7419x7.0471 Pearson=hR4.99 (?)
Density(c)=8.390 Density(m)=8.210 Mwt=338.09 Vol=201.21 F(30)=24.4(0.028,44)
Ref= Matsuo et al.
J. Am. Ceram. Soc., 52 516 (1969)

NOTE: Unit cell to be published from Ceram. Assoc. Japan, Miyazawa (co-analyzer). Single-crystal prepared by heating 8.57PbO + ZnO + Nb2 O5 in platinum crucible at 1150 C for 5 hours and then cooling at a rate of 25 C per hour. A rhombohedrally distorted perivskite structure. Rhombohedral cell: a=4.063, $GA=89.92.

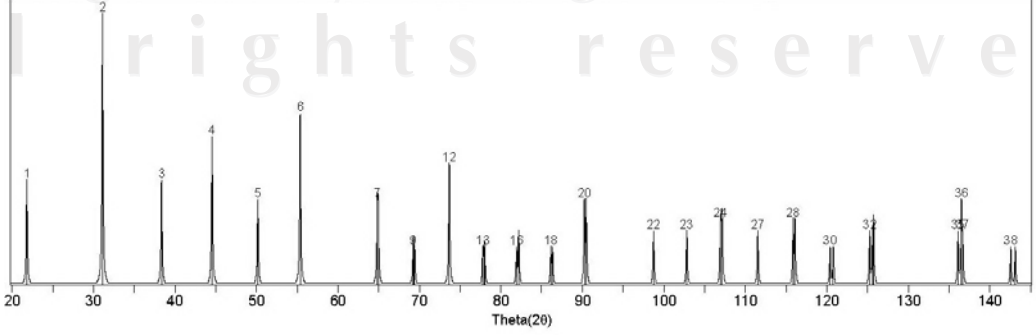
Color: Light yellow

Strong Line: 2.87/X 1.66/4 2.03/3 1.29/2 4.07/2 2.35/2 1.82/1 1.44/1 1.44/1 1.09/1

39 Lines, Wavelength to Compute Theta = 1.54056A(Cu), I%-Type = (Unknown)

#	d(A)	I(f)	h	k	l	2-Theta	Theta	1/(2d)	#	d(A)	I(f)	h	k	l	2-Theta	Theta	1/(2d)
1	4.0700	15.0	1	0	1	21.819	10.909	0.1229	21	1.0850	10.0	4	1	0	90.459	45.230	0.4608
2	2.8730	100.0	0	1	2	31.104	15.552	0.1740	22	1.0150	4.0	4	0	4	98.734	49.367	0.4926
3	2.3450	15.0	0	2	1	38.353	19.176	0.2132	23	0.9856	4.0	3	1	5	102.802	51.401	0.5073
4	2.0320	30.0	2	0	2	44.553	22.276	0.2461	24	0.9585	6.0	3	0	6	106.956	53.478	0.5216
5	1.8170	10.0	2	1	1	50.166	25.083	0.2752	25	0.9578	6.0	3	2	4	107.070	53.535	0.5220
6	1.6580	40.0	1	2	2	55.367	27.683	0.3016	26	0.9573	6.0	5	0	2	107.151	53.575	0.5223
7	1.4370	10.0	0	2	4	64.828	32.414	0.3479	27	0.9318	4.0	2	4	1	111.514	55.757	0.5366
8	1.4350	10.0	2	2	0	64.929	32.465	0.3484	28	0.9090	6.0	2	2	6	115.858	57.929	0.5501
9	1.3560	2.0	0	1	5	69.229	34.615	0.3687	29	0.9079	6.0	4	2	2	116.080	58.040	0.5507
10	1.3550	2.0	3	0	3	69.288	34.644	0.3690	30	0.8877	2.0	2	1	7	120.391	60.195	0.5633
11	1.3530	2.0	1	3	1	69.405	34.702	0.3695	31	0.8860	2.0	5	1	1	120.776	60.388	0.5643
12	1.2850	20.0	2	1	4	73.660	36.830	0.3891	32	0.8674	4.0	0	1	8	125.254	62.627	0.5764
13	1.2270	2.0	2	0	5	77.772	38.886	0.4075	33	0.8660	4.0	0	5	4	125.613	62.807	0.5774
14	1.2250	2.0	2	2	3	77.923	38.962	0.4082	34	0.8656	6.0	1	5	2	125.716	62.858	0.5776
15	1.2240	2.0	4	0	1	77.999	39.000	0.4085	35	0.8305	4.0	2	0	8	136.094	68.047	0.6020
16	1.1750	2.0	0	0	6	81.924	40.962	0.4255	36	0.8293	10.0	2	4	4	136.507	68.253	0.6029
17	1.1720	4.0	0	4	2	82.179	41.089	0.4266	37	0.8289	4.0	6	0	0	136.646	68.323	0.6032
18	1.1280	2.0	1	2	5	86.137	43.069	0.4433	38	0.8133	2.0	1	3	7	142.562	71.281	0.6148
19	1.1260	2.0	3	2	1	86.327	43.164	0.4440	39	0.8120	2.0	4	3	1	143.107	71.554	0.6158
20	1.0870	10.0	1	1	6	90.247	45.123	0.4600									

