

Reference

- Aksay, I. A., and Kikuchi, R., in Science of Ceramic Chemical Processing Wiley, New York, 1985: 513-521
- Amick, J.A., Purification of Rice Hulls as a Source of Solar Grade Silicon for Solar Cells, J. Electrochem., 129 (1982): 864-866
- Ashkin, Daniel, et al., Elastic Properties of Porous Silica Derived from Colloidal Gels, J. American Ceramic Society, November, 73(1990): 3376-3381
- Avrami, M., J. Chem. Phys., 7(1939): 1103-1112, 8(1940): 212-224, 9(1941): 177-184
- Barby, D., Characterization of Powder Surfaces, in Silicas, eds, G.D. Parfitt, K.S.W., Sing, Academic Press, London, 1976
- Bermudez, V.M., J. Phys. Chem., 74(1970): 4160, 75(1971): 3249
- Bode, R., Feach, H., and Fratzscher H., J. Paint Oil and Colour, 1968: 415
- Brinker, C. Jeffrey, and Scherer George W., Sol-Gel Science in The Physics and Chemistry of Sol-Gel Processing, Academic press: 881 pp.
- Chakraverty, A., Mishra, P., Banerjee, H.D., Investigation of Combustion of Raw and Acid-Leached Rice Husk for Production of Pure Amorphous White Silica, J. of Material Science, 23(1988): 21-24

- Clasen, Rolf Preparation of High Purity Silica Glass by Sintering Colloidal Particles, Glastechn. Ber. 60(1987): 125-132
- Ibid, Preparation of Glass and Ceramics by Sintering Colloidal Particles Deposited from the Gas Phase, Glastechn. Ber., 60 (1987): 119-126
- Ibid, Sintering Behaviour of Submicron Silica Particles, Glastechn. Ber., 62 (1987): 234-243
- Clegg, W. J., Alford, N. McN., Birchall, J.D., Improved Process for Making Dense Vitreous Silica from Submicrometer Particles by Sintering near 1000 °C, J. American Ceramic Society, 72(1988): 432-436
- Conratt, R., P. Pimkhaokham, and U. Leela-Adisorn, Nano - Structure Silica from Rice Husk, J. of Non-Crystalline Solids, 1992: 5 pp.
- Conratt, R., Private communication
- Dwivedi, R.K, J. Mater Science Letter, 5(1986): 373-376
- Heller, W., in Polymer Colloids II, ed. R. M. Fitch Plenum, New York, 1980: 153-207
- Hunt, L.D., Dismukes, J.P., Anick, J.A., Schei, A., and Larsen, K., J. Electrochem. Society, 131(1984): 1683
- Hunter, R.J., Zeta Potential in Colloid Science, Academic Press, New York, 1981
- Iler, R.K., The Chemistry of Silica, Wiley, New York, 1979
- Janney, Mark A., and Strehlow Richard A., Gelcasting a New Ceramic Forming Process, Ceramic Bulletin, 70(1991): 1641-1649
- Kawaguchi, T., Inra, J., Taneda, N., Hishikura, H., and Kokubu, Y., J. Non-Cryst. Solids, 82(1986): 50-56
- Napper, D. H., Polymeric Stabilization of Colloidal Dispersions, Academic Press, New York, 1983

- Ong, H.K., Yeoh, A.K., and Woo, S.K., ASEAN J. Sci. Technol. Develop, 7(1990): 81
- Park, G. A., Chem. Rev., 65(1965): 177-198
- Patel, M., Karera, A., and Prasanna, P., Effect of Thermal and Chemical Treatments on Carbons and Silica Contents in Rice Husk, J. Material Science, 22(1987): 2457-2464
- Pierre, Alain C., Sol-Gel Processing of Ceramic Powders, Ceramic Bulletin, 70(1991): 1281-1288
- Rabinovich, E.M., Johnson, D.W., Jr., McChesney, J.B., Vogel, E.M., Preparation of High Silica Glass from Colloidal Gels J. Am. Soc. 66(1983): 683-688
- Sacks, Michael D., and Tseng, Tseung-Yuen, Preparation of SiO₂ Glass from Model Powder Compacts: II, Sintering, J. American Ceramic Society, 67(August, 1984): 532-536
- Ibid, Vora, S.D., Preparation of SiO₂ Glass from Model Powder Compacts, III, Enhanced Densification by Sol Infiltration, J. Am. Ceram. Soc., 71(1988): 245-249
- Sacher, I., and Wein, A., Sprechsaal 121, 1988: 1081
- Sakka, S., Sol-Gel Synthesis of Glasses : Present and Future, Am. Ceram. Soc. Bull., 64(1985): 1463-1466
- Scherer, G. W., and Bachman, D.L., Sintering of Low-Density Glasses, J. Am. Ceram. Soc., 60(1977): 239-243
- Ibid, Theory of Drying, J. Am. Soc., 73(1990): 3-14
- Sharma, H.K., Williams, W.S., and Zangvil, A., J. Am. Ceram. Soc., 67(1984): 715
- Simpkins, Peter G., Johnson, David W., Jr., and Fleming, Debra A., Drying Behavior of Colloidal Silica Gels, J. Am. Ceram. Soc., 72(1989): 1816-1821

Uhlmann, D.R., Zelinski, B.J., Silverman, L., Warner, S.B., Fabes, B. D., and Doyle, W. F., in Science of Ceramic Chemical Processing, eds. L.L.Hench, and Ulrich, D.R., Wiley, New York, 1986: 173-183

U. Leela-adisorn Thesis, Chulalongkorn University, Bangkok, 1992

Wagner, J. Paint Oil and Colour, (1960): 514



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Appendix

1 Determine of Gel Formation

1.1 Weight Fraction

$$y(\text{SiO}_2) = \frac{m(\text{SiO}_2)}{m(\text{SiO}_2) + m(\text{H}_2\text{O})}$$

$$y(\text{H}_2\text{O}) = 1 - y(\text{SiO}_2)$$

$y(\text{SiO}_2)$ = wt. fraction of SiO_2 in gel

$y(\text{H}_2\text{O})$ = wt. fraction of H_2O in gel

$m(\text{SiO}_2)$ = mass of SiO_2 powder in gel

$m(\text{H}_2\text{O})$ = volume of H_2O (solution) in gel

2 Determination of Drying

2.1 Mass Loss

$$\% \text{mass loss} = 100 - 100 \frac{m_s - (1 - y(\text{H}_2\text{O}))}{y(\text{H}_2\text{O})} \left(\frac{m_s}{m_o} \right)$$

or

$$= \frac{1}{y(\text{H}_2\text{O})} \left(\frac{m_s}{m_o} - (1 - y(\text{H}_2\text{O})) \right)$$

m_o : 100% was mean $m_o(\text{H}_2\text{O}) + m_o(\text{SiO}_2)$

$$m_o(\text{H}_2\text{O}) = y(\text{SiO}_2) \cdot m_o$$

$$m_o(\text{SiO}_2) = y(\text{SiO}_2) \cdot m_o = (1 - y(\text{H}_2\text{O})) \cdot m_o$$

when

$$y(\text{H}_2\text{O}) + y(\text{SiO}_2) = 1.00$$

$$m_s : \quad m_s(\text{H}_2\text{O}) = m_s - m_o(\text{SiO}_2) \\ = m_s - (1 - y(\text{H}_2\text{O})) \cdot m_o \quad \text{-----(1)}$$

$$\text{wt\%H}_2\text{O in gel} = \frac{m_s(\text{H}_2\text{O})}{m_o(\text{H}_2\text{O})} \times 100 \quad \text{-----(2)}$$

(2) was substituted in (1)

$$\text{wt\% H}_2\text{O} = \left(\frac{m_s - (1 - y(\text{H}_2\text{O})) \cdot m_o}{y(\text{H}_2\text{O}) \cdot m_o} \right) \frac{m_o}{m_o} \\ = \frac{1}{y(\text{H}_2\text{O})} \left(\frac{m_s}{m_o} - (1 - y(\text{H}_2\text{O})) \right)$$

2.2 Shrinking

For planar shape was found wide, which occurred error of measurement from formular :

V_o = starting volume

V_t = volume at time

V_{∞} = volume near end point of shrinkage

L = diameter of planar shape

D = wide of planar shape

$$\frac{V_o - V_t}{V_o - V_{\infty}} \quad \text{normalized volume shrinkage}$$

$$dV = \frac{\partial V}{\partial L} \cdot dL + \frac{\partial V}{\partial D} \cdot dD$$

$$V = \frac{\pi L^2 \cdot D}{4} \quad \frac{\partial V}{\partial L} = \frac{\pi L \cdot D}{2}$$

$$\frac{\partial V}{dD} = \frac{\pi L^2}{4}$$

$$\frac{dV}{V} = \frac{\pi(L/2) \cdot D \cdot dL}{\pi(L^2/4) \cdot D} + \frac{\pi(L^2/4) \cdot dD}{\pi(L^2/4) \cdot D}$$

$$\frac{dV}{V} = \frac{2dL}{L} + \frac{dD}{D}$$

when

$$\left(\frac{dV}{V} \right)_{\max} = \frac{V_0 - V_{t \rightarrow \infty}}{V_0 - V_{\infty}}$$

$$\text{assume: } \frac{dL}{L} \sim \frac{dD}{D} \sim \frac{dX}{X}$$

$$\text{so } \frac{dV}{V} \sim \frac{3 \cdot dX}{X}$$

as long as $dV \ll V$

So, in this research work determined shrinking from linear shrinkage.

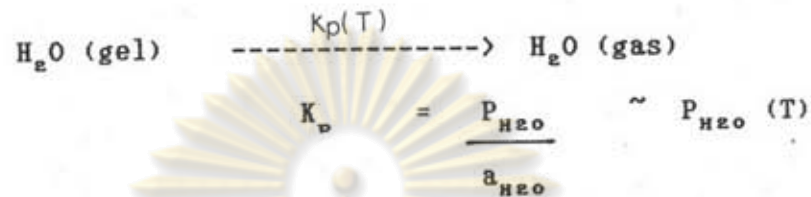
$$\% \text{ linear shrinkage} = \frac{L}{L_0} \times 100$$

2.3 Arrhenius Equation

$$\begin{aligned} \log(\text{slope}) &\sim \log \exp(-E_A / RT) \\ &\sim 2.303 (-E_A / RT) \\ &\sim -2.303 (E_A / RT) \end{aligned}$$

T plotted vs. $\frac{1000}{T_1 / ^\circ\text{C} + 273.15}$; E_A in kJ / mol.

2.4 Relative Humidity



$$\text{drying rate} \left(\frac{\text{mg. H}_2\text{O}}{\text{cm}^2 \cdot \text{h}} \right) = \beta \times (P_{\text{H}_2\text{O}}(T) - P_{\text{sat}})$$

