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APPENDICES

Appendix 1.

Pot Mill Grinding Times

In determining the appropriate grinding time by using rapid pot mill [with 400 rpm. revolution], the LI-23 composition was chosen.

Procedure ;- pot mill with mill volume 1,000 cc.,
- balls , diameter 1.5-2.0 cm., total weight 900 gm.,
- total batch weight 800 gm.[LI-23 composition],
- water added 560 cc.,
- 0.2 gm./cc. Dispex N 40 = 8 cc.,
- the sample after grinding time 25, 45, 65, and 85 mins. were picked up, dried and sieving through 150 mesh.,
- the powders were characterized by SEM and particle size analyzer.,
- the appropriate grinding time was determined from SEM. photographs and particle size distribution curves.

Ball mill Grinding times

In determining the appropriate grinding time by using ball mill (with 33 rpm revolution), the LI-23 composition was chosen.

procedure:
- Ball mill with mill volume = 110 lts.
- 50% of mill volume occupied by balls. = 55.0 lt.
- By using 3 sizes of ball; 5.3 cm., 4.3 cm., 2.8 cm. with ratio by weight 20% 60% 20%
- From experiment we got 8.4 kg. of balls had bulk volume = 4.3 lts.
- So, we must used total ball weight = 55.0 x 8.4 = 107.5 kg.

  which were divided into :

  20 % large balls = 21 kg.
  60 % medium balls = 65.5 kg.
  20 % small balls = 21 kg.
- Density of balls = 3.3 gm./cm.^{3}

  True volume of balls = $\frac{107.5}{3.3}$ = 32.6 lt.

  Void volume between balls = 55-32.6 = 22.4 lts.
- Batch volume must bigger than void volume between balls and = 20 - 25 % of mill volume,

  assumed 20.0 % = 0.2x110 lts. = 22.0 lts.
- From experiment, the density of LI-23 is 3.61 gm./cm.^{3}

  Batch weight = 22.0x3.61 = 79.42 = 80 Kg.
- Water content = 70 % of batch weight = 56 Kg.
- 0.1 % deflocculant (Dispex N40 with 0.2 gm./cc.) = 400 cc.

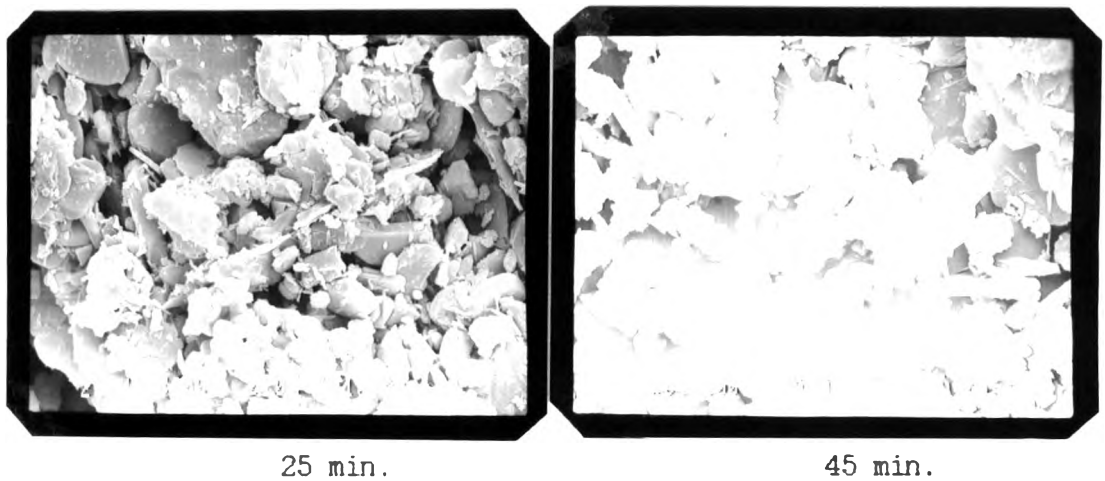
Result from Pot Mill Grinding Times.

In determining the appropriate grinding time by using rapid pot mill [with revolution 400 rpm.] , the LI.-23 composition was chosen.

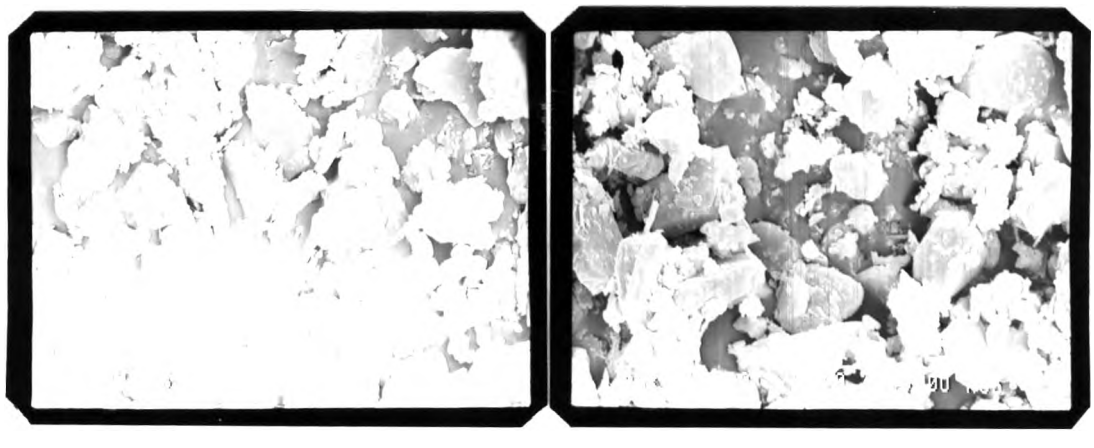
1. Morphology.

From SEM micrographs, the morphology of powders shown particle agglomerates of plate-liked, irregular shape in milled alumina powders, the size of agglomeration depended on grinding times, as shown in following figure.

SEM. micrographs of composition by pot mill grinding.



25 min. 45 min.



65 min. 85 min.

10 μm

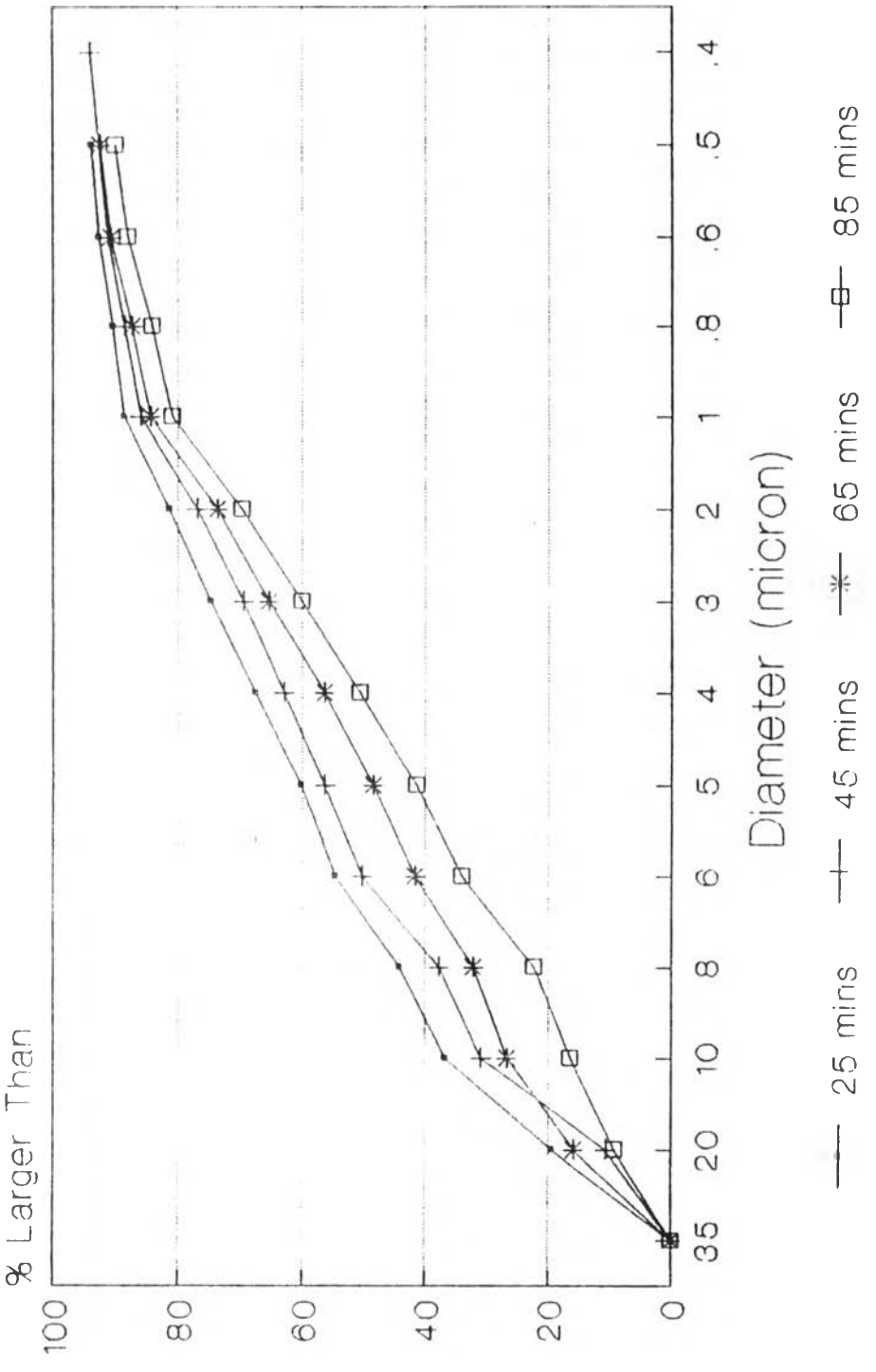
2. Particle Size Distribution.