Simulation Parameters: Fixed-Slit Intensities, 2-Theta Range =19.82/145.11/0.02, FWHM = 0.1, SQR(I)



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PDF#70-4057: QM=Calculated; d=Calculated; I=Calculated | **PDF Card**

Lead Zirconium Titanium Oxide
Pb (Zr0.5 Ti0.5) O3

Radiation=CuKa1 Lambda=1.54060 Filter=
Calibration= d-Cutoff=17.7 I/Ic(RIR)=11.99
Ref= Calculated from ICSD using POWD-12++

Tetragonal - Profile Analysis, P4mm (99) Z=1 mp=
Cell=4.03x4.145 Pearson=tP5 (?)
Density(c)=8.009 Density(m)=7.65A Mwt=324.76 Vol=67.32 F(28)=999.9(.0000,28)
Ref= Frantti, J., Lappalainen, J., Eriksson, S., Lantto, V., Nishio, S., Kakihana, M., Ivanov, S., Rundlof, H.
Jpn. J. Appl. Phys. Part 1, 39 5697 (2000)

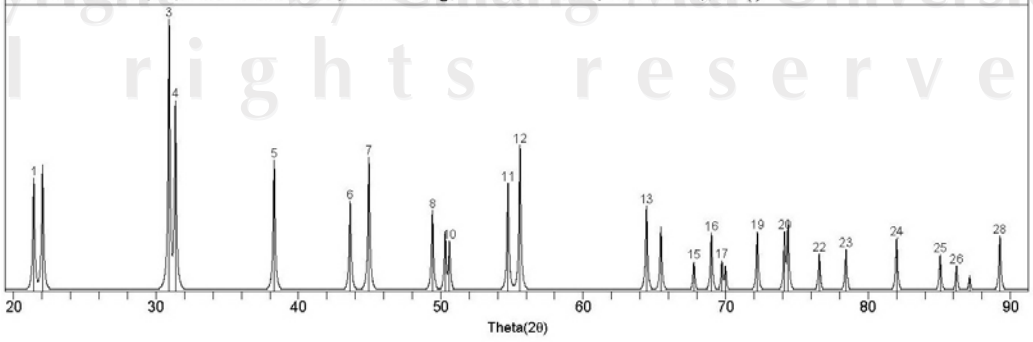
FIZ=090475: REF Japanese Journal of Applied Physics, Part 1. CLAS 4mm (Hermann-Mauguin) - C4v (Schoenflies). PRS tP5. ANX ABX3. WYCK d c b2. ITF Rietveld profile refinement applied Neutron diffraction studies of Pb (Zrx Ti1-x) O3 ceramics

Strong Line: 2.89/X 2.85/5 1.65/3 2.02/2 2.35/2 4.03/2 4.15/2 1.68/2 2.07/1 1.44/1

28 Lines, Wavelength to Compute Theta = 1.54056A(Cu), I%-Type = Peak Height

#	d(A)	I(f)	h	k	l	2-Theta	Theta	1/(2d)	#	d(A)	I(f)	h	k	l	2-Theta	Theta	1/(2d)
1	4.1450	17.2	0	0	1	21.419	10.710	0.1206	15	1.3817	1.2	0	0	3	67.766	33.883	0.3619
2	4.0300	21.6	1	0	0	22.038	11.019	0.1241	16	1.3600	4.6	2	1	2	68.998	34.499	0.3677
3	2.8894	100.0	1	0	1	30.922	15.461	0.1730	17	1.3474	1.3	2	2	1	69.732	34.866	0.3711
4	2.8496	49.1	1	1	0	31.365	15.683	0.1755	18	1.3433	0.9	3	0	0	69.977	34.988	0.3722
5	2.3482	23.2	1	1	1	38.298	19.149	0.2129	19	1.3070	4.8	1	0	3	72.222	36.111	0.3826
6	2.0725	10.9	0	0	2	43.637	21.818	0.2413	20	1.2779	4.8	3	0	1	74.137	37.069	0.3913
7	2.0150	24.3	2	0	0	44.949	22.475	0.2481	21	1.2744	6.8	3	1	0	74.375	37.188	0.3923
8	1.8431	8.8	1	0	2	49.409	24.704	0.2713	22	1.2432	1.9	1	1	3	76.570	38.285	0.4022
9	1.8122	4.9	2	0	1	50.308	25.154	0.2759	23	1.2181	2.4	3	1	1	78.448	39.224	0.4105
10	1.8023	3.4	2	1	0	50.605	25.302	0.2774	24	1.1741	3.8	2	2	2	81.998	40.999	0.4259
11	1.6761	15.8	1	1	2	54.718	27.359	0.2983	25	1.1395	1.8	2	0	3	85.060	42.530	0.4388
12	1.6528	28.8	2	1	1	55.556	27.778	0.3025	26	1.1272	0.9	3	0	2	86.208	43.104	0.4436
13	1.4447	9.8	2	0	2	64.440	32.220	0.3461	27	1.1177	0.3	3	2	0	87.126	43.563	0.4473
14	1.4248	5.6	2	2	0	65.451	32.726	0.3509	28	1.0965	4.2	2	1	3	89.252	44.626	0.4560