$$\beta = \frac{\text{Sh} \cdot D}{L} = \text{constant}$$

$$\text{Sh} = f(v, n)$$

$$D = D(T) \sim T^{1.7} \sim T^{1.5}$$

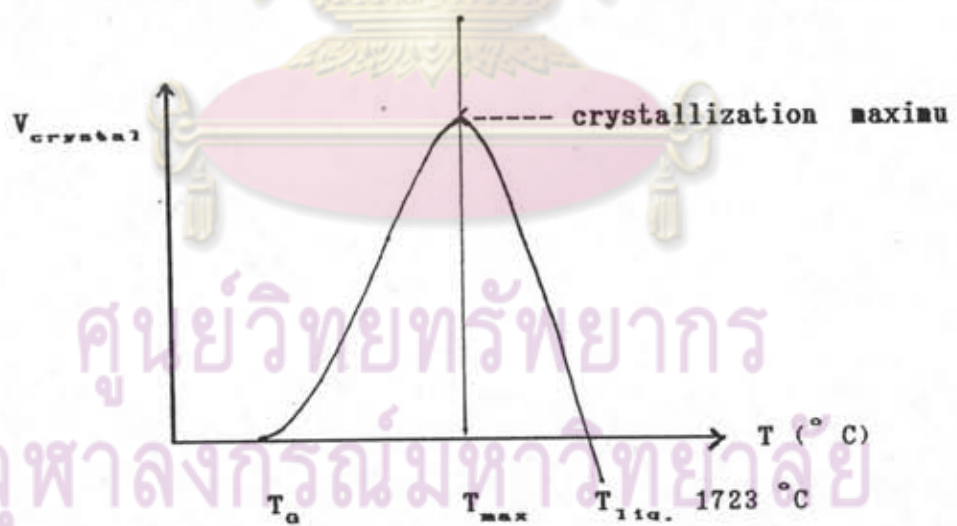
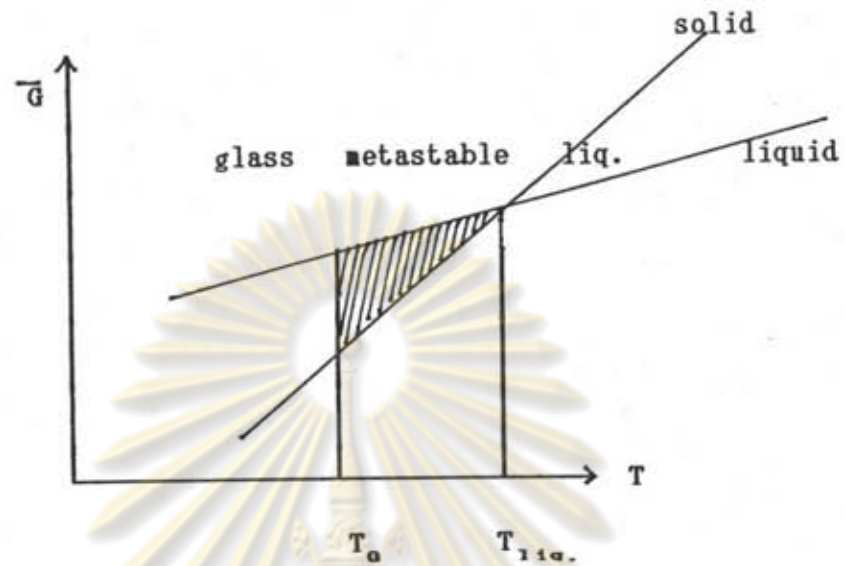
$$L = \text{size of sample}$$

$$\text{relative humidity} = f(T, P_{\text{H}_2\text{O}}^\circ)$$

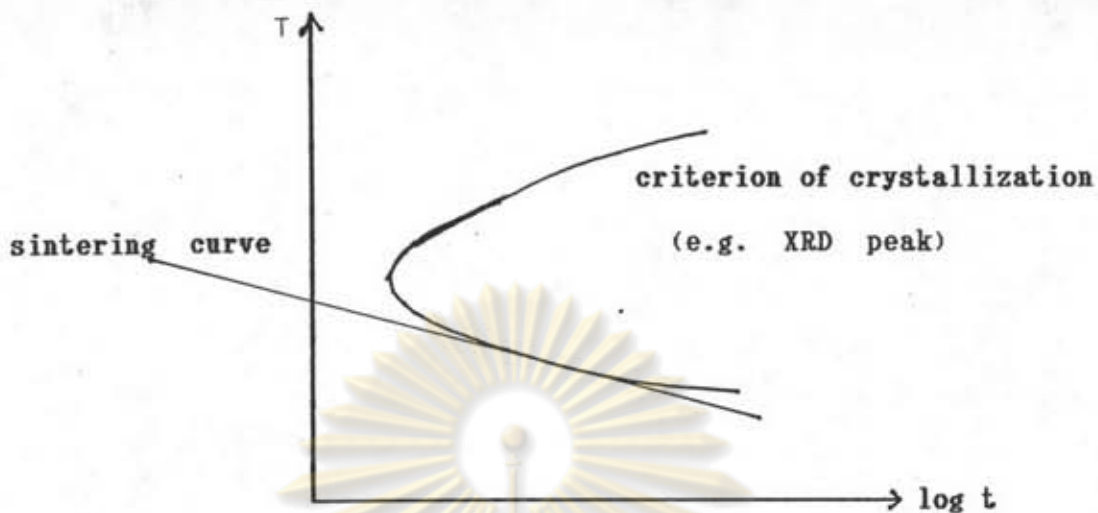
$P_{\text{H}_2\text{O}}^\circ$ seen from table of pressure of aqueous vapor (Handbook D-167).

$$P_{\text{sat}} = \frac{P_{\text{H}_2\text{O}}(T) \cdot \text{relative humidity}}{}$$

2.5 Sintering



T_0	1000 to 1100	for silica glass
	700 to 800	for wet gel



3 Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity

3.1 Calculation

M = saturated mass perform the blotting operation by rolling the specimen lightly on the wet cloth, which shall previously have been saturated with water and then pressed only enough to remove such water as will drip from the cloth

D = dry mass by heating in an oven at 150°C

S = mass of specimen while suspended in water

3.1.1 Calculate the exterior volume, V, in cubic centimetres, as followed:

$$V = M - S$$

3.1.2 Calculate the volumes of open pores and imprevious portions in cubic centimeter as follows

$$\text{volume of open pore, cm}^3 = M - D$$

$$\text{volume of imprevious portion, cm}^3 = D - S$$

3.1.3 The apparent porosity, P, expresses, as a percentage, the relationship of the volume of the open pores of the specimen to its exterior volume. Calculate the apparent porosity as followed :

$$P = [(M - D)/V] \times 100$$

3.1.4 The water absorption, A, expresses as a percentage, the relationship of the mass of water absorbed to the mass of the dry specimen. Calculate the water absorption as follows:

$$A = [(M - D)/D] \times 100$$

3.1.5 The bulk density, B, in grams per cubic centimetre, of a specimen is the quotient of its dry mass divided by the exterior volume, including pores. Calculate the bulk density as followed :

$$B = (D / V)$$

4 Thermal Expansion

$$\alpha = (8.5 \times 10^{-4}) \times (\%) / T$$

$$8.5 \times 10^{-4} = \text{constant temperature}$$

$$\% = \text{percent of linear thermal expansion}$$

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Annex

This part shows in detail the results of drying and sintering of
OX-50.



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Table I

PRESSURE OF AQUEOUS VAPOR
VAPOR PRESSURE OF ICE

Pressure of aqueous vapor over ice in mm of Hg for temperatures from
-93 to 0°C.

Temp. °C	0	2	4	6	8	Temp. °C	0.0	0.2	0.4	0.6	0.8
-90	.000370	.000345	.000333	.000322	.000315	-19	0.854	0.838	0.822	0.806	0.791
-80	.00040	.00029	.00020	.00014	.00010	-18	0.939	0.921	0.904	0.887	0.870
-70	.00194	.00143	.00105	.00077	.00056	-17	1.031	1.012	0.993	0.975	0.956
-60	.00508	.00364	.00264	.00194	.00146	-16	1.132	1.111	1.091	1.070	1.051
-50	.02953	.0230	.0178	.0138	.0106	-15	1.241	1.219	1.196	1.175	1.153
-40	.0965	.0768	.0609	.0481	.0378	-14	1.361	1.336	1.312	1.288	1.264
-30	.2859	.2318	.1873	.1507	.1209	-13	1.490	1.464	1.437	1.411	1.386
						-12	1.632	1.602	1.574	1.546	1.518
						-11	1.785	1.753	1.722	1.691	1.661
						-10	1.950	1.916	1.883	1.849	1.817
-29	0.317	0.311	0.304	0.298	0.292	-9	2.131	2.093	2.057	2.021	1.985
-28	0.351	0.344	0.337	0.330	0.324	-8	2.326	2.285	2.246	2.207	2.168
-27	0.389	0.381	0.374	0.366	0.359	-7	2.537	2.493	2.450	2.408	2.367
-26	0.430	0.422	0.414	0.405	0.397	-6	2.765	2.718	2.672	2.626	2.581
-25	0.476	0.467	0.457	0.448	0.439	-5	3.013	2.962	2.912	2.862	2.813
-24	0.526	0.515	0.505	0.495	0.486	-4	3.280	3.225	3.171	3.117	3.065
-23	0.580	0.569	0.558	0.547	0.536	-3	3.568	3.509	3.451	3.393	3.336
-22	0.640	0.627	0.615	0.603	0.592	-2	3.880	3.816	3.753	3.691	3.630
-21	0.705	0.691	0.678	0.665	0.652	-1	4.217	4.147	4.079	4.012	3.946
-20	0.776	0.761	0.747	0.733	0.719	0	4.579	4.504	4.431	4.359	4.287

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VAPOR PRESSURE OF WATER BELOW 100°C

Pressure of aqueous vapor over water in mm of Hg for temperatures from -15.8 to 100°C. Values for fractional degrees between 50 and 89 were obtained by interpolation.

Temp. °C	0.0	0.2	0.4	0.6	0.8	Temp. °C	0.0	0.2	0.4	0.6	0.8
-15	1.436	1.414	1.390	1.368	1.345	42	61.50	62.14	62.80	63.46	64.12
-14	1.560	1.534	1.511	1.485	1.460	43	64.80	65.48	66.16	66.86	67.56
-13	1.691	1.665	1.637	1.611	1.585	44	68.26	68.97	69.69	70.41	71.14
-12	1.834	1.804	1.776	1.748	1.720	45	71.88	72.62	73.36	74.12	74.88
-11	1.987	1.955	1.924	1.893	1.863	46	75.65	76.43	77.21	78.00	78.80
-10	2.149	2.116	2.084	2.050	2.018	47	79.60	80.41	81.23	82.05	82.87
-9	2.326	2.289	2.254	2.219	2.184	48	83.71	84.56	85.42	86.28	87.14
-8	2.514	2.475	2.437	2.399	2.362	49	88.02	88.90	89.79	90.69	91.59
-7	2.715	2.674	2.633	2.593	2.553	50	92.51	93.5	94.4	95.3	96.3
-6	2.931	2.887	2.843	2.800	2.757	51	97.20	98.2	99.1	100.1	101.1
-5	3.163	3.115	3.069	3.022	2.976	52	102.09	103.1	104.1	105.1	106.2
-4	3.410	3.359	3.309	3.259	3.211	53	107.20	108.2	109.3	110.4	111.4
-3	3.673	3.620	3.567	3.514	3.461	54	112.51	113.6	114.7	115.8	116.9
-2	3.956	3.898	3.841	3.785	3.730	55	118.04	119.1	120.3	121.5	122.6
-1	4.258	4.196	4.135	4.075	4.016	56	123.80	125.0	126.2	127.4	128.6
0	4.579	4.513	4.448	4.385	4.320	57	129.82	131.0	132.3	133.5	134.7
1	4.926	4.847	4.775	4.705	4.635	58	136.08	137.3	138.5	139.9	141.2
2	5.294	5.206	5.131	5.058	4.985	59	142.60	143.9	145.2	146.6	148.0
3	5.685	5.588	5.500	5.415	5.330	60	149.38	150.7	152.1	153.5	155.0
4	6.101	6.000	5.910	5.822	5.735	61	156.43	157.8	159.3	160.8	162.3
5	6.543	6.438	6.345	6.254	6.165	62	163.77	165.2	166.8	168.3	169.8
6	7.013	6.904	6.810	6.718	6.627	63	171.38	172.9	174.5	176.1	177.7
7	7.513	7.399	7.299	7.200	7.103	64	179.31	180.9	182.5	184.2	185.8
8	8.045	7.926	7.822	7.722	7.624	65	187.54	189.2	190.9	192.6	194.3
9	8.609	8.485	8.381	8.282	8.185	66	196.09	197.8	199.5	201.3	203.1
10	9.209	9.080	8.981	8.882	8.785	67	204.96	206.8	208.6	210.5	212.3
11	9.844	9.710	9.617	9.524	9.433	68	214.17	216.0	218.0	219.9	221.8
12	10.518	10.379	10.282	10.189	10.097	69	223.73	225.7	227.7	229.7	231.7
13	11.231	11.088	10.998	10.909	10.820	70	233.7	235.7	237.7	239.7	241.8
14	11.987	11.839	11.754	11.670	11.586	71	243.9	246.0	248.2	250.3	252.4
15	12.788	12.635	12.556	12.477	12.398	72	254.6	256.8	259.0	261.2	263.4
16	13.634	13.476	13.402	13.328	13.254	73	265.7	268.0	270.2	272.6	274.8
17	14.530	14.367	14.300	14.232	14.164	74	277.2	279.4	281.8	284.2	286.6
18	15.477	15.309	15.248	15.186	15.124	75	289.1	291.5	294.0	296.4	298.8
19	16.477	16.304	16.249	16.192	16.135	76	301.4	303.8	306.4	308.9	311.4
20	17.535	17.357	17.308	17.257	17.206	77	314.1	316.6	319.2	322.0	324.6
21	18.650	18.467	18.423	18.377	18.330	78	327.3	330.0	332.8	335.6	338.2
22	19.827	19.639	19.601	19.561	19.521	79	341.0	343.8	346.6	349.4	352.2
23	21.068	20.875	20.843	20.810	20.776	80	355.1	358.0	361.0	363.8	366.8
24	22.377	22.179	22.152	22.124	22.095	81	369.7	372.6	375.6	378.8	381.8
25	23.756	23.553	23.532	23.510	23.487	82	384.9	388.0	391.2	394.4	397.4
26	25.209	25.001	25.000	25.000	25.000	83	400.6	403.8	407.0	410.2	413.6
27	26.739	26.526	26.531	26.535	26.539	84	416.8	420.2	423.6	426.8	430.2
28	28.349	28.131	28.143	28.154	28.165	85	433.6	437.0	440.4	444.0	447.5
29	30.043	29.820	29.838	29.855	29.872	86	450.9	454.4	458.0	461.6	465.2
30	31.824	31.596	31.620	31.643	31.666	87	468.7	472.4	476.0	479.8	483.4
31	33.695	33.463	33.493	33.522	33.551	88	487.1	491.0	494.7	498.5	502.2
32	35.663	35.426	35.462	35.497	35.532	89	506.1	510.0	513.9	517.8	521.8
33	37.729	37.487	37.529	37.570	37.611	90	525.76	529.77	533.80	537.86	541.95
34	39.898	39.651	39.700	39.748	39.796	91	546.05	550.18	554.35	558.53	562.75
35	42.175	41.923	41.978	42.032	42.086	92	566.99	571.26	575.55	579.87	584.22
36	44.563	44.306	44.368	44.429	44.490	93	588.60	593.00	597.43	601.89	606.38
37	47.067	46.804	46.873	46.941	47.009	94	610.90	615.44	620.01	624.61	629.24
38	49.692	49.423	49.499	49.574	49.649	95	633.90	638.59	643.30	648.05	652.82
39	52.442	52.168	52.251	52.333	52.415	96	657.62	662.45	667.31	672.20	677.12
40	55.324	55.045	55.135	55.224	55.313	97	682.07	687.04	692.05	697.10	702.17
41	58.34	58.056	58.153	58.249	58.345	98	707.27	712.40	717.56	722.75	727.98
						99	733.24	738.53	743.85	749.20	754.58
						100	760.00	765.45	770.93	776.44	782.00
						101	787.57	793.18	798.82	804.50	810.21