The particle size distributions, measured by sedimentation technique were presented in data and figure as followed.

Particle size distribution of powders composition by pot mill grinding

micron	% cumulative larger than [CUMUL%] 25 mins.	45 mins.	65 mins.	85 mins.
35.0	0.0	0.0	0.0	0.0
20.0	19.4	10.7	15.8	9.2
10.0	36.7	30.9	26.7	16.5
8.0	44.1	37.7	32.1	22.4
6.0	54.5	50.1	41.6	34.0
5.0	60.2	56.3	48.3	41.3
4.0	67.5	62.9	56.3	50.5
3.0	74.7	69.4	65.3	60.0
2.0	81.4	76.9	73.7	69.7
1.0	88.6	86.0	84.4	80.9
0.8	90.5	88.6	87.4	84.2
0.6	92.6	91.2	90.7	88.0
0.5	93.8	92.6	92.4	90.0
0.4	-	94.0	-	-

The particle size distribution curves of powder composition by pot mill grinding.



From the distribution curves,the particle size distribution after various grinding times were presented as followed ;

Grinding time [min.]	20 % by weight finer than [micron]
25	2.20
45	1.60
65	1.25
85	1.10

The appropriate grinding time for labolatory rapid pot mill was 85 minutes because the increased grinding time (more than 85 min.) was not effective.

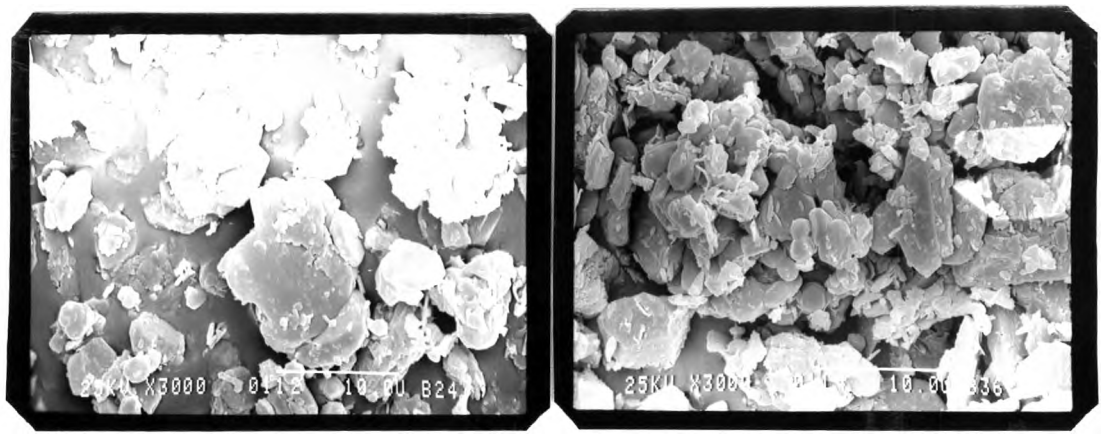
Result from Ball Mill Grinding.

In determining the appropriate grinding times of ball mill, the LI.-23 composition was chosen and the batch weight was 80 kg.

1. Morphology

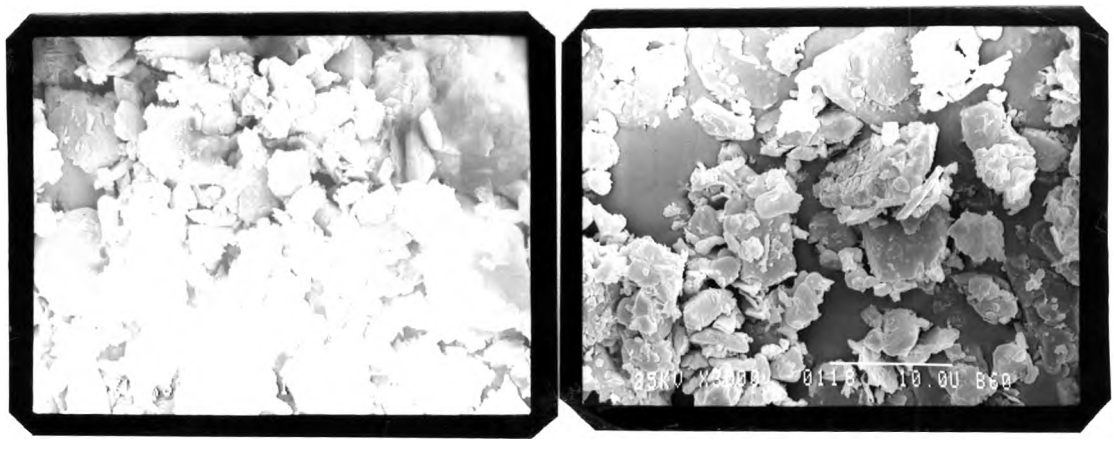
From SEM micrographs, the morphology of powders shown particle aggromerates of plate-liked, irregular-shaped in milled alumina powders as the same as grinding from rapid pot mill, as followed.

SEM. micrographs of composition by ball mill grinding.



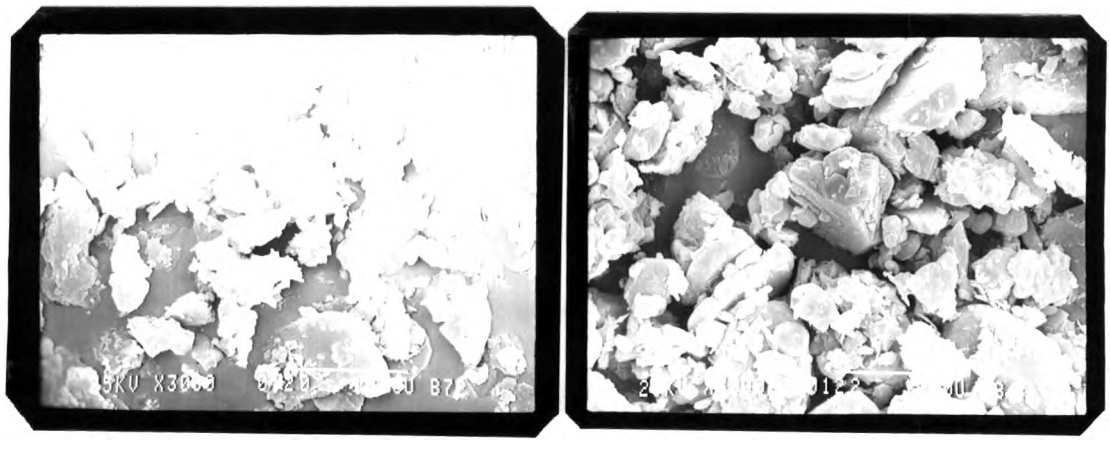
24 hr.

36 hr.



48 hr.

60 hr.



72 hr.

84 hr.

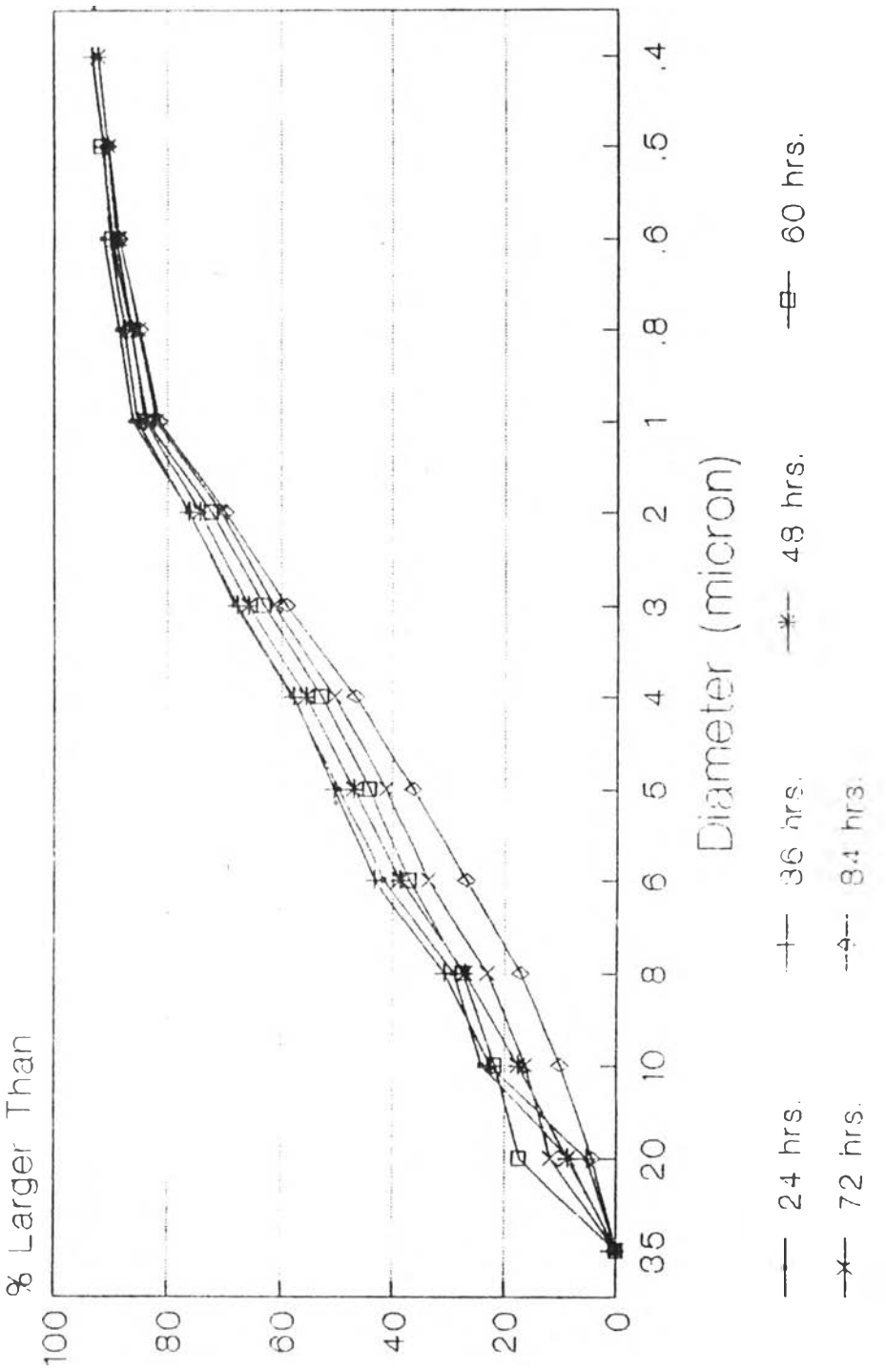
2. Particle Size Distribution.