Simulation Parameters: Fixed-Slit Intensities, 2-Theta Range =19.42/91.25/0.02, FWHM = 0.1, SQR(I)



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Conference Presentations and Publications Related to Thesis

International Publications:

1. **A. Ngamjarurojana**, O. Khamman, R. Yimnirun and S. Ananta, "Effect of Calcination Conditions on Phase Formation and Particle Size of Zinc Niobate Powders Synthesized by Solid-State Reaction", *Materials Letters*, 60, pp 2867-2872 (2006).
2. **A. Ngamjarurojana**, O. Khamman, S. Ananta and R. Yimnirun, "Synthesis and Characterizations of Lead Zinc Niobate-Lead Zirconate Titanate Powders" *Journal of Electroceramics* (2007) *in press.*

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3. **A. Ngamjarurojana**, S. Ural, S.-H. Park, S. Ananta, R. Yimnirun, and K. Uchino, Piezoelectric and Dielectric Properties of MnO_2-Doped $0.2Pb(Zn_{1/3}Nb_{2/3})O_3$-$0.8Pb(Zr_{1/2}Ti_{1/2})O_3$ Ceramic Materials", *Ceramics International* (2007) *accepted.*

National Publications:

1. **A. Ngamjarurojana**, S. Wongsaenmai, R. Tipakontitikul, S. Ananta and R. Yimnirun, "Effect of Uniaxial Stress on Hysteresis Properties of 0.1PMN-0.9PZT Ceramic," *Chiang Mai University Journal*, 2005, 4(2), 129-135.
2. **A. Ngamjarurojana**, S. Wongsaenmai, O. Khamman, S. Ananta and R. Yimnirun, "Hysteresis Properties of Lead Zirconate Titanate Ceramic Under Uniaxial compressive Pre-Stress," *Chiang Mai Journal of Science*, 2005, 32(3), 355-359.
3. **A. Ngnamjarurojana**, Y. Laosiritaworn, S. Ananta, and R. Yimnirun, "Synthesis and Characterization of Zinc Niobate Nanopowder via a Vibro-Milling Method", *Chiang Mai University Journal*, 2005, 4(1), 47-52.

National Conference:

1. **A. Ngamjarurojana**, S. Wongsaenmai, S. Ananta, R. Yimnirun, Effect of Uniaxial Stress on Hysteresis Properties of Lead Zirconate Titanate Ceramic. *30th Congress on Science and Technology of Thailand*, 19-21 Oct. 2004, Bangkok.

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2. **A. Ngnamjarurojana**, Y. Laosiritaworn, S. Ananta, and R. Yimnirun, " Synthesis and Characterization of Zinc Niobate Nanopowder via a Vibro-Milling Method" *Seminar on Nano Materials Fabrication Technology*, Chiang Mai, Thailand (28-29 July 2005).
3. **A. Ngamjarurojana**, O. Khamman, S. Ananta, R. Yimnirun, Synthesis, Phase Formation and Characterization of Lead Zinc Niobate – Lead Zirconate Titanate Powders via a Rapid Vibro-Milling Method. *31th Congress on Science and Technology of Thailand*, 18-20 Oct. 2005, Bangkok .

***International Conference*:**

1. **A. Ngamjarurojana**, S. Wongsaenmai, R. Tipakontitikul, S. Ananta and R. Yimnirun, "Hysteresis Properties of Lead Zirconate Titanate Ceramic Under Uniaxial compressive Pre-Stress," *Proceeding of the International Conference on Smart Materials: Smart/Intelligent Materials and Nanotechnology*, 2004, pp 156-157
2. **A. Ngamjarurojana**, O. Khamman, S. Ananta and R. Yimnirun, "Synthesis and Characterizations of Lead Zinc Niobate-Lead Zirconate Titanate Powders" AMEC-4, Hangzhou, China (June 2005).
3. **A. Ngamjarurojana**, S. Ural, S.-H. Park, S. Ananta, R. Yimnirun, and K. Uchino, "Piezoelectric and Dielectric Properties of MnO_2-Doped $0.2Pb(Zn_{1/3}Nb_{2/3})O_3$-$0.8Pb(Zr_{1/2}Ti_{1/2})O_3$ Ceramic Materials", AMEC-5, Bangkok, Thailand (December 2006).

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