VAPOR PRESSURE OF WATER ABOVE 100° C.

Based on values given by Keyes in the International Critical Tables.

Temp. °C	Pressure		Temp. °F	Temp. °C	Pressure		Temp. °F	Temp. °C	Pressure		Temp. °F	Temp. °C	Pressure		Temp. °F
	mm	Pounds per sq. in.			mm	Pounds per sq. in.			mm	Pounds per sq. in.			mm	Pounds per sq. in.	
100	760	14 696	212.0	170	5940.92	114 579	335.0	240	25100.52	485 365	464.0	310	74024.00	1431 390	590.0
101	767.51	15 228	213.8	171	6085.32	117 671	339.8	241	25543.60	493 933	465.8	311	75042.40	1451 083	591.8
102	815.86	15 776	215.6	172	6233.52	120 537	341.6	242	25994.28	502 647	467.6	312	76076.00	1471 070	593.6
103	845.12	16 342	217.4	173	6385.24	123 432	343.4	243	26449.52	511 450	469.4	313	77117.20	1491 203	595.4
104	875.06	16 921	219.2	174	6538.28	126 130	345.2	244	26912.36	520 400	471.2	314	78166.00	1511 484	597.2
105	906.07	17 531	221.0	175	6694.08	129 442	347.0	245	27381.28	529 467	473.0	315	79230.00	1532 058	599.0
106	937.92	18 136	222.8	176	6852.92	132 514	348.8	246	27855.52	538 638	474.8	316	80294.00	1552 632	600.8
107	970.60	18 798	224.6	177	7015.56	135 659	350.6	247	28335.84	547 926	476.6	317	81373.20	1573 501	602.6
108	1004.12	19 422	226.4	178	7180.48	138 545	352.4	248	28823.76	557 360	478.4	318	82467.60	1594 563	604.4
109	1038.92	20 069	228.2	179	7349.20	142 110	354.2	249	29317.00	566 898	480.2	319	83569.60	1615 972	606.2
110	1074.56	20 779	230.0	180	7520.20	145 417	356.0	250	29817.84	576 583	482.0	320	84688.80	1637 575	608.0
111	1111.20	21 457	231.8	181	7694.24	148 782	357.8	251	30324.00	586 370	483.8	321	85819.20	1659 472	609.8
112	1148.74	22 213	233.6	182	7872.08	152 221	359.6	252	30837.76	596 305	485.6	322	86959.20	1681 516	611.6
113	1187.42	22 961	235.4	183	8052.96	155 719	361.4	253	31356.84	606 342	487.4	323	88114.40	1703 854	613.4
114	1227.25	23 731	237.2	184	8236.88	159 275	363.2	254	31885.04	616 556	489.2	324	89277.20	1726 339	615.2
115	1267.98	24 519	239.0	185	8423.84	162 500	365.0	255	32427.80	626 858	491.0	325	90447.60	1748 971	617.0
116	1309.94	25 330	240.8	186	8614.12	166 609	366.8	256	32985.40	637 292	492.8	326	91633.20	1771 869	618.8
117	1352.65	26 162	242.6	187	8808.92	170 356	368.6	257	33549.56	647 888	494.6	327	92826.00	1794 969	620.6
118	1397.18	27 017	244.4	188	9007.52	174 177	370.4	258	34120.40	658 601	496.4	328	94042.40	1818 433	622.4
119	1442.63	27 896	246.2	189	9208.16	178 057	372.2	259	34698.76	669 417	498.2	329	95273.60	1842 291	624.2
120	1489.14	28 795	248.0	190	9413.36	182 025	374.0	260	35285.00	680 425	500.0	330	96512.40	1866 245	626.0
121	1536.80	29 717	249.8	191	9620.08	186 022	375.8	261	35761.80	691 520	501.8	331	97758.80	1890 346	627.8
122	1586.04	30 669	251.6	192	9831.36	190 107	377.6	262	36243.20	702 763	503.6	332	99020.40	1914 742	629.6
123	1636.96	31 642	253.4	193	10047.20	194 281	379.4	263	36732.20	714 152	505.4	333	100297.20	1939 431	631.4
124	1688.81	32 637	255.2	194	10266.32	198 499	381.2	264	37231.56	725 703	507.2	334	101581.60	1964 267	633.2
125	1740.93	33 664	257.0	195	10488.76	202 819	383.0	265	38133.00	737 372	509.0	335	102851.20	1989 398	635.0
126	1795.12	34 712	258.8	196	10715.24	207 199	384.8	266	38742.52	749 158	510.8	336	104196.00	2014 822	636.8
127	1850.83	35 789	260.6	197	10944.76	211 637	386.6	267	39361.92	761 135	512.6	337	105526.00	2040 540	638.6
128	1907.83	36 891	262.4	198	11179.40	216 178	388.4	268	39988.64	773 215	514.4	338	106851.20	2066 552	640.4
129	1966.35	38 023	264.2	199	11417.48	220 775	390.2	269	40619.72	785 457	516.2	339	108224.00	2092 710	642.2
130	2026.16	39 180	266.0	200	11659.16	225 451	392.0	270	41261.16	797 861	518.0	340	109592.00	2119 163	644.0
131	2087.42	40 364	267.8	201	11905.40	230 213	393.8	271	41910.20	810 411	519.8	341	110967.60	2145 763	645.8
132	2150.44	41 582	269.6	202	12155.44	235 048	395.6	272	42566.08	823 094	521.6	342	112358.40	2172 657	647.6
133	2214.64	42 824	271.4	203	12408.52	239 942	397.4	273	43229.56	835 923	523.4	343	113749.20	2199 550	649.4
134	2280.76	44 103	273.2	204	12666.16	244 924	399.2	274	43902.16	848 929	525.2	344	115178.00	2227 179	651.2
135	2347.76	45 389	275.0	205	12929.12	250 008	401.0	275	44580.84	862 053	527.0	345	116614.40	2254 954	653.0
136	2416.34	46 724	276.8	206	13197.40	255 196	402.8	276	45269.40	875 367	528.8	346	118073.60	2283 171	654.8
137	2486.16	48 113	278.6	207	13467.96	260 428	404.6	277	45964.04	888 799	530.6	347	119552.80	2311 387	656.6
138	2556.07	49 515	280.4	208	13742.24	265 738	406.4	278	46669.32	902 437	532.4	348	121014.80	2340 044	658.4
139	2626.34	50 950	282.2	209	14022.76	271 156	408.2	279	47382.20	916 222	534.2	349	122504.40	2368 848	660.2
140	2707.92	52 421	284.0	210	14305.48	276 623	410.0	280	48104.20	930 133	536.0	350	124001.60	2397 799	662.0
141	2789.44	53 930	285.8	211	14590.04	282 222	411.8	281	48833.80	944 291	537.8	351	125512.00	2427 191	663.8
142	2867.48	55 488	287.6	212	14888.40	287 895	413.6	282	49570.24	958 532	539.6	352	127049.20	2456 730	665.6
143	2948.80	57 080	289.4	213	15184.80	293 626	415.4	283	50316.56	972 963	541.4	353	128599.60	2486 516	667.4
144	3027.64	58 622	291.2	214	15488.04	299 490	417.2	284	51072.76	987 586	543.2	354	130157.60	2516 837	669.2
145	3116.76	60 268	293.0	215	15792.80	305 383	419.0	285	51838.08	1002 385	545.0	355	131730.80	2547 258	671.0
146	3203.40	61 944	294.8	216	16104.40	311 405	420.8	286	52611.76	1017 345	546.8	356	133326.60	2578 119	672.8
147	3292.32	63 664	296.6	217	16420.56	317 522	422.6	287	53395.32	1032 497	548.6	357	134945.60	2609 422	674.6
148	3382.76	65 412	298.4	218	16742.04	323 738	424.4	288	54187.24	1047 810	550.4	358	136579.60	2641 018	676.4
149	3474.24	67 220	300.2	219	17067.32	330 025	426.2	289	54989.04	1063 314	552.2	359	138228.80	2672 908	678.2
150	3570.48	69 042	302.0	220	17395.64	336 377	428.0	290	55799.20	1078 980	554.0	360	139893.20	2705 093	680.0
151	3667.00	70 908	303.8	221	17731.56	342 872	429.8	291	56612.40	1094 705	555.8	361	141572.80	2737 571	681.8
152	3766.56	72 833	305.6	222	18072.80	349 471	431.6	292	57448.40	1110 471	557.6	362	143275.20	2770 490	683.6
153	3868.88	74 773	307.4	223	18417.84	356 143	433.4	293	58294.40	1127 036	559.4	363	144992.80	2803 703	685.4
154	3970.24	76 772	309.2	224	18766.68	362 886	435.2	294	59133.60	1143 496	561.2	364	146733.20	2837 357	687.2
155	4075.88	78 815	311.0	225	19123.12	369 781	437.0	295	59994.40	1160 102	563.0	365	148519.20	2871 892	689.0
156	4183.80	80 901	312.8	226	19482.60	376 732	438.8	296	60860.80	1176 856	564.8	366	150320.40	2906 722	690.8
157	4293.24	83 018	314.6	227	19848.92	383 815	440.6	297	61742.40	1193 803	566.6	367	152129.20	2941 698	692.6
158	4404.96	85 178	316.4	228	20219.80	390 957	442.4	298	62624.00	1210 950	568.4	368	153960.80	2977 116	694.4
159	4519.72	87 397	318.2	229	20596.76	398 276	444.2	299	63528.40	1228 439	570.2	369	155815.20	3012 974	696.2
160	4636.00	89 646	320.0	230	20978.28	405 654	446.0	300	64432.80	1245 927	572.0	370	157692.40	3049 273	698.0
161	4755.32	91 953	321.8	231	21365.12	413 134	447.8	301	65352.40	1263 709	573.8	371	159584.80	3085 866	699.8
162	4876.92	94 304	323.6	232	21757.28	420 717	449.6	302	66279.60	1281 638	575.6	372	161507.60	3123 047	701.6
163	5000.04	96 685	325.4	233	22154.00	428 388	451.4	303	67214.40	1299 714	577.4	373	163468.80	3160 963	703.4
164	5126.96	99 139	327.2	234	22555.32	436 207	453.2	304	68156.80	1317 937	579.2	374	165467.20	3199 613	705.2
165	5256.16	101 638	329.0	235	22967.96	444 128	455.0	305	69114.40	1336 454	581.0				
166	5386.88	104 165	330.8	236	23382.92	452 152	456.8	306	70072.00	1354 971	582.8				
167	5521.40	106 706	332.6	237	23802.44	460 284	458.6	307	71052.40	1373 929	584.6				
168	5658.20	109 412													