The particle size distributions, measured by sedimentation technique, were presented in data and figure as followed.

Particle size distribution of powders composition by ball mill grinding.

	% cumulative larger than [CUMUL%]					
micron	24 hrs.	36 hrs.	48 hrs.	60 hrs.	72 hrs.	84 hrs.
35.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0	8.3	5.2	8.6	17.3	11.6	4.3
10.0	24.1	22.5	17.6	21.7	16.3	9.9
8.0	29.0	30.7	27.0	27.4	23.0	17.0
6.0	41.6	43.4	38.7	37.1	33.6	26.7
5.0	49.8	50.6	47.1	44.2	41.2	36.3
4.0	58.2	57.9	55.7	52.9	50.6	46.7
3.0	68.2	67.9	65.9	63.1	61.4	59.1
2.0	76.4	76.4	74.4	72.4	70.6	69.9
1.0	86.2	85.4	84.0	83.6	82.0	81.5
0.8	88.6	87.6	86.4	86.6	85.1	84.9
0.6	91.3	90.3	89.1	89.9	88.6	88.6
0.5	-	91.4	90.6	91.6	90.4	90.6
0.4	-	93.2	92.1	-	-	-

The distribution curves of powder composition by ball mill grinding.



From the distribution curves, the particle size distribution after various grinding times were presented as followed ;

Grinding time [hrs.]	20 % by weight finer than [micron]
24	1.6
36	1.6
48	1.4
60	1.3
72	1.2
84	1.15

The appropriate grinding time for ball milling was 84 hours, because increased grinding time [more than 84 hours] was not effective and at this time the particle size distribution of the composition was nearly the same as from 85 min. laboratory testing.

Appendix 2.

Physical properties of the LI-16 and LI-19 test specimens after firing from curve A.

Physical properties	LI-16	LI-19
Bulk density[gm./cm.^{3}]	3.325	3.303
% Apparent porosity	0.169	0.194
% Water absorption	0.051	0.058
MOR.[kg./cm.^{2}]	2222.120	2402.470
% Al_2O_3 content [from EDS.]	82.460	79.890

These results showed that the sintering temperture was neary reached [the water absorption are neary zero] , but the bulk densities and % alumina contents were to low by comparing to the commercial liners.

Physical properties of the LI-24 test specimens after firing from curve D.

Bulk density[gm./cm.^{3}]	3.511
% Apparent porosity	1.487
% Water absorption	0.432
MOR.[kg./cm.^{2}]	3289.600
% Al_2O_3 content [from EDS.]	91.050

These results showed that at this firing condition, the sintering point of this composition was not reached [the water absorption was more than 0.03 %].

Appendix 3.

Volume, bulk density, % apparent porosity, % water absorpton.

a). From firing curve A.

		V	D	P	A
LI-22,	no.				
	1.	8.16	3.140	11.397	3.630
	2.	7.77	3.081	14.671	4.762
	3.	7.95	3.126	12.075	3.863
	4.	7.55	3.295	1.060	0.322
	5.	8.10	3.122	11.852	3.796
	6.	7.59	3.191	7.642	2.395
	7.	8.12	3.278	1.601	0.488
	8.	7.68	3.251	2.241	0.681
	9.	7.70	3.213	4.416	1.374
	10.	8.05	3.097	13.292	4.292
Average		-	3.179	8.022	2.560
Standard Deviation		-	0.073	5.007	1.627
LI-23,	1.	8.33	3.148	10.564	3.356
	2.	8.45	3.281	5.207	1.587
	3.	8.38	3.130	10.621	3.393
	4.	8.44	3.160	17.891	5.662
	5.	8.42	3.290	5.463	1.661
	6.	8.13	3.214	7.872	2.449
	7.	8.25	3.178	8.970	2.822
	8.	8.27	3.058	17.412	5.694
	9.	8.50	3.114	11.176	3.589
	10.	8.44	3.280	5.924	1.806
Average		-	3.185	10.110	3.202
Standard Deviation		-	0.075	4.300	1.418

b). From firing curce B.

LI-22.	no.	V	D	P	A
	1.	10.76	3.439	0.093	0.027
	2.	11.38	3.295	3.866	1.173
	3.	10.97	3.258	5.014	1.539
	4.	11.67	3.367	1.542	0.458
	5.	8.91	3.317	3.479	1.049
	6.	11.38	3.262	5.272	1.616
	7.	12.05	3.394	0.332	0.098
	8.	10.31	3.380	1.164	0.344
	9.	10.13	3.414	0.197	0.058
	10.	11.77	3.254	5.438	1.671
Average		-	3.338	2.640	0.803
Standard Deviation		-	0.066	2.092	0.643

LI-23.	1.	11.33	3.142	12.268	3.904
	2.	12.74	3.133	12.088	3.859
	3.	12.46	3.137	12.440	3.965
	4.	11.90	3.277	8.571	2.615
	5.	11.89	3.388	3.617	1.068
	6.	11.22	3.406	1.693	0.497
	7.	12.09	3.345	4.384	1.311
	8.	11.97	3.307	6.015	1.819
	9.	11.94	3.224	9.464	2.936
	10.	12.00	3.163	11.417	3.609
Average		-	3.252	8.196	2.558
Standard Deviation		-	0.101	3.800	1.237

c). From firing curve C.

LI-22,	no.	V	D	P	A
	1.	7.14	3.497	0.280	0.080
	2.	10.39	3.473	0.385	0.111
	3.	11.56	3.450	0.173	0.050
	4.	9.96	3.443	0.301	0.088
	5.	9.54	3.434	0.419	0.122
	6.	10.90	3.503	0.183	0.052
	7.	10.53	3.492	0.285	0.082
	8.	10.02	3.507	0.200	0.057
	9.	11.00	3.511	0.182	0.052
	10.	8.86	3.498	0.339	0.097
Average		-	3.481	0.275	0.079
Standard Deviation		-	0.027	0.084	0.025
LI-23,	1.	10.87	3.451	0.920	0.267
	2.	10.50	3.467	1.429	0.412
	3.	10.74	3.547	0.279	0.079
	4.	10.56	3.520	0.379	0.108
	5.	11.33	3.462	1.412	0.408
	6.	10.83	3.549	0.369	0.104
	7.	11.39	3.482	0.966	0.277
	8.	10.10	3.483	0.594	0.171
	9.	10.47	3.448	0.860	0.249
	10	-	-	-	-
Average		-	3.490	0.801	0.231
Standard Deviation		-	0.037	0.407	0.118

From firing curve D.

LI-22,	no.	V	D	P	A
	1.	8.54	3.501	0.117	0.033
	2.	9.12	3.492	0.000	0.000
	3.	11.12	3.497	0.000	0.000
	4.	9.89	3.503	0.000	0.000
	5.	11.22	3.504	0.000	0.000
	6.	10.71	3.499	0.000	0.000
	7.	9.29	3.497	0.108	0.031
	8.	9.82	3.507	0.000	0.000
	9.	10.70	3.467	0.000	0.000
	10.	9.38	3.499	0.000	0.000
Average		-	3.497	0.023	0.006
Standard Deviation		-	0.011	0.045	0.013
LI-23,	1.	10.71	3.534	0.093	0.026
	2.	11.72	3.532	0.085	0.024
	3.	10.65	3.544	0.094	0.026
	4.	11.55	3.513	0.000	0.000
	5.	10.50	3.537	0.000	0.000
	6.	11.61	3.550	0.000	0.000
	7.	12.12	3.533	0.000	0.000
	8.	9.43	3.539	0.000	0.000
	9.	11.91	3.563	0.084	0.024
	10.	10.38	3.550	0.096	0.027
Average		-	3.540	0.045	0.013
Standard Deviation		-	0.013	0.044	0.013

Appendix 4.

MOR. of specimens.

a). MOR. of the specimens from firing curve A

no.	LI-22	LI-23	
1.	2810.49	2527.55	
2.	2282.87	2462.21	
3.	2641.25	2888.26	
4.	2510.27	2885.64	
5.	2385.42	2198.21	
6.	3329.18	2629.49	
7.	2587.55	2200.83	
8.	2693.07	2958.83	
9.	2444.87	-	
10.	2875.88	-	
MOR. average	2656.07	2593.88	
Standard Deviation	284.59	282.63	kg./cm.^{2}

b). MOR. of specimens from firing curve B

1.	2907.09	3386.52	
2.	2984.38	2777.31	
3.	2809.00	2636.52	
4.	3023.02	3035.84	
5.	2927.90	2544.37	
6.	2707.94	2659.56	
7.	2609.84	2925.77	
8.	3382.69	2792.67	
9.	2609.84	2559.73	
10.	2886.28	-	
MOR. average	2884.80	2813.14	
Standard Devation	216.22	254.73	kg,/cm.^{2}

c). MOR. of specimens from firing curve C

no.	LI-22	LI-23	
1.	2983.85	2562.63	
2.	2567.57	2637.83	
3.	2655.68	2693.54	
4.	3226.93	2487.42	
5.	2640.49	2818.89	
6.	2558.45	3008.30	
7.	2579.72	2888.53	
8.	3424.43	2242.30	
9.	3257.31	2999.94	
10.	2795.46	-	
MOR. average	2868.99	2704.38	
Standard Deviation	312.20	238.51	kg./cm.^{2}

d). MOR. of specimenc from firing curve D

1.	3174.91	2940.33	
2.	2730.67	3024.67	
3.	2671.64	2742.56	
4.	2721.35	2605.87	
5.	2892.21	3338.77	
6.	3740.30	3379.49	
7.	2941.92	3600.52	
8.	3100.35	3059.57	
9.	2823.67	2972.32	
10.	2966.77	-	
11.	3740.30	-	
MOR. average	3045.84	3073.79	
Standard Deviation	359.13	298.23	kg./cm.^{2}

Appendix 5.