1 drying 50°C every 1hr

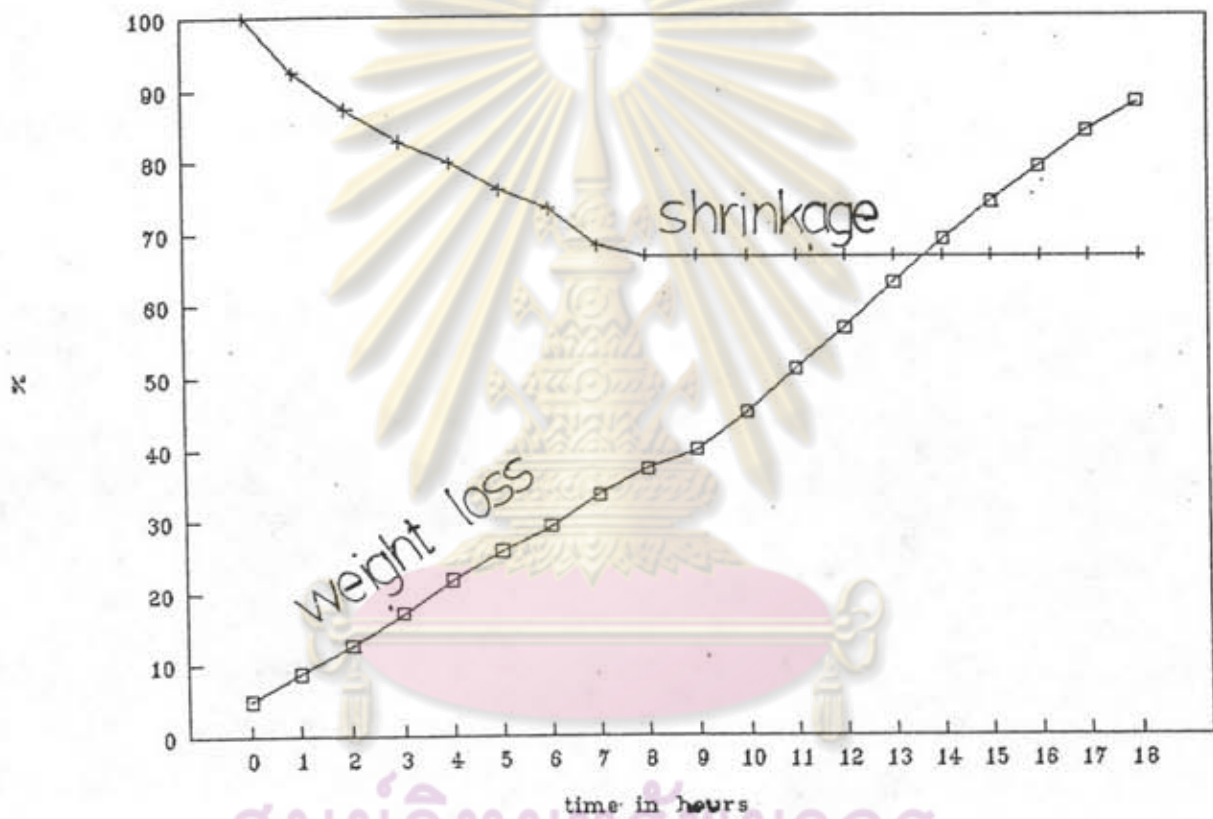
			50°C			4.794285 -10.8495			94.30761	
%MASS LOSS			MAX	MIN	AVG	%MASS LOSS	4.094880	5.634666	%SHRINKAGE	-3.65428
3.93	5.99	4.77	5.99	3.93	4.90	4.90	4.79	-10.85	100	94.31
7.49	10.17	8.6	10.17	7.49	8.75	8.75	8.89	-5.21	92.32	90.65
11.1	14.28	12.39	14.28	11.1	12.59	12.59	12.98	0.42	87.26	87.00
14.92	18.99	17.23	18.99	14.92	17.05	17.05	17.08	6.05	82.76	83.34
19.89	23.61	21.69	23.61	19.89	21.73	21.73	21.17	11.69	79.76	79.69
23.81	27.79	25.69	27.79	23.81	25.76	25.76	25.27	17.32	75.99	76.04
25.71	32.03	29.79	32.03	25.71	29.18	29.18	29.36	22.96	73.30	72.38
31.19	36.09	33.55	36.09	31.19	33.61	33.61	33.46	28.59	68.11	68.73
34.51	39.76	37.02	39.76	34.51	37.10	37.10	37.55	34.23	66.68	65.07
37.26	42.05	39.86	42.05	37.26	39.72	39.72	41.65	39.86	66.68	61.42
42.21	47.75	45.03	47.75	42.21	45.00	45.00	45.74	45.50	66.68	57.76
47.57	53.89	51.65	53.89	47.57	51.04	51.04	49.84	51.13	66.68	54.11
52.12	59.35	58.61	59.35	52.12	56.69	56.69	53.93	56.77	66.68	50.46
58.19	66.07	64.47	66.07	58.19	62.91	62.91	58.03	62.40	66.68	46.80
63.43	72.35	70.95	72.35	63.43	68.91	68.91	62.12	68.04	66.68	43.15
68.25	77.76	76.61	77.76	68.25	74.21	74.21	66.22	73.67	66.68	39.49
72.73	82.71	81.91	82.71	72.73	79.12	79.12	70.31	79.31	66.68	35.84
77.69	87.57	86.77	87.57	77.69	84.01	84.01	74.41	84.94	66.68	32.18
82.21	91.32	90.55	91.32	82.21	88.03	88.03	78.50		66.68	28.53

%SHRINKAGE

100	100	100	100	100	100.00
90.27	93.67	93.03	93.67	90.27	92.32
87.03	87.79	86.95	87.79	86.95	87.26
85.26	79.31	83.7	85.26	79.31	82.76
82.42	76.71	80.15	82.42	76.71	79.76
78.98	73.54	75.44	78.98	73.54	75.99
76.19	70.44	73.26	76.19	70.44	73.30
66.46	68.85	69.02	69.02	66.46	68.11
64.84	68.57	66.62	68.57	64.84	66.68
64.84	68.57	66.62	68.57	64.84	66.68
64.84	68.57	66.62	68.57	64.84	66.68
64.84	68.57	66.62	68.57	64.84	66.68
64.84	68.57	66.62	68.57	64.84	66.68

ศูนย์วิจัยอาหาร
ภาควิชาเทคโนโลยี

weight loss and shrinkage at 50 °C



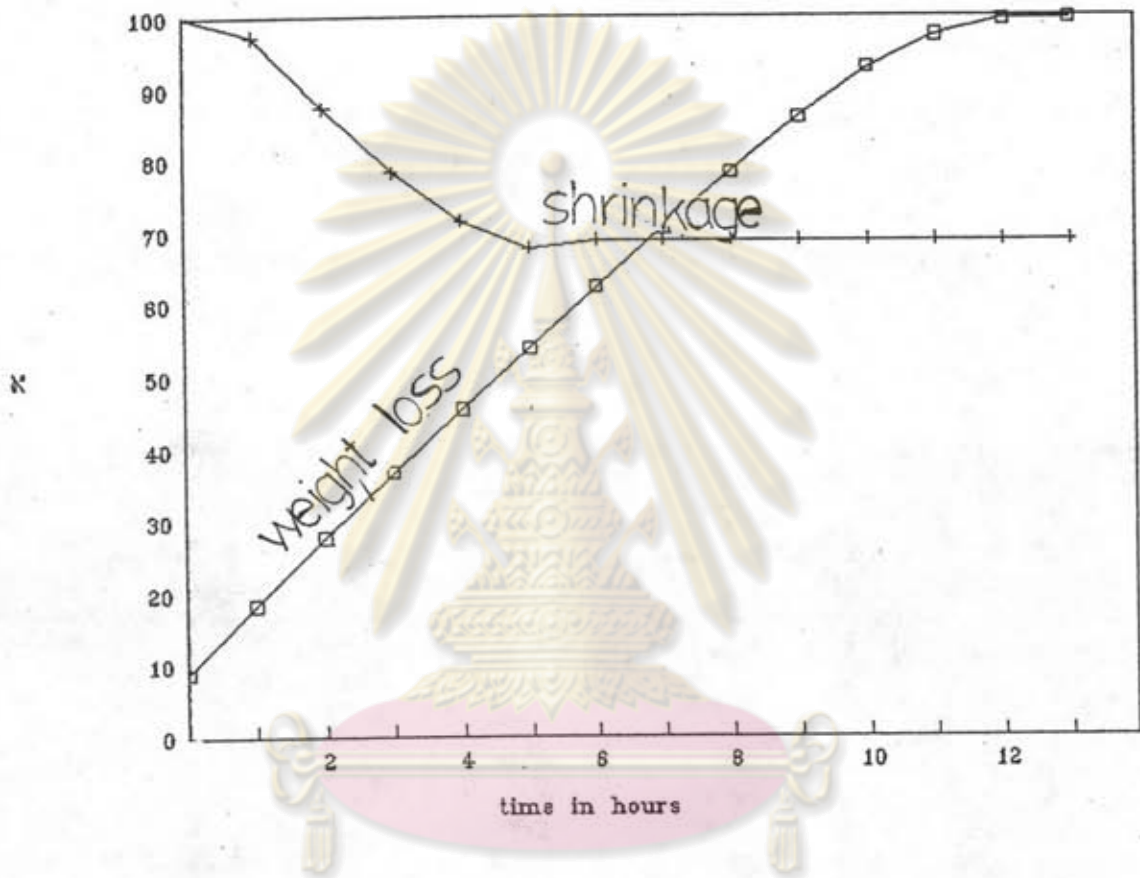
ศูนย์วิจัยทรัพย์สิน
จุฬาลงกรณ์มหาวิทยาลัย

2 drying 70 °C every 1 hr											max	min	avg	std		
%mass loss	8.72	7.26	8.51	6.28	7.16	6.27	8.65	11.29	11.73	11.52	10.4	9.15	11.73	6.27	8.91	1.885067
	17.08	16.62	20.35	15.72	17.18	16.93	17.35	19.95	21.02	20.04	19.41	18.57	21.02	15.72	18.35	1.673941
	26.22	26.5	32.51	24.38	26.18	26.95	26.72	29.04	30.6	29.58	26.95	28.3	32.51	24.38	27.83	2.161974
	34.69	35.25	43.28	33.24	35.62	36.99	35.39	37.7	39.84	38.66	34.44	37.24	43.28	33.24	36.86	2.648332
	42.76	43.86	54.11	41.61	44.67	46.28	44.01	46.19	48.55	47.26	41.82	45.54	54.11	41.61	45.56	3.283325
	50.68	52.43	64.55	49.38	53.26	55.54	52.21	54.31	57.36	55.63	48.66	54.11	64.55	48.66	54.01	4.029336
	58.41	60.83	75.11	57.25	61.92	64.88	60.14	61.95	65.79	64.47	55.95	62.5	75.11	55.95	62.43	4.791647
	66.16	68.96	84.76	65.04	70.33	73.87	68.26	69.76	74.07	72.87	62.62	70.49	84.76	62.62	70.60	5.413376
	73.93	76.94	92.82	72.76	78.71	82.79	75.94	77.41	82.29	80.85	69.24	78.3	92.82	69.24	78.50	5.724163
	81.71	85.32	98.16	80.47	86.66	90.24	83.91	85.31	89.9	88.64	76.12	86.21	98.16	76.12	86.05	5.325827
	89.33	93.28	99.98	88.19	93.82	96.21	91.26	92.78	96.01	95.58	85.37	93.54	99.98	85.37	92.95	3.804012
	95.57	98.37	100.13	94.83	98.12	99.04	97.46	98.21	96.99	100.12	91.82	98.87	100.13	91.82	97.39	2.460465
	99.01	98.41	100.15	99.36	99.24	99.08	100.75	99.1	99.1	100.16	101.84	98.91	101.84	98.41	99.59	0.919847
	99.06	98.5	100.18	99.4	99.3	99.15	100.84	99.18	99.15	100.24	101.92	98.98	101.92	98.5	99.66	0.922973
%shrinkage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0
	94.26	100	97.62	100	94.43	100	100	94.36	94.95	98.78	94.1	99.33	100	94.1	97.32	2.540569
	89.47	93.94	82.59	84.75	88.56	94.87	94.87	85.71	86.12	83.58	79.23	85.35	94.87	79.23	87.42	4.832149
	75.69	86.36	69.43	80.32	75.93	82.59	84.17	85.71	76.89	77.07	71.54	76.07	86.36	69.43	78.48	5.177661
	70.02	75.54	66.63	72.58	69.16	76.38	77.9	77.94	71.29	66.99	66.56	68.41	77.94	66.56	71.62	4.176237
	67.23	59.08	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	67.78	5.208316
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733
	67.23	72.34	65.8	68.04	67.66	74.82	74.81	75.52	68.93	65.67	58.82	67.02	75.52	58.82	68.89	4.617733

t	70 °C	11.10419	105.22
0	%MASS LOSS	8.543142	%SHRINKAG -8.604
1	8.91	11.10419	100
2	18.35	19.64733	97.32
3	27.83	28.19047	87.42
4	36.86	36.73361	78.48
5	45.56	45.27676	71.62
6	54.01	53.81990	67.78
7	62.43	62.36304	68.89
8	70.60	70.90619	68.89
9	78.50	79.44933	68.89
10	86.05	87.99247	68.89
11	92.95	96.53561	68.89
12	97.39	105.0787	68.89
13	99.59	113.6219	68.89
			19.18
			10.576
			1.972
			-6.632

ศูนย์วิจัยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

weight loss and shrinkage at 70 °C



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

3 drying 90°C every 1 hr
 %mass loss

												max	min	avg	std
9.05	8.55	12.68	7.13	6.16	5.88	9.03	8.36	7.43	5.85	5.42	4.78	12.68	4.78	7.53	2.090025
26.86	25.6	30.37	23.99	22.86	25.12	22.81	20.48	21.33	25.02	25.18	25.17	30.37	20.48	24.57	2.496091
43.36	42.79	49.58	39.91	37.81	42.77	39.27	35.67	38.35	45.17	43.63	44.41	49.58	35.67	41.89	3.670477
59.84	59.72	68.58	55.98	53.29	60.73	56.66	50.99	55.13	63.03	61.49	62.67	68.58	50.99	59.01	4.638959
77.19	76.64	85.99	71.87	69.82	78.62	74.21	66.98	72.5	79.01	77.56	80.19	85.99	66.98	75.88	4.911175
90.9	90.84	95.81	86.58	84.78	93.35	88.93	81.74	87.95	90.67	92.01	94.09	95.81	81.74	89.80	3.870517
97.26	97.39	97.36	96.87	97.2	99.44	97.6	94.11	97.58	98.28	99.65	99.7	99.7	94.11	97.70	1.455537
97.46	97.61	97.49	99.55	99.6	99.63	99.05	98.78	98.67	100.65	100.56	100.28	100.65	97.46	99.11	1.097348
97.5	97.66	97.51	99.61	99.66	99.67	99.13	98.88	98.72	100.69	100.39	100.31	100.69	97.5	99.14	1.075751
97.53	97.69	97.53	99.64	99.69	99.7	99.15	98.92	98.75	100.71	100.41	100.35	100.71	97.53	99.17	1.075546

%shrinkage

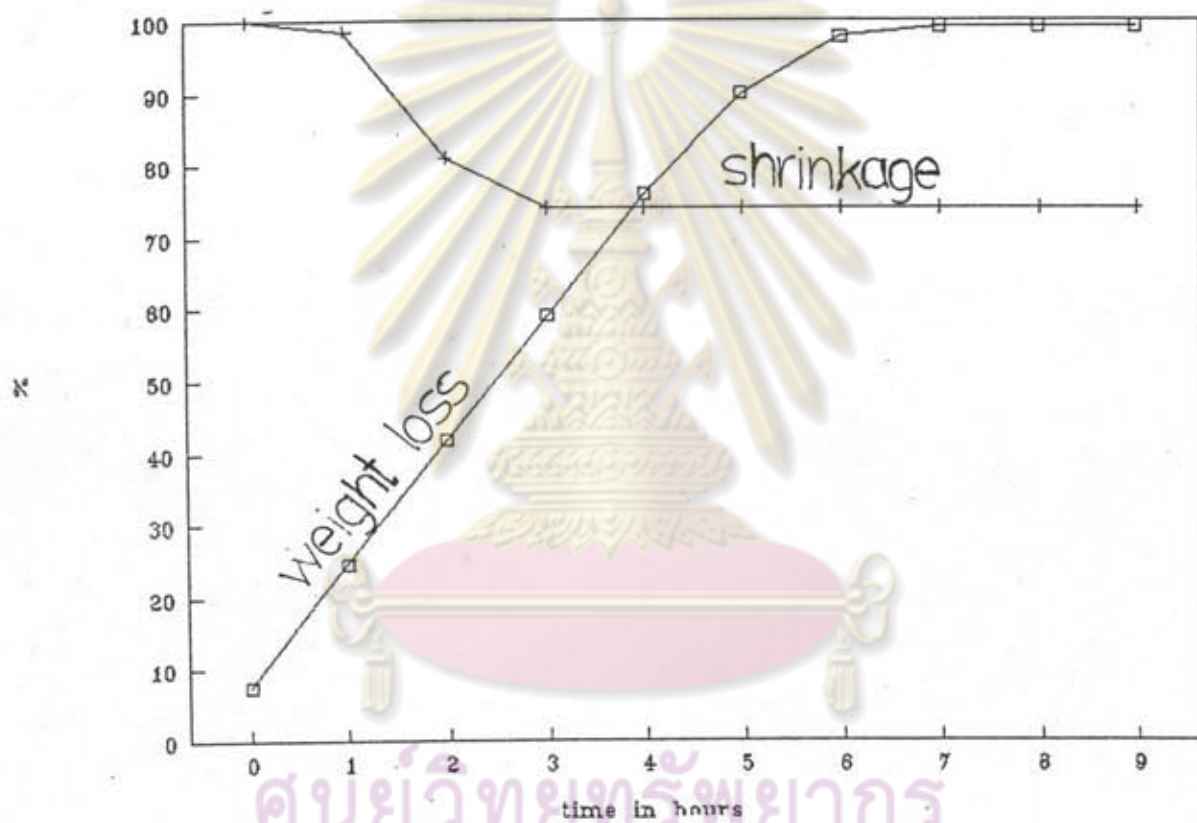
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0
100	98.27	98.27	98.2	93.77	98.13	98.97	100	98.96	100	100	98.77	100	93.77	98.61	1.634558
87.9	83.63	83.92	78.08	83.56	85.67	78.25	74.13	78.65	82.89	77.49	78.43	87.9	74.13	81.05	3.901828
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608
83.5	77.41	77.56	69.04	75.32	78.13	77.63	73.79	78.64	68.14	64.35	64.46	83.5	64.35	74.00	5.853608

90°C 8.18 102.749

t	%MASS LOS	8.18	%SHRINKAG	-9.556
0	7.53	8.180	100	102.749
1	24.57	24.820	98.61	93.193
2	41.89	41.460	81.05	83.637
3	59.01	58.100	74.00	74.081
4	75.88	74.740	74.00	64.525
5	89.80	91.380	74.00	54.969
6	97.70	108.020	74.00	
7	99.11	124.660	74.00	
8	99.14	141.300	74.00	
9	99.17	157.940	74.00	

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weight loss and shrinkage at 90 °C



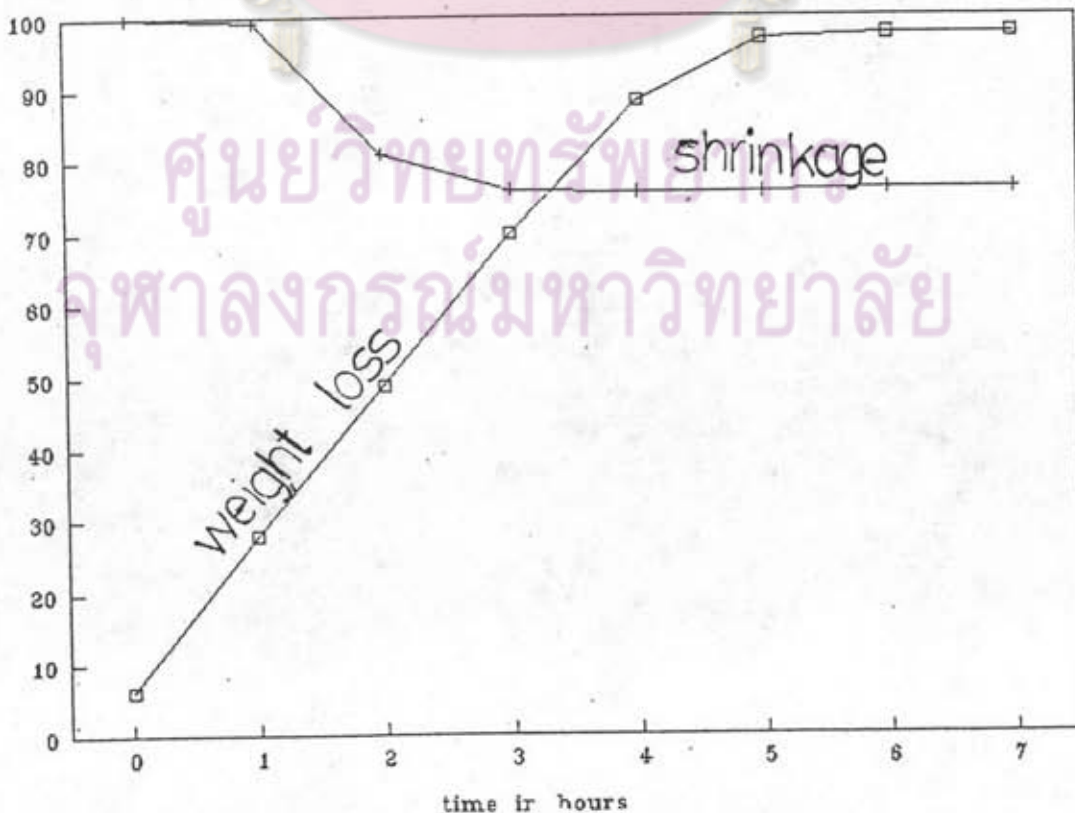
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drying 110 °C
%mass loss

												max	min	avg	std
5.66	5.62	6.06	5.4	6.73	6.6	7.5	6.18	6.03	6.22	6.39	6.29	7.5	5.4	6.22	0.538970
29.91	29.43	27.72	26.65	26.63	29.37	28.16	24.74	26.67	28.1	28.13	29.6	29.91	24.74	27.93	1.480165
53.31	51.85	53.53	48.26	46.77	51.55	47.54	42.58	46.29	47.91	46.67	49.19	53.53	42.58	48.79	3.109740
76.77	73.84	78.22	69.55	66.84	74.16	68.26	61.03	66.44	67.69	65.41	70.3	78.22	61.03	69.88	4.814144
94.47	93.17	93.6	89.06	85.74	91.73	85.74	78.49	84.71	87.26	84.73	89.57	94.47	78.49	88.19	4.469728
97.26	97.42	95.13	98.17	97.83	98.59	96.79	93.66	96.11	97.33	97.06	97.45	98.59	93.66	96.90	1.307465
97.35	97.5	95.22	98.38	98.91	98.68	97.86	97.43	97.38	97.54	97.72	97.56	98.91	95.22	97.63	0.884271
97.38	97.53	95.24	98.4	98.95	98.71	97.91	97.48	97.43	97.54	97.75	97.59	98.95	95.24	97.66	0.886993
												100	100	100	0
												100	100	100	0
100	100	100	100	100	100	100	100	100	100	100	100	100	100	99.37	0.977039
100	100	100	97.48	97.67	99.22	100	100	100	100	98.03	100	100	97.48	99.37	0.977039
78.67	82.11	79.46	72.13	93.54	73.13	85.7	84.08	83.7	83.36	74.72	82.29	93.54	72.13	81.07	5.718176
76.62	80.03	78.89	67.64	73.12	69.09	75.93	79.62	77.32	80.81	71.31	80.5	80.81	67.64	75.91	4.387851
73.12	80.03	78.89	67.64	73.12	69.09	75.93	79.62	77.32	80.81	71.31	80.5	80.81	67.64	75.62	4.446671
73.12	80.03	78.89	67.64	73.12	69.09	75.93	79.62	77.32	80.81	71.31	80.5	80.81	67.64	75.62	4.446671
73.12	80.03	78.89	67.64	73.12	69.09	75.93	79.62	77.32	80.81	71.31	80.5	80.81	67.64	75.62	4.446671
73.12	80.03	78.89	67.64	73.12	69.09	75.93	79.62	77.32	80.81	71.31	80.5	80.81	67.64	75.62	4.446671
73.12	80.03	78.89	67.64	73.12	69.09	75.93	79.62	77.32	80.81	71.31	80.5	80.81	67.64	75.62	4.446671