% wt. loss/hr. (400 rpm. testing) of bodies sintered from firing curves A,B,C, and D in 48 mins./cycle.

grinding cycle.	A.	B.	C.	D.
1st.	0.8413	0.6649	0.4819	0.4902
2nd.	0.7260	0.7293	0.4233	0.4306
3th.	0.5477	0.5501	0.2427	0.3704
4th.	0.4890	0.5526	0.4258	0.3096
5th.	0.7364	0.4317	0.3662	0.3103
6th.	0.9259	0.3061	0.3061	0.3111
7th.	0.4975	0.4296	0.4260	0.2495
8th.	0.1875	0.3695	0.3695	0.1875
9th.	0.4397	0.2470	0.2470	0.1878
10th.	0.6281	0.1856	0.1856	0.1881
11th.	0.3157	0.1859	0.1859	0.1883
12th.	0.3797	0.1862	0.1862	0.1886

Appendix 6.

Impact Energy of Liner-Product

No.of Specimen	Impact Energy	
1.	10.2	kp.cm./cm^2
2.	8.2	
3.	10.2	
4.	8.2	
5.	12.2	
Average	9.8	
Standard Deviation	1.50	

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

Alumina 27-APR-93.
Standardless Analysis
15.0 kV 51.0 Degrees

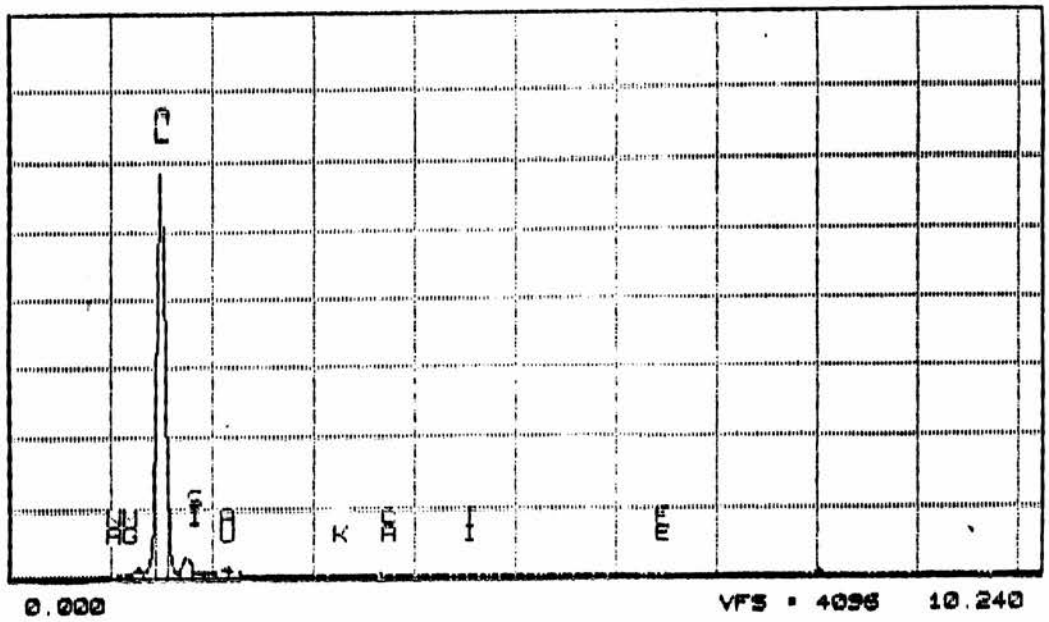
Refit _NAK' _NAK" _MGK' _MGK" _TIK' _TIK"
Refit _SIK' _SIK" _CAK" _FEL" _F K' _F K"
Chi-sqd = 3.63

Element	Rel. K-ratio	Net Counts
Al-K	0.91354 +/- 0.00743	23665 +/- 243
Si-K	0.04791 +/- 0.00182	1761 +/- 67
Ca-K	0.01060 +/- 0.00190	219 +/- 40
Na-K	0.00872 +/- 0.00193	131 +/- 29
Fe-K	0.00729 +/- 0.00409	63 +/- 35
Mg-K	0.00519 +/- 0.00220	144 +/- 61
K -K	0.00407 +/- 0.00148	102 +/- 37
Ti-K	0.00268 +/- 0.00213	44 +/- 35

ZAF Correction 15.00 kV 51.00 deg
No.of Iterations = 4

Element	K-ratio	Z	A	F	ZAF	Atom%	Wt%
Al-K	0.860	1.002	1.027	0.998	1.027	89.30	88.32
Si-K	0.045	0.974	1.752	1.000	1.706	7.47	7.69
Ca-K	0.010	1.004	1.081	1.000	1.084	0.74	1.08
Na-K	0.008	0.995	1.156	0.979	1.126	1.10	0.92
Fe-K	0.007	1.116	1.007	1.000	1.123	0.38	0.77
Mg-K	0.005	0.971	1.068	0.955	0.990	0.54	0.48
K -K	0.004	1.025	1.118	0.999	1.145	0.31	0.44
Ti-K	0.003	1.102	1.041	0.999	1.146	0.16	0.29
					Total=	100.00%	

NORAN SERIES II *** TISTR *** TUE 27-APR-93 14:01
Cursor: 0.000keV = 0



0.000 VFS = 4096 10.240

129 Alumina 27-APR-93
[L1.-13 powder]

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

ALUMINA (22B) 16/DEC/92. [1500°C.]
Standardless Analysis
15.0 kV 51.0 Degrees

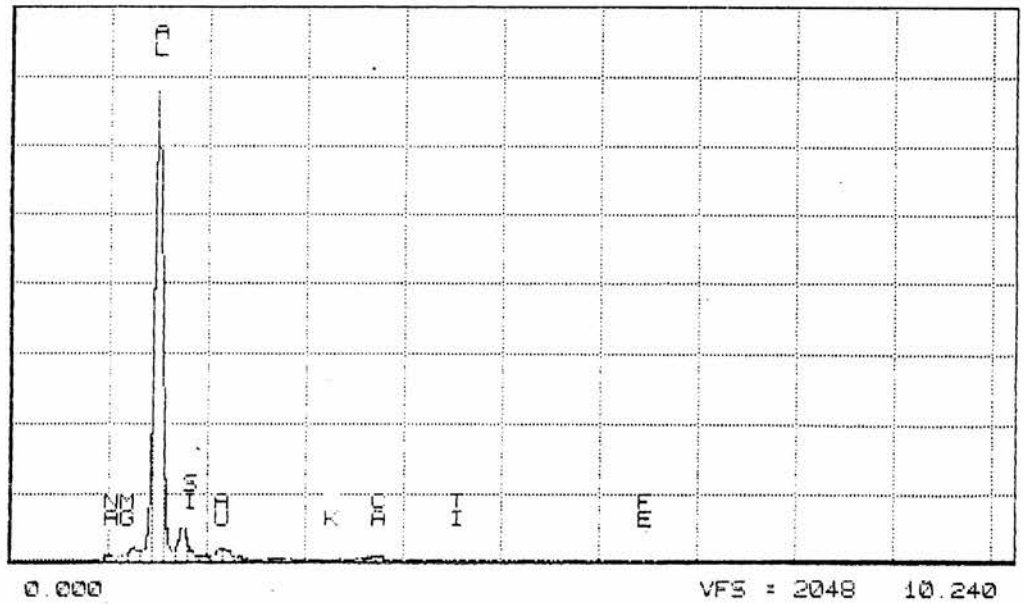
Refit _MGK' _MGK" _NAK' _NAK" _TIK' _TIK" _K K' _K K" _FEK' _FEK"
Refit _SIK" _CAK'
Chi-sqd = 2.43

Element	Rel. K-ratio	Net Counts
Al-K	0.88779 +/- 0.01052	17641 +/- 209
Si-K	0.06147 +/- 0.00271	1383 +/- 61
Ca-K	0.01958 +/- 0.00505	248 +/- 64
Mg-K	0.00851 +/- 0.00307	144 +/- 52
Na-K	0.00926 +/- 0.00272	85 +/- 25
Ti-K	0.00332 +/- 0.00229	33 +/- 23
K -K	0.00298 +/- 0.00176	46 +/- 27
Fe-K	0.00708 +/- 0.00414	38 +/- 22

ZAF Correction 15.00 kV 51.00 deg
No.of Iterations = 4

Element	K-ratio	Z	A	F	ZAF	Atom%	Wt%
Al-K	0.824	1.002	1.034	0.998	1.035	86.45	85.24
Si-K	0.057	0.975	1.728	1.000	1.684	9.36	9.61
Ca-K	0.018	1.005	1.081	0.999	1.086	1.35	1.97
Mg-K	0.008	0.971	1.074	0.957	0.999	0.89	0.79
Na-K	0.009	0.996	1.165	0.980	1.136	1.16	0.98
Ti-K	0.003	1.103	1.042	0.999	1.148	0.20	0.35
K -K	0.003	1.026	1.117	0.998	1.144	0.22	0.32
Fe-K	0.007	1.116	1.007	1.000	1.124	0.36	0.74
						Total=	100.00%