t	110 °C	%MASS LOS	%SHRINKAG
0	7.024	20.589	108.91
1	27.93	27.613	99.37
2	48.79	48.202	81.07
3	69.88	68.791	75.91
4	88.19	89.38	75.62
5	96.90	109.969	50.26
6	97.63	130.558	38.53
7	97.66	151.147	26.8

weight loss and shrinkage at 110 °C

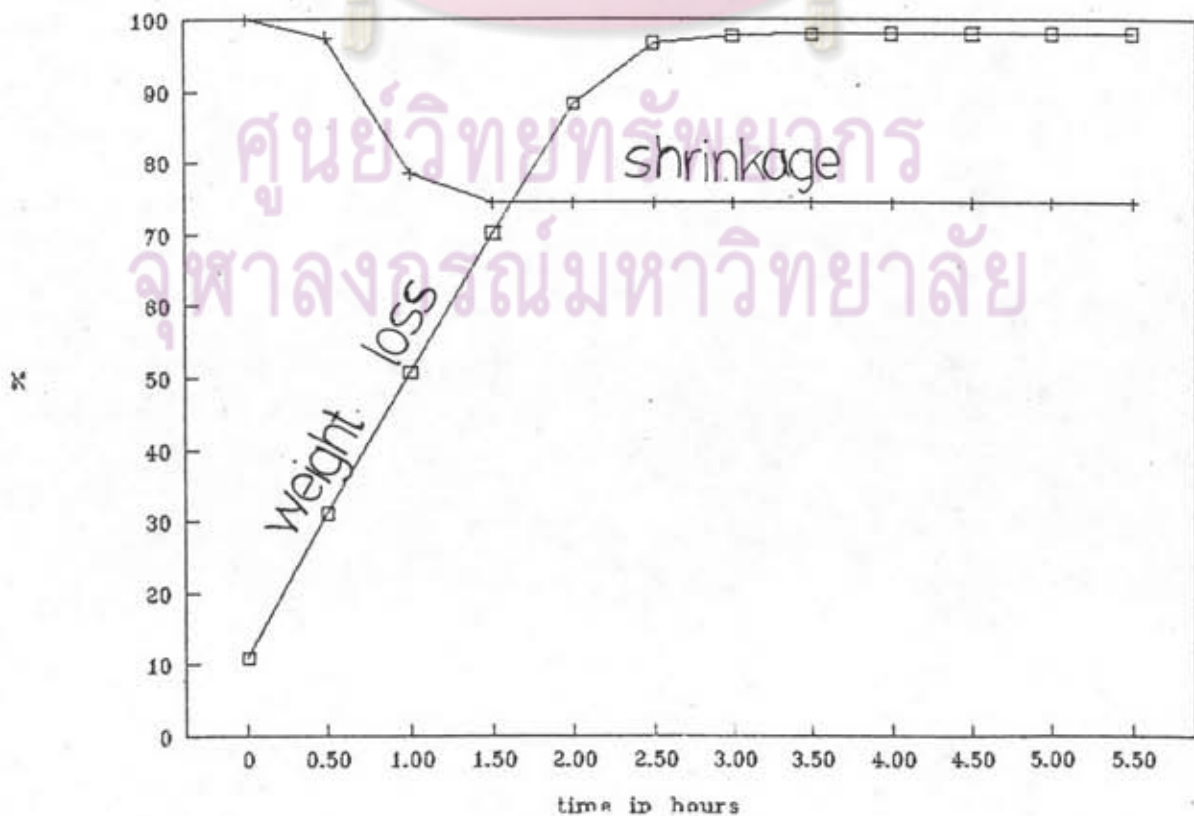


5 drying 150°C every 30 min

												max	min	avg	std
10.46	11.17	9.1	8.9	7.45	9.2	16.46	11.22	11.1	10.86	11.66	13.79	16.46	7.45	10.95	2.27777
32.79	32.07	32.34	30.1	28.11	31.01	35.15	29.17	30.49	29.74	29.12	33.68	35.15	28.11	31.15	2.003780
54.6	52.79	54.62	50.78	47.24	52.54	53.91	46.4	49.21	48.43	46.58	53.47	54.62	46.4	50.88	3.037681
74.77	72.96	77.09	70.68	65.81	72.83	66.69	64.85	69.15	68.79	64.85	74.12	77.09	64.85	70.22	3.983435
92.69	90.72	93.31	89.11	84.24	90.56	81.08	84.87	89.52	87.79	83.2	91.19	93.31	81.08	88.19	3.789619
98.74	98.58	98.6	97.12	95.53	97.14	90.91	96.06	98.07	96.45	95.21	97.32	98.74	90.91	96.68	2.071159
98.8	98.7	98.65	97.28	97.34	97.28	96.62	98.1	98.44	97.45	97.4	97.42	98.8	96.62	97.79	0.683288
98.89	98.79	98.74	97.34	97.37	97.34	98.24	98.15	98.48	97.54	97.49	97.49	98.89	97.34	97.99	0.596696
98.9	98.81	98.76	97.36	97.39	97.35	98.34	98.18	98.52	97.56	97.52	97.53	98.9	97.35	98.02	0.599108
98.93	98.83	98.78	97.37	97.41	97.37	98.72	98.17	98.51	97.56	97.51	97.51	98.93	97.37	98.06	0.629013
												100	100	100	0
shrinkage												100	100	100	0
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0
98.36	98.39	94.27	97.59	99.17	94.44	98.38	94.44	98.57	98.2	98.48	98.71	99.17	94.27	97.42	1.785106
74.95	78.63	72.87	78.99	76.51	75.61	82.41	75.61	82.31	78.83	82.3	82.3	82.41	72.87	78.44	3.214229
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153
72.81	76.36	70.94	77.14	72.21	74.13	75.15	74.13	73.9	75.06	75.4	75.4	77.14	70.94	74.39	1.684153

t	%MASS LOS	150°C	%SHRINKAG
0	10.95	12.495	100
0.50	31.15	31.541	97.42
1.00	50.88	50.587	78.44
1.50	70.22	69.633	74.39
2.00	88.19	88.679	60.38666
2.50	96.68	107.725	48.87166
3.00	97.79	126.771	37.35666
3.50	97.99	145.817	25.84166
4.00	98.02	164.863	14.32666
4.50	98.06	183.909	2.811666
5.00	98.02	202.955	-8.70333
5.50	98.06	222.001	-20.2183

weight loss and shrinkage at 150 °C

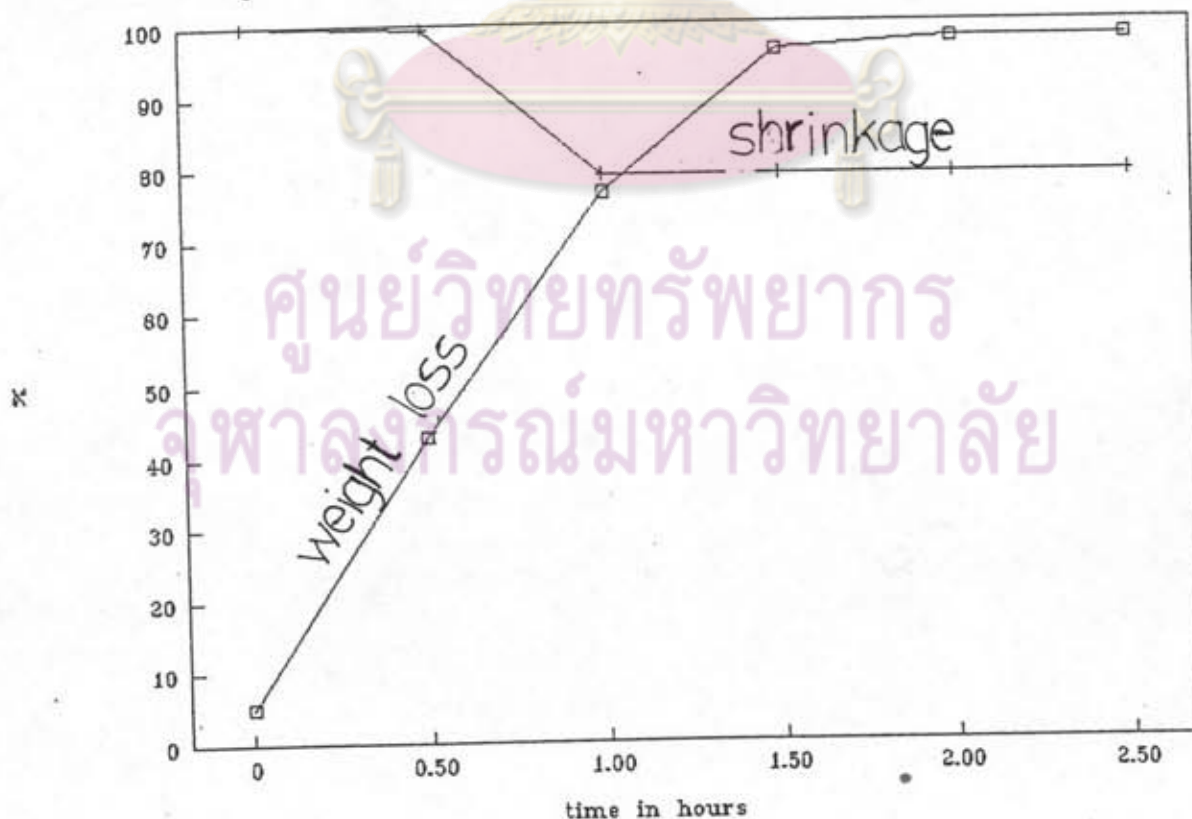


6 drying 200 °C every 30 min

												max	min	avg	std
Mass loss												7.61	3.43	4.96	1.254497
3.43	3.95	4.42	3.49	4.45	4.28	7.61	6.99	5.93	5.03	4.62	5.34	7.61	3.43	4.96	1.254497
38.02	35.16	39.59	46.42	44.73	48.38	47.9	42.49	45.27	41.79	40.03	43.39	48.38	35.16	42.76	3.880726
71.72	66.24	72.31	79.29	80.1	83.86	84.08	74.29	82.33	74.38	71.87	77.94	84.08	66.24	76.53	5.361171
96	93.63	95.26	96.61	96.95	97.06	98.11	95.75	96.52	96.02	95.3	97.16	98.11	93.63	96.20	1.107385
98.36	98.59	98.58	97.23	97.14	97.26	98.37	96.56	96.8	97.91	98.12	98.11	98.59	96.56	97.76	0.682928
98.49	98.76	98.76	97.3	97.25	97.37	98.51	96.72	96.92	97.98	98.2	98.19	98.76	96.72	97.87	0.694375
shrinkage												100	100	100	0
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0
100	100	100	95.65	98.32	99.33	100	100	100	100	100	100	100	95.65	99.44	1.240059
82.54	77.3	81.58	75.44	76.51	76.35	83.59	80.33	77.51	79.31	77.59	79.66	83.59	75.44	78.98	2.509051
82.54	77.3	81.58	75.44	76.51	76.35	83.59	80.33	77.51	79.31	77.59	79.66	83.59	75.44	78.98	2.509051
82.54	77.3	81.58	75.44	76.51	76.35	83.59	80.33	77.51	79.31	77.59	79.66	83.59	75.44	78.98	2.509051
82.54	77.3	81.58	75.44	76.51	76.35	83.59	80.33	77.51	79.31	77.59	79.66	83.59	75.44	78.98	2.509051
82.54	77.3	81.58	75.44	76.51	76.35	83.59	80.33	77.51	79.31	77.59	79.66	83.59	75.44	78.98	2.509051