NORAN SERIES II *** TISTR *** WED 16-DEC-92 15:02
Cursor: 0.000keV = 0



0.000 VFS = 2048 10.240

158 ALUMINA (22B) 16/DEC/92.
[1500°C.]

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

ALUMINA 22B 1500c(3hr) 18/FEB/93.
Standardless Analysis
15.0 kV 51.0 Degrees

Refit _MGK' _MGK" _FEK' _FEK" _NAK' _NAK" _TIK' _TIK" _K K' _K K"
Refit _SIK" _CAK'
Chi-sqd = 4.39

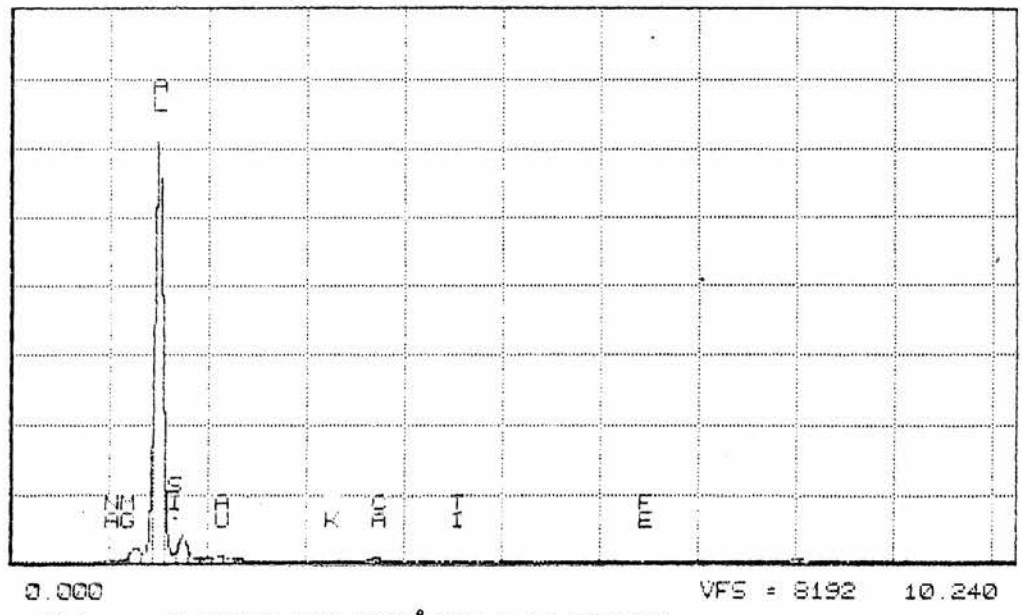
Element	Rel. K-ratio	Net Counts
Al-K	0.89022 +/- 0.00569	63186 +/- 404
Si-K	0.05688 +/- 0.00139	4570 +/- 112
Ca-K	0.01731 +/- 0.00276	783 +/- 125
Mg-K	0.01446 +/- 0.00162	875 +/- 98
Fe-K	0.00852 +/- 0.00247	162 +/- 47
Na-K	0.00820 +/- 0.00134	269 +/- 44
Ti-K	0.00287 +/- 0.00134	103 +/- 48
K -K	0.00155 +/- 0.00095	85 +/- 52

ZAF Correction 15.00 kV 51.00 deg
No.of Iterations = 4

Element	k-ratio	Z	A	F	ZAF	Atom%	Wt%
Al-K	0.826	1.002	1.038	0.998	1.039	86.87	85.77
Si-K	0.053	0.975	1.736	1.000	1.692	8.69	8.93
Ca-K	0.016	1.005	1.081	0.999	1.085	1.19	1.74
Mg-K	0.013	0.971	1.072	0.958	0.997	1.50	1.34
Fe-K	0.008	1.117	1.007	1.000	1.125	0.44	0.89
Na-K	0.008	0.996	1.163	0.980	1.135	1.03	0.86
Ti-K	0.003	1.103	1.041	0.999	1.147	0.17	0.31
K -K	0.001	1.026	1.118	0.998	1.144	0.11	0.16

Total= 100.00%

NORAN SERIES II *** TISTR *** THU 18-FEB-93 14:31
Cursor: 0.000keV = 0

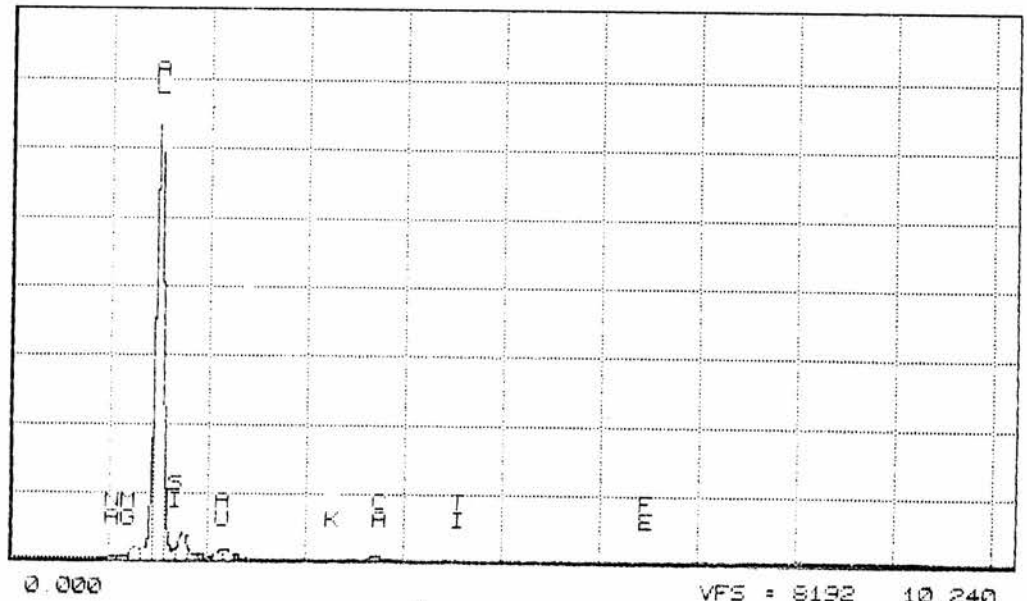


0.000 VFS = 8192 10.240

211 ALUMINA 22B 1500c(3hr) 18/FEB/93.

```
S0: SETUP DEFINITIONS
S0: QUANTIFY

ALUMINA 22B 1520c(15min) 18/FEB/93.
Standardless Analysis
 15.0 kV   51.0 Degrees

Refit _NAK' _NAK" _MGK' _MGK" _TIK' _TIK" _K K' _K K"
Refit _SIK" _FEK'
Chi-sqd = 5.08

Element      Rel. K-ratio          Net Counts
  Al-K   0.90487 +/- 0.00556    66090 +/-   406
  Si-K   0.05612 +/- 0.00134     4641 +/-   111
  Ca-K   0.02019 +/- 0.00273      940 +/-   127
  Na-K   0.00617 +/- 0.00130      208 +/-    44
  Fe-K   0.00486 +/- 0.00455       95 +/-    89
  Mg-K   0.00390 +/- 0.00154      243 +/-    96
  Ti-K   0.00252 +/- 0.00135       93 +/-    50
  K -K   0.00136 +/- 0.00096       77 +/-    54

ZAF Correction 15.00 kV  51.00 deg
No.of Iterations = 3

Element  k-ratio     Z      A      F     ZAF    Atom%    Wt%
  Al-K    0.849   1.002  1.025  0.998  1.025   88.22   87.07
  Si-K    0.053   0.975  1.738  1.000  1.694    8.69    8.92
  Ca-K    0.019   1.005  1.081  1.000  1.086    1.40    2.06
  Na-K    0.006   0.995  1.154  0.978  1.123    0.77    0.65
  Fe-K    0.005   1.116  1.007  1.000  1.124    0.25    0.51
  Mg-K    0.004   0.971  1.067  0.955  0.989    0.41    0.36
  Ti-K    0.002   1.103  1.042  1.000  1.148    0.16    0.27
  K -K    0.001   1.026  1.118  0.998  1.144    0.10    0.15
                                              Total= 100.00%
```

```
NORAN SERIES II      ***  TISTR  ***          THU 18-FEB-93  14:45
Cursor: 0.000keV = 0
```




```
0.000                                          VFS = 8192   10.240
 211      ALUMINA 22B 1520c(15min) 18/FEB/93.
```

S0: SETUP DEFINITIONS

S0: QUANTIFY

ALUMINA 22B 1520c(3hr) 18/FEB/93.
Standardless Analysis
15.0 kV 51.0 Degrees

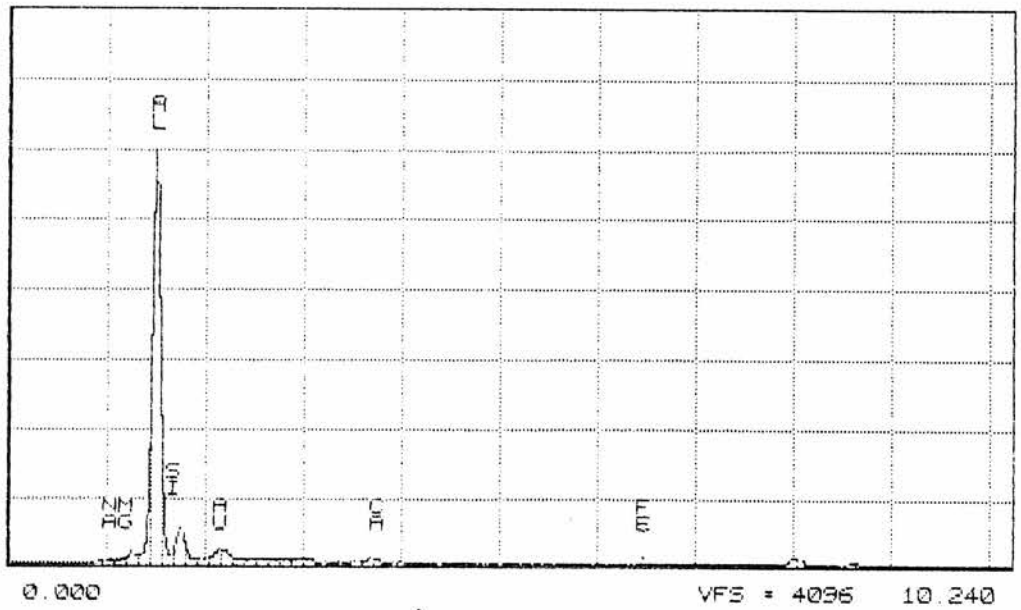
Refit _MGK' _MGK" _NAK' _NAK"
Refit _FEK"
Chi-sqd = 5.06

Element	Rel. K-ratio	Net Counts
Al-K	0.88023 +/- 0.00890	31467 +/- 318
Si-K	0.08212 +/- 0.00514	3323 +/- 208
Ca-K	0.02059 +/- 0.00426	469 +/- 97
Fe-K	0.00966 +/- 0.00376	92 +/- 36
Mg-K	0.00511 +/- 0.00283	156 +/- 71
Na-K	0.00230 +/- 0.00212	38 +/- 35

ZAF Correction 15.00 kV 51.00 deg
No.of Iterations = 3

Element	K-ratio	Z	A	F	ZAF	Atom%	Wt%
Al-K	0.814	1.003	1.027	0.997	1.027	84.93	83.58
Si-K	0.076	0.976	1.707	1.000	1.665	12.34	12.64
Ca-K	0.019	1.006	1.082	1.000	1.088	1.42	2.07
Fe-K	0.009	1.118	1.008	1.000	1.126	0.49	1.01
Mg-K	0.005	0.972	1.067	0.956	0.991	0.53	0.47
Na-K	0.002	0.995	1.163	0.979	1.133	0.29	0.24
					Total=	100.00%	

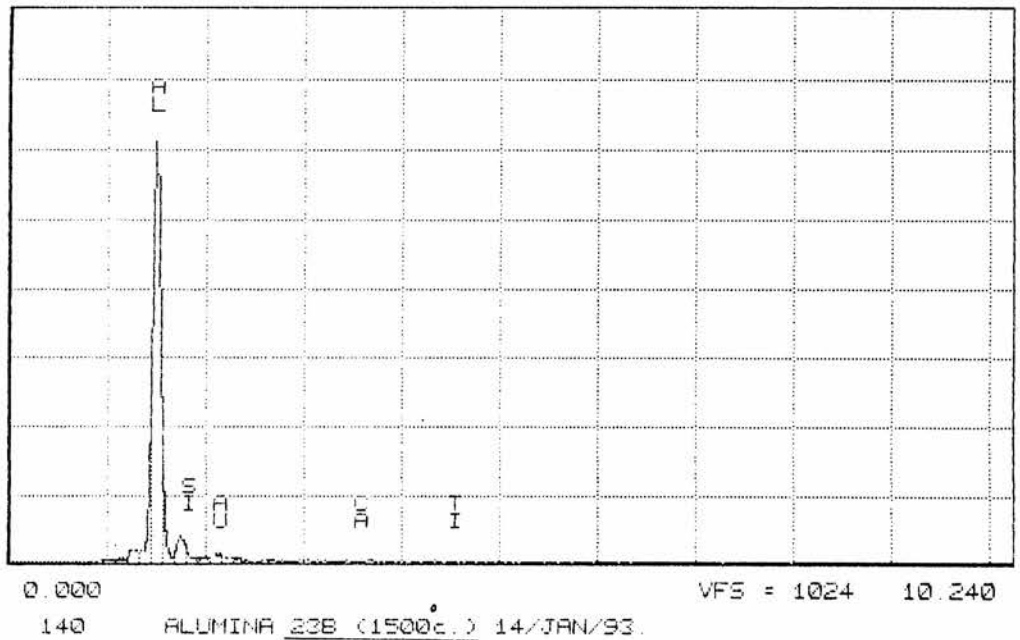
NORAN SERIES II *** TISTR *** THU 18-FEB-93 15:28
Cursor: 0.000keV = 0



0.000 VFS = 4096 10.240

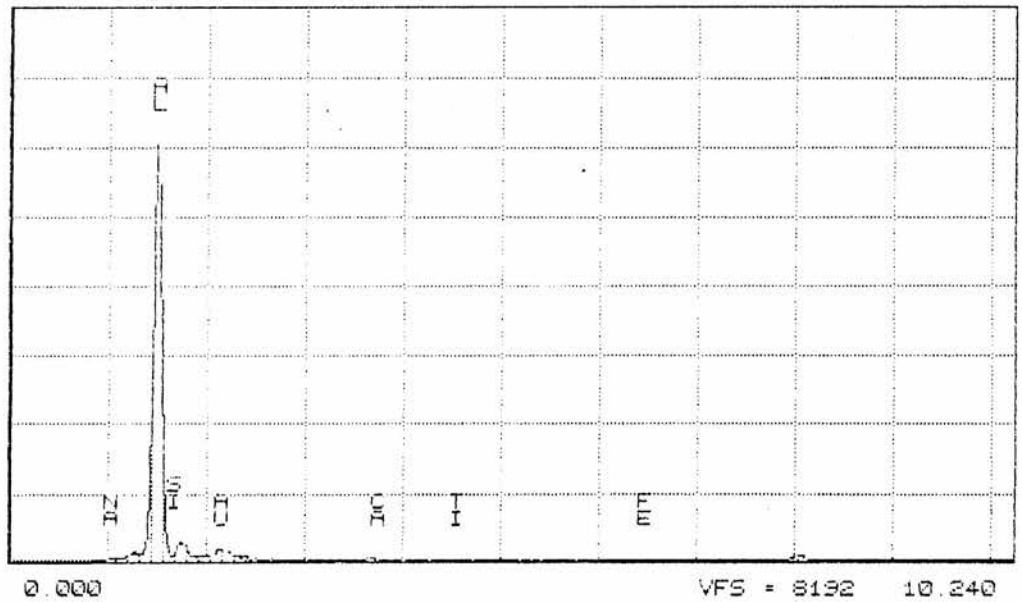
 ALUMINA 22B 1520c(3hr) 18/FEB/93.

```
S0: SETUP DEFINITIONS

S0: QUANTIFY

ALUMINA 23B (1500c.) 14/JAN/93.
Standardless Analysis
  15.0 kV   51.0 Degrees

Refit _CAK' _CAK" _TIK' _TIK"
Refit _SIK"
Chi-sqd = 1.45

Element        Rel. k-ratio          Net Counts
  Al-K    0.92474 +/- 0.01447      8051 +/-   126
  Si-K    0.05363 +/- 0.00396       529 +/-    39
  Ca-K    0.01715 +/- 0.00342        95 +/-    19
  Ti-K    0.00448 +/- 0.00386        20 +/-    17

ZAF Correction 15.00 kV  51.00 deg
No.of Iterations = 3

Element  K-ratio     Z      A      F     ZAF    Atom%    Wt%
  Al-K    0.880   1.002  1.012  0.998  1.012   90.07   89.05
  Si-K    0.051   0.975  1.746  1.000  1.702    8.44    8.69
  Ca-K    0.016   1.005  1.081  1.000  1.086    1.21    1.77
  Ti-K    0.004   1.103  1.041  1.000  1.148    0.28    0.49
                                          Total= 100.00%
```