t	200 °C	5.631666	119.9
0	% MASS LOS	71.57	% SHRINKAGE -40.92
0.50	4.96	5.631666	100
1.00	42.76	41.41666	99.44
1.50	76.53	77.20166	78.98
2.00	96.20	112.9866	78.98
2.50	97.76	148.7716	78.98
	97.87	184.5566	78.98

weight loss and shrinkage at 200 °C



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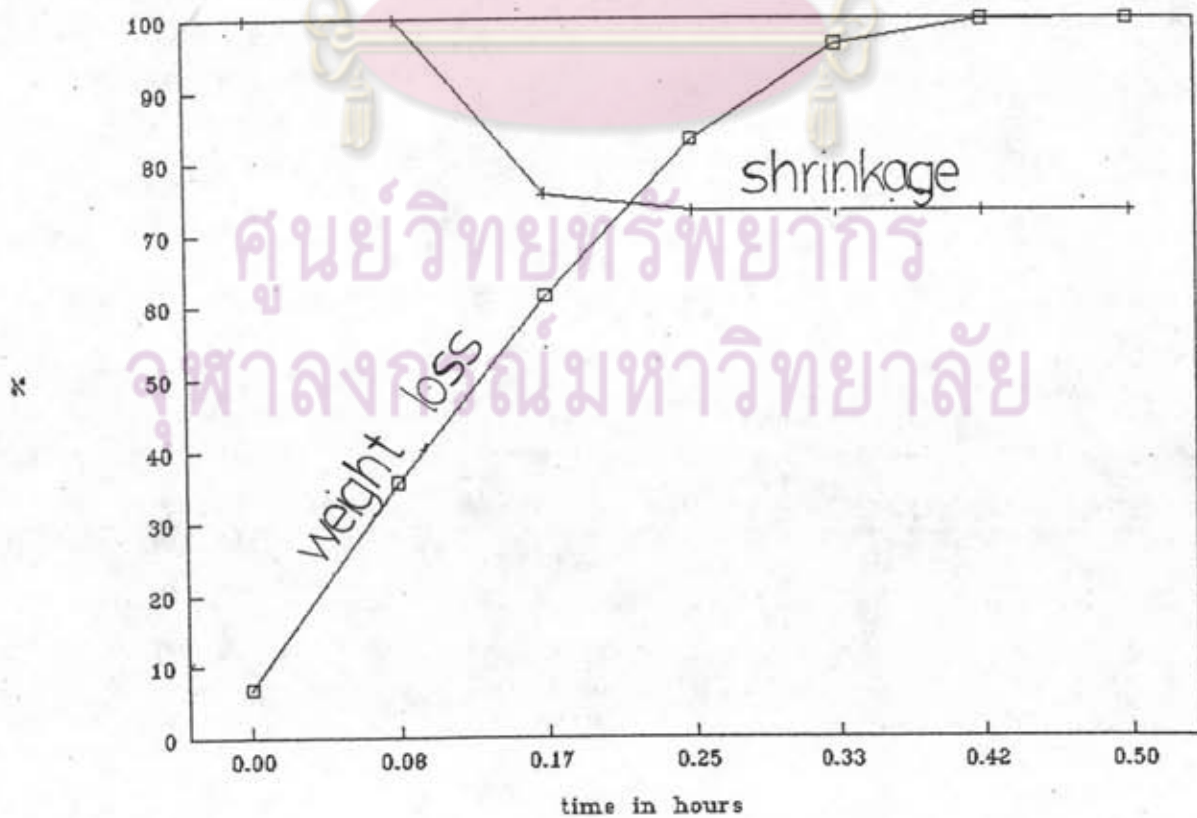
7 drying 300°C every 5 min

%mass loss					max	min	avg
6.15	6.46	11.56	4.64	5	11.56	4.64	6.76
33.89	35.75	40.45	34.43	33.65	40.45	33.65	35.63
62.96	66.54	69.38	55.53	53.31	69.38	53.31	61.54
86.75	84.38	91.55	77.9	75.68	91.55	75.68	83.25
98.07	94.33	101.07	95.74	93.25	101.07	93.25	96.49
99.12	98.77	101.33	100.31	99.72	101.33	98.77	99.85
99.14	99.35	101.35	100.33	99.85	101.35	99.14	100.00

%shrinkage					100	100	100
100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100
75.53	77.01	72.55	78.53	74.63	78.53	72.55	75.65
74.6	75.53	70.51	74.34	71.72	75.53	70.51	73.34
74.6	75.53	70.51	74.34	71.72	75.53	70.51	73.34
74.6	75.53	70.51	74.34	71.72	75.53	70.51	73.34
74.6	75.53	70.51	74.34	71.72	75.53	70.51	73.34
74.6	75.53	70.51	74.34	71.72	75.53	70.51	73.34

t	300°C MASS LOS	8.5	ASHRINKAG	124.4
0.00	6.76	8.488	100	124.35
0.08	35.63	34.026	100	100
0.17	61.54	59.564	75.65	75.65
0.25	83.25	85.102	73.34	51.3
0.33	96.49	110.64	73.34	26.95
0.42	99.85	136.178	73.34	2.6
0.50	100.00	161.716	73.34	-21.75

weight loss and shrinkage at 300 °C



Compare (different parameter)

- 1 ratio of SiO₂:NH₄F
- 2 weight of gel (in mold)
- 3 kinds of support
- 4 cotton around sample
- 5 humidity
- 6 size

1 ratio 40:60,43:57 at 110°C every 1 hr.

%mass loss time	ratio 40:60				ratio 43:57			
	0	1	2	3	4	5	6	7
	5.38	33.94	60.02	83.88	97.70	99.29	99.29	99.29
	9.268	32.726	56.184	79.642	103.1	126.558	9.268	173.474
	6.22	27.93	48.79	69.88	88.19	96.9	97.63	97.66
	7.024	27.613	48.202	68.791	89.38	109.969	7.024	151.147
%shrinkag	98.08	90.43	82.79	75.14	67.19	59.86	98.08	44.57
	-7.64	99.37	81.07	75.91	75.62	75.62	75.62	75.62
	100	93.10	87.43	81.77	76.10	70.43	98.76	59.10

2 weight of gel (in mold g.) at 70°C every 1hr.

%mass loss time	9.423333		11.28095		100.7376		100.642	
	31 g.	11.58	27 g.	12.59828	31 g.	-6.34971	27 g.	-7.21
0	8.69	9.42	9.41	11.28	100	100.74	100	100.64
1	22.47	21.00	25.05	23.88	99.28	94.39	95.76	93.43
2	31.85	32.58	37.66	36.48	87.74	88.04	85.79	86.22
3	33.14	44.16	50.07	49.08	75.1	81.69	75.46	79.01
4	29.06	55.74	60.81	61.67	73.53	75.34	74.1	71.80
5	32.99	67.32	73.66	74.27	73.53	68.99	73.26	64.59
6	44.67	78.90	91.65	86.87	73.53	62.64	73.26	57.38
7	52.83	90.48	95.61	99.47	73.53	56.29	73.26	50.17
8	61.84	102.06	96.07	112.07	73.53	49.94	73.26	42.96

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3 kinds of support at 70°C every 1 hr.

3.1 refractory

3.2 refractory has many holes

3.3 steel support has many holes

time	3.1	6.582	3.2	7.706	3.3	6.486
0	6.27	6.58	6.37	7.71	4.78	6.49
1	16.16	16.60	20.50	19.87	23.61	22.32
2	27.60	26.61	33.17	32.03	39.61	38.15
3	37.20	36.62	45.35	44.19	53.99	53.98
4	45.82	46.64	54.75	56.35	68.74	69.81
5	67.91	56.65	87.97	68.51	82.44	85.64
6	77.50	66.67	95.43	80.67	92.46	101.47
7	85.98	76.68	100.02	92.83	97.52	117.30

%shrinkage

3.1	3.2	3.3
100	100	100
100	100	99.65
91.85	92.36	85.65
83.12	77.66	76.17
74.51	71.61	71.79
67.56	71.04	71.79
67.56	71.04	71.79
67.56	71.04	71.79

4 cotton at 70°C every 1 hr.

4.1 around sample

4.2 no have

%mass loss

time	4.1	4.1	4.2	4.2	avg(4.1)	avg(4.2)
0	8.69	5.38	11.77	6.37	7.035	9.07
1	22.47	21.34	19.61	20.5	21.905	20.055
2	31.85	36.24	33.72	33.17	34.045	33.445
3	33.14	34.89	45.8	45.35	34.015	45.575
4	29.06	32.47	57.25	54.75	30.765	56
5	32.99	37.45	69.47	66.94	35.22	68.205
6	44.67	52.56	87.59	87.97	48.615	87.78
7	52.83	62.5	96.54	95.43	57.665	95.985
8	61.84	73.48	100.75	100.02	67.66	100.385

%shrinkage

time	4.1	4.1	4.2	4.2	avg(4.1)	avg(4.2)
0	100	100	100	100	100	100
1	99.28	89.31	100	92.36	94.295	96.18
2	87.74	76.23	93.42	77.66	81.985	85.54
3	75.1	72.16	78.66	71.61	73.63	75.135
4	75.1	72.16	70.1	71.04	73.63	70.57
5	73.53	70.69	70.1	71.04	72.11	70.57
6	73.53	70.69	70.1	71.04	72.11	70.57
7	73.53	70.69	70.1	71.04	72.11	70.57
8	73.53	70.69	70.1	71.04	72.11	70.57

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5 humidity

5.1 high humidity (porous refractory)

5.2 high humidity (steel has holes)

5.3 low humidity (porous refractory)

5.4 low humidity (steel has holes)

%mass loss

time	5.1	5.2	avg	5.3	5.4	
0	8.69	9.14	10.97	10.06	5.38	4.78
1	22.47	20.46	22.55	21.51	21.34	23.61
2	31.85	29.78	32.72	31.25	36.24	39.61
3	33.14	38.97	42.91	40.94	34.89	53.99
4	29.06	47.09	51.63	49.36	32.47	68.74
5	32.99	55.81	60.9	58.36	37.45	82.44
6	44.67	64.77	70.33	67.55	52.56	95.46
7	52.83	73.85	79.74	76.80	62.5	97.52
8	61.84	82.38	88.02	85.20	73.48	97.92
		95.06	97.62			
		99.75	100.62			

6 size

6.1 small size (steel has holes)

6.2 big size (steel has holes)