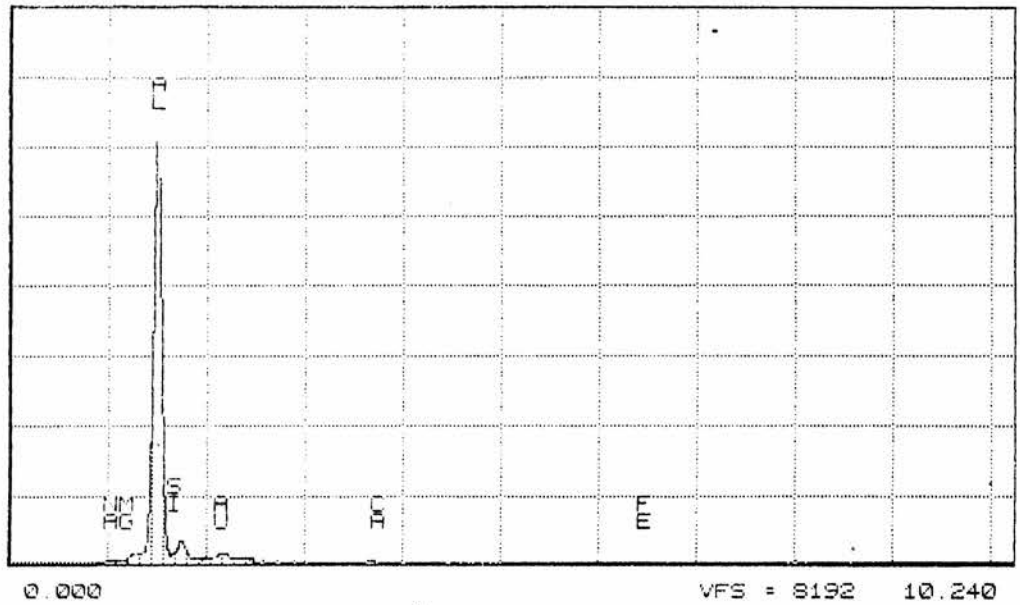
```
S0: SETUP DEFINITIONS

S0: QUANTIFY

ALUMINA 23B 1500c(3hr) 18/FEB/93.
Standardless Analysis
 15.0 kV   51.0 Degrees

Refit _FEK' _FEK"
Refit _CAK' _CAK" _NAK" _TIK'
Chi-sqd = 7.59

Element       Rel. K-ratio          Net Counts
  Al-K    0.92480 +/- 0.00572     62566 +/-   387
  Si-K    0.04496 +/- 0.00324      3445 +/-   248
  Ca-K    0.01134 +/- 0.00139       489 +/-    60
  Fe-K    0.00791 +/- 0.00259       143 +/-    47
  Na-K    0.00744 +/- 0.00187       233 +/-    43
  Ti-K    0.00405 +/- 0.00286       139 +/-    98

ZAF Correction 15.00 kV  51.00 deg
No.of Iterations = 3

Element  K-ratio    Z      A      F      ZAF    Atom%    Wt%
  Al-K    0.876   1.001  1.022  0.999  1.022   90.52   89.47
  Si-K    0.043   0.374  1.758  1.000  1.712    7.09    7.29
  Ca-K    0.011   1.003  1.080  0.999  1.083    0.79    1.16
  Fe-K    0.007   1.115  1.007  1.000  1.123    0.41    0.84
  Na-K    0.007   0.994  1.152  0.978  1.120    0.94    0.79
  Ti-K    0.004   1.102  1.040  0.999  1.145    0.25    0.44
                                          Total= 100.00%
```

```
NORAN SERIES II      ***  TISTR  ***          THU 18-FEB-93  14:27
Cursor: 0.000keV = 0
```




```
0.000                                   VFS = 8192    10.240
 222      ALUMINA 23B 1500c(3hr) 18/FEB/93.
```

```
TN FLEXTRAN [13-B]

*X 'SQ
SQ -3B/80

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

ALUMINA 23B 1520°C(15min) 18/FEB/93.
Standardless Analysis
  15.0 kV   51.0 Degrees

Refit _NAK' _NAK" _MGK' _MGK"
Refit _SIK' _SIK" _FEK'
Chi-sqd = 4.98

Element       Rel. K-ratio          Net Counts
  Al-K    0.91965 +/- 0.00539     62767 +/-   368
  Si-K    0.04964 +/- 0.00131      3386 +/-   101
  Ca-K    0.01151 +/- 0.00269       501 +/-   117
  Na-K    0.00818 +/- 0.00139       258 +/-    44
  Fe-K    0.00809 +/- 0.00476       148 +/-    87
  Mg-K    0.00293 +/- 0.00160       170 +/-    93

ZAF Correction 15.00 kV  51.00 deg
No.of Iterations = 4

Element  K-ratio    Z      A      F     ZAF    Atom%    Wt%
  Al-K    0.868   1.002  1.023  0.998  1.024   89.69   88.83
  Si-K    0.047   0.974  1.754  1.000  1.709    7.76    8.00
  Ca-K    0.011   1.004  1.080  1.000  1.084    0.80    1.18
  Na-K    0.008   0.994  1.149  0.978  1.117    1.02    0.86
  Fe-K    0.008   1.116  1.007  1.000  1.123    0.42    0.86
  Mg-K    0.003   0.971  1.066  0.954  0.986    0.31    0.27
                                          Total= 100.00%

START? DL

        NORAN SERIES II      ***  TISTR  ***          THU 18-FEB-93  14:38
        Cursor: 0.000keV = 0

23
```




```
0.000                                                  VFS = 8192   10.240
 191      ALUMINA 23B 1520°C(15min) 18/FEB/93.
```

SQ: SETUP DEFINITIONS

SQ: QUANTIFY

ALUMINA 23B 1520°c(3hr) 18/FEB/93.
Standardless Analysis
15.0 kV 51.0 Degrees

Refit _K K' _K K" _NAK' _NAK" _TIK' _TIK" _MGK' _MGK"
Refit _SIK' _FEK' _FEK"
Chi-sqd = 4.95

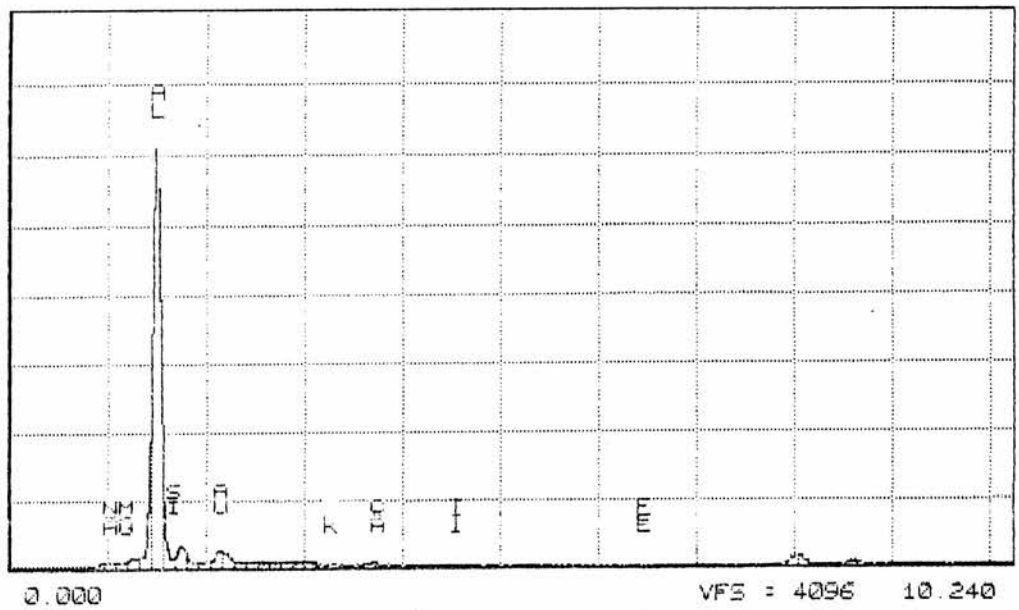
Element	Rel. K-ratio	Net Counts
Al-K	0.91703 +/- 0.00752	32088 +/- 263
Si-K	0.05597 +/- 0.00364	2217 +/- 144
Ca-K	0.00982 +/- 0.00426	219 +/- 95
Fe-K	0.00555 +/- 0.00395	52 +/- 37
K -K	0.00317 +/- 0.00156	86 +/- 42
Na-K	0.00305 +/- 0.00229	49 +/- 37
Ti-K	0.00270 +/- 0.00226	48 +/- 40
Mg-K	0.00270 +/- 0.00235	81 +/- 70

ZAF Correction 15.00 kV 51.00 deg
No.of Iterations = 3

Element	K-ratio	Z	A	F	ZAF	Atom%	Wt%
Al-K	0.866	1.002	1.019	0.998	1.019	89.23	88.22
Si-K	0.053	0.974	1.744	1.000	1.699	8.73	8.98
Ca-K	0.009	1.004	1.081	1.000	1.085	0.68	1.01
Fe-K	0.005	1.116	1.007	1.000	1.124	0.29	0.59
K -K	0.003	1.026	1.119	0.999	1.146	0.24	0.34
Na-K	0.003	0.994	1.148	0.977	1.116	0.38	0.32
Ti-K	0.003	1.102	1.041	1.000	1.147	0.17	0.29
Mg-K	0.003	0.971	1.059	0.952	0.979	0.28	0.25

Total= 100.00%

NORAN SERIES II *** TISTR *** THU 18-FEB-93 15:25
Cursor: 0 000keV = 0



0.000 VFS = 4096 10.240

163 ALUMINA 23B 1520°c(3hr) 18/FEB/93.

S0: SETUP DEFINITIONS

S0: QUANTIFY

PRODUCT(RIM) 9-MAR-93.
Standardless Analysis
15.0 kV 51.0 Degrees

Refit _FEK' _FEK" _K K' _K K"
Refit _SIK' _SIK" _NAK"
Chi-sqd = 3.14

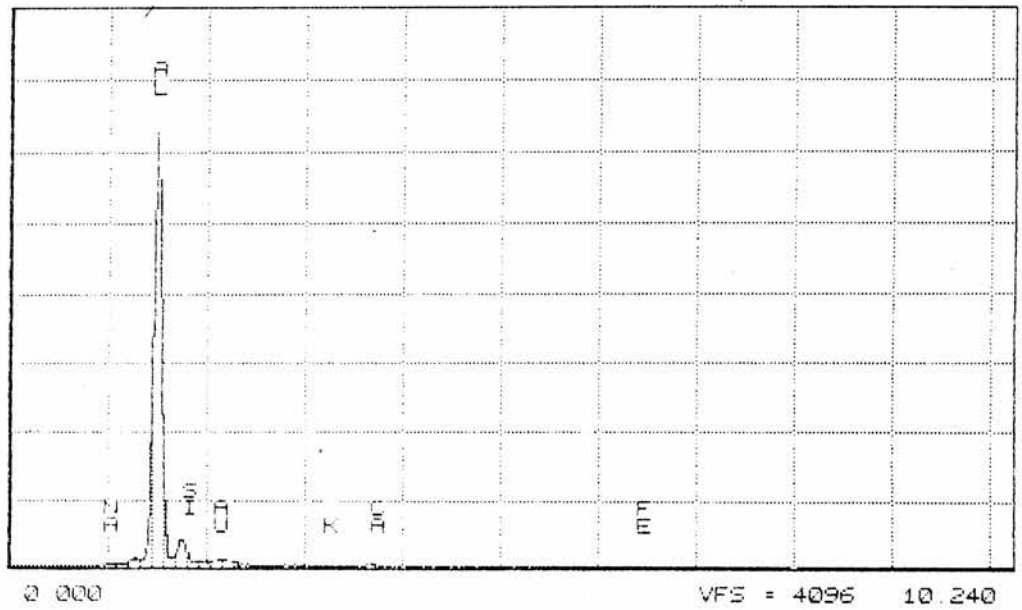
Element	Rel. K-ratio	Net Counts
Al-K	0.91889 +/- 0.00675	32256 +/- 237
Si-K	0.05747 +/- 0.00186	2284 +/- 74
Ca-K	0.00938 +/- 0.00362	210 +/- 81
Na-K	0.00811 +/- 0.00197	132 +/- 32
Fe-K	0.00479 +/- 0.00309	45 +/- 29
K -K	0.00136 +/- 0.00133	37 +/- 36

ZAF Correction 15.00 kV 51.00 deg
No.of Iterations = 3

Element	K-ratio	Z	A	F	ZAF	Atom%	Wt%
Al-K	0.867	1.002	1.018	0.998	1.018	89.05	88.31
Si-K	0.054	0.975	1.745	1.000	1.701	8.94	9.22
Ca-K	0.009	1.004	1.081	1.000	1.086	0.65	0.96
Na-K	0.008	0.995	1.142	0.977	1.110	1.01	0.85
Fe-K	0.005	1.116	1.007	1.000	1.124	0.25	0.51
K -K	0.001	1.026	1.119	0.999	1.147	0.10	0.15

Total= 100.00%

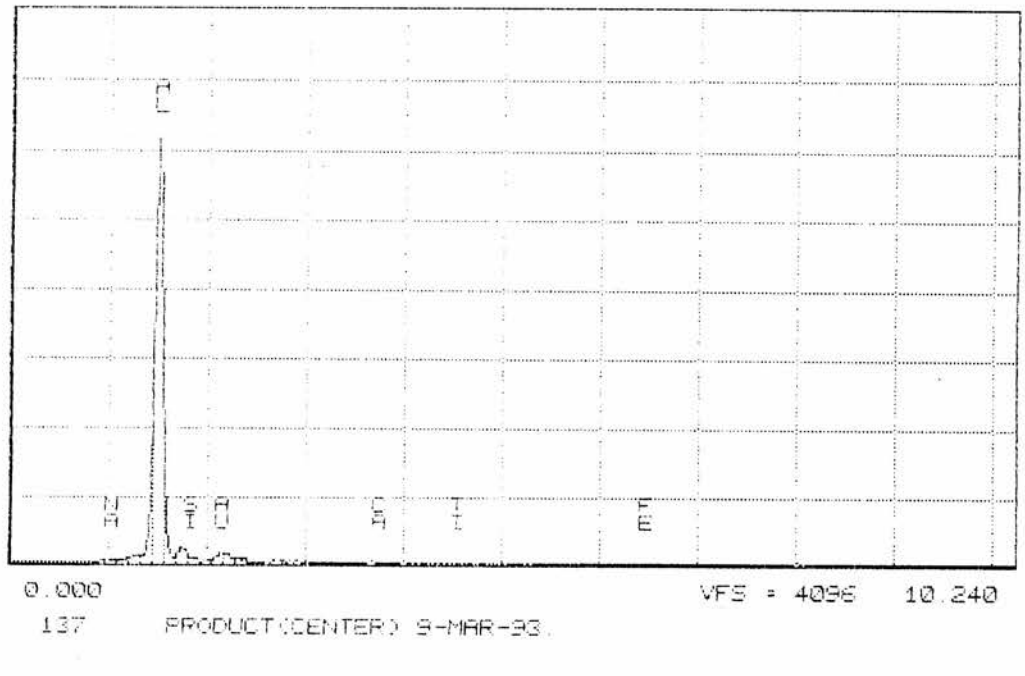
NORAN SERIES II *** TISTR *** TUE 09-MAR-93 12:03
Cursor: 0.000keV = 0



0.000 VFS = 4096 10.240

112 PRODUCT(RIM) 9-MAR-93.

```
S0: SETUP DEFINITIONS

S0: QUANTIFY

PRODUCT(CENTER) 9-MAR-93.
Standardless Analysis
 15.0 KV   51.0 Degrees

Refit _CAK' _CAK" _FEK' _FEK" _TIK' _TIK"
Refit _SIK'
Cm-eqd = 3.26

Element        Rel. k-ratio          Net Counts
  Al-K    0.93171 +/- 0.00671     32630 +/-   235
  Si-K    0.03780 +/- 0.00308      1499 +/-   122
  Na-K    0.01340 +/- 0.00370       217 +/-    60
  Ca-K    0.00753 +/- 0.00175       168 +/-    39
  Fe-K    0.00667 +/- 0.00341        62 +/-    32
  Ti-K    0.00289 +/- 0.00132        51 +/-    24

ZAF Correction 15.00 KV  51.00 deg
No.of Iterations = 4

Element  k-ratio     Z      A      F     ZAF    Atom%    Wt%
  Al-K    0.935   1.001  1.023  0.999  1.023    91.27   90.58
  Si-K    0.036   0.974  1.770  1.000  1.724     5.99    6.19
  Na-K    0.013   0.994  1.148  0.978  1.116     1.68    1.42
  Ca-K    0.007   1.003  1.080  1.000  1.083     0.53    0.78
  Fe-K    0.006   1.115  1.007  1.000  1.123     0.35    0.71
  Ti-K    0.003   1.102  1.040  0.999  1.145     0.18    0.31
                                                Total= 100.00%
```



Appendix 8.

From XRD patterns of the liner-product , the 2θ angles and d-spacings of α-Al_2O_3 and spinels were presented as followed.

The 2θ angles of α -Al_2O_3 were ;

2θ angle	correspond to	d-spacing
25.60		3.477
35.20		2.547
37.80		2.378
43.40		2.088
52.60		1.738
57.50		1.601
59.70		1.545
61.30		1.510

The 2θ angles of spinel, $MgAl_2O_4$, were ;

2θ angle	correspond to	d-spacing
19.10		4.634
28.00		3.184
31.35		2.855
36.85		2.434
44.82		2.021
59.40		1.554

Appendix 9

10-173 MINOR CORRECTION

d	2.09	2.55	1.60	3.48	α-Al_2O_3
I/I_1	100	90	80	75	ALUMINUM OXIDE (CORUNDUM)

Rad. $CuK\alpha_1$ λ 1.5405 Filter Ni Dia.
Cut off I/I_1 DIFFRACTOMETER
Ref. NAT. BUR. STANDARDS (U.S.) CIRC. 539 9 3 (1959)

Sys. TRIGONAL S.G. D^6_{3d} - R3c (167)
a_0 4.758 b_0 c_0 12.991 A C 2.7303
α β γ Z 6 Dx 3.987
Ref. IBID.

$\epsilon\alpha$ $n\omega\beta$ $\epsilon\gamma$ Sign
2V D mp Color
Ref.

SAMPLE ANNEALED AT 1400°C FOR FOUR HOURS IN AN Al_2O_3 CRUCIBLE. SPECT. ANAL. SHOWED <0.1% K,Na,Si; <0.01% Ca, Cu, Fe,Mg,Pb; <0.001% B,Cr,Li,Mn,Ni.
PATTERN MADE AT 26°C.

d Å	I/I_1	hkl	d Å	I/I_1	hkl
3.479	75	012	1.1382	2	311
2.552	90	104	1.1255	6	312
2.379	40	110	1.1246	4	128
2.165	<1	006	1.0988	8	0.2.10
2.085	100	113	1.0831	4	0.0.12
1.964	2	202	1.0781	8	134
1.740	45	024	1.0426	14	226
1.601	80	116	1.0175	2	402
1.546	4	211	0.9976	12	1.2.10
1.514	6	122	.9857	<1	1.1.12
1.510	8	018	.9819	4	404
1.404	30	124	.9431	<1	321
1.374	50	030	.9413	<1	1.2.11
1.337	8	125	.9345	4	318
1.276	4	208	.9178	4	229
1.239	16	1.0.10	.9076	14	324
1.2343	8	119	.9052	4	0.1.14
1.1898	8	220	.8991	8	410
1.1600	<1	306	.8884	<1	235
1.1470	6	223	PLUS 11 LINES TO .7931		

21-1152

d	2.44	2.02	1.43	4.66	$MgAl_2O_4$
I/I_1	100	65	55	35	Magnesium Aluminum Oxide (Spinel)

Rad. $CuK\alpha_1$ λ 1.54056 Filter Mono. Dia.
Cut off I/I_1 Diffractometer
Ref. National Bureau of Standards, Mono. 25, Sec. 9 (1971)

Sys. Cubic S.G. Fd3m (227)
a_0 8.0831 b_0 c_0 A C
α β γ Z 8 Dx 3.578
Ref. IDid.

$\epsilon\alpha$ $n\omega\beta$ 1.718 $\epsilon\gamma$ Sign
2V D mp Color Colorless
Ref. Ibid.

The sample was furnished by H. R. Shell of the Bureau of Mines, College Park, Md. He used a carbon electrode furnace and removed an excess of MgO with hot HCl after crushing.
I/Icor.=1.7
Pattern at 25°C

d Å	I/I_1	hkl	d Å	I/I_1	hkl
4.66	35	111	.9038	6	840
2.858	40	220	.8872	2	911
2.437	100	311	.8820	<2	842
2.335	4	222	.8616	<2	664
2.020	65	400	.8474	8	931
1.650	10	422	.8249	18	844
1.5534	45	511	.8123	<2	933
1.4289	55	440	.7927	2	1020
1.3662	4	531	.7814	12	951
1.2780	4	620			
1.2330	8	533			
1.2187	2	622			
1.1666	6	444			
1.1320	2	711			
1.0802	6	642			
1.0524	12	731			
1.0104	8	800			
0.9887	8	822			
.9334	8	751			
.9274	2	662			

VITA.

Mrs. Aree Poopaibool recieved her Bachelor Degree of Science from General Science Department, Faculty of Science, Chulalongkorn University in 1974.

She has started her work in ceramic industry since May, 1974 and now she is working with Compound Clay Co;Ltd. and Asian Insulator Co;Ltd.

She began her master study in June, 1991 and completed the programme in May, 1993.