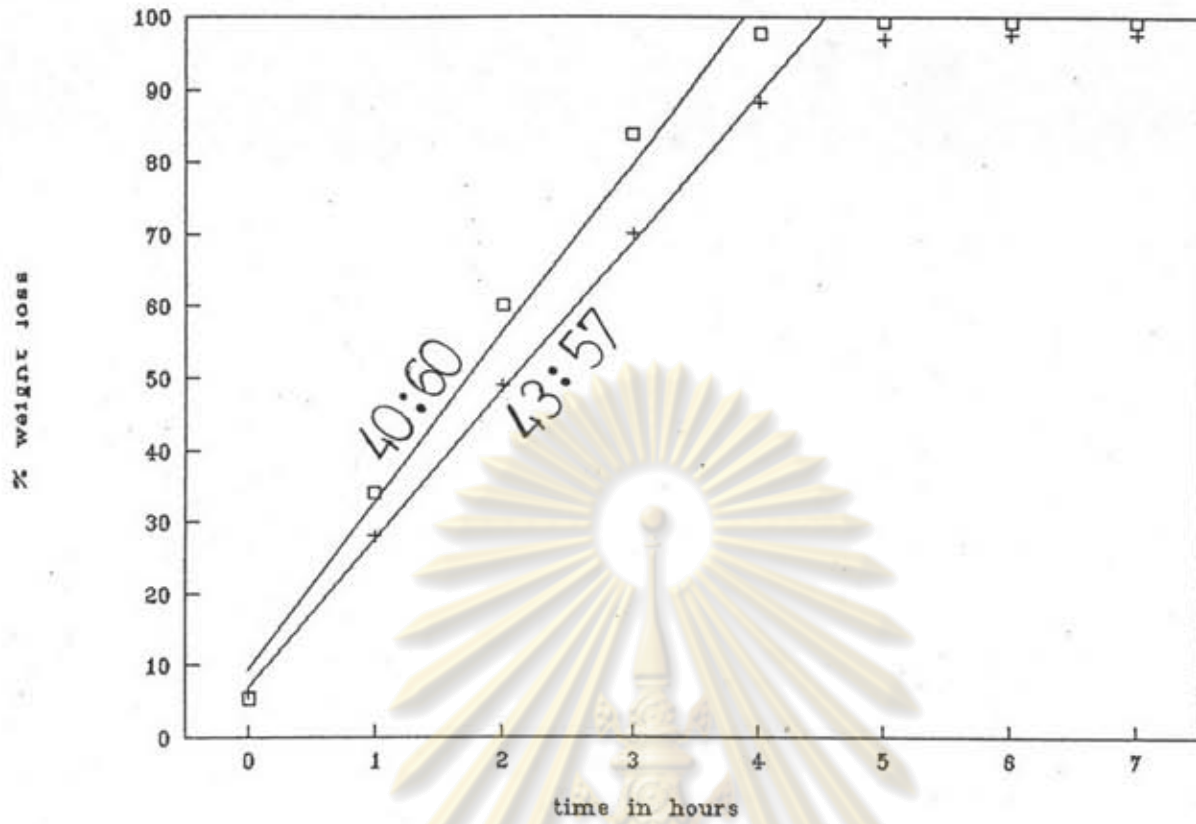
%mass loss

time	6.1	avg	6.2				
0	16.07	16.06	16.08	18.67	16.73	16.72	4.78
1	67.15	65.65	67.13	76.09	68.48	68.90	23.61
2	95.17	93.98	94.74	98.31	95.46	95.53	39.61
3	98.41	98.83	98.78	98.73	98.71	98.69	53.99
4							68.74
5							82.44
6							95.46
7							97.52
8							97.92

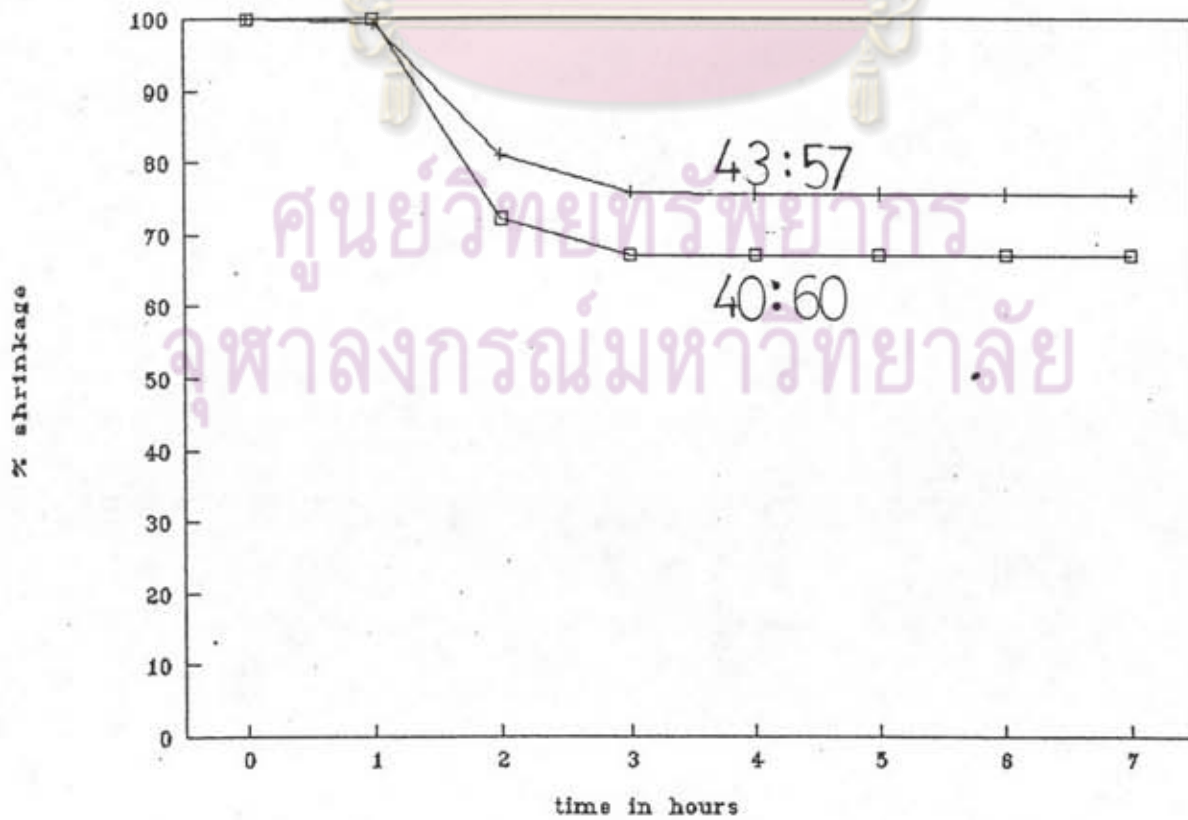
%shrinkage

time	5.1	5.2	avg	5.3	5.4	
0	100	100	100	100	100	
1	99.28	100	98.26	99.13	100	99.65
2	87.74	89.93	87.71	88.82	89.31	85.65
3	75.1	81.66	76.62	79.14	76.23	76.17
4	75.1	70.38	72.99	71.69	72.16	71.79
5	73.53	70.38	72.99	71.69	72.16	71.79
6	73.53	70.38	72.99	71.69	70.69	71.79
7	73.53	70.38	72.99	71.69	70.69	71.79
8	73.53	70.38	72.99	71.69	70.69	71.79

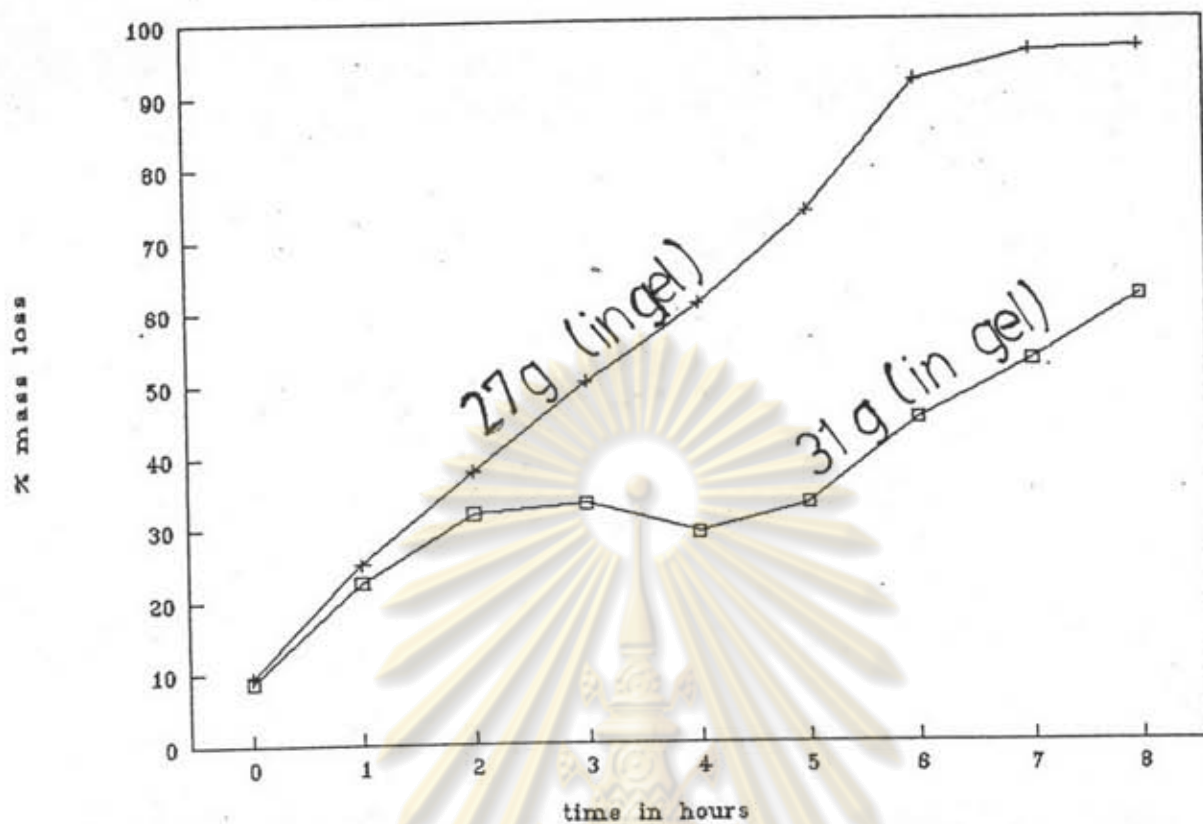
to compare % ratio $\text{SiO}_2:\text{NH}_4\text{F}$



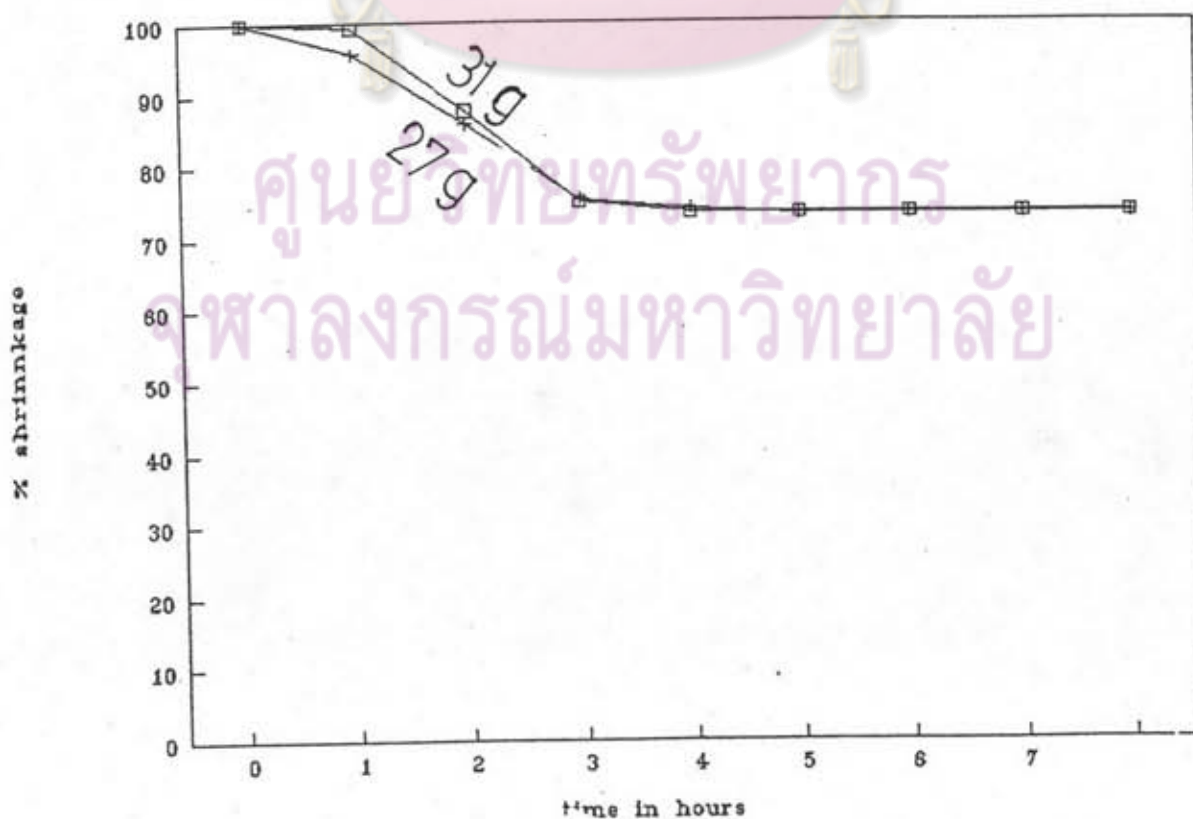
to compare % ratio $\text{SiO}_2:\text{NH}_4\text{F}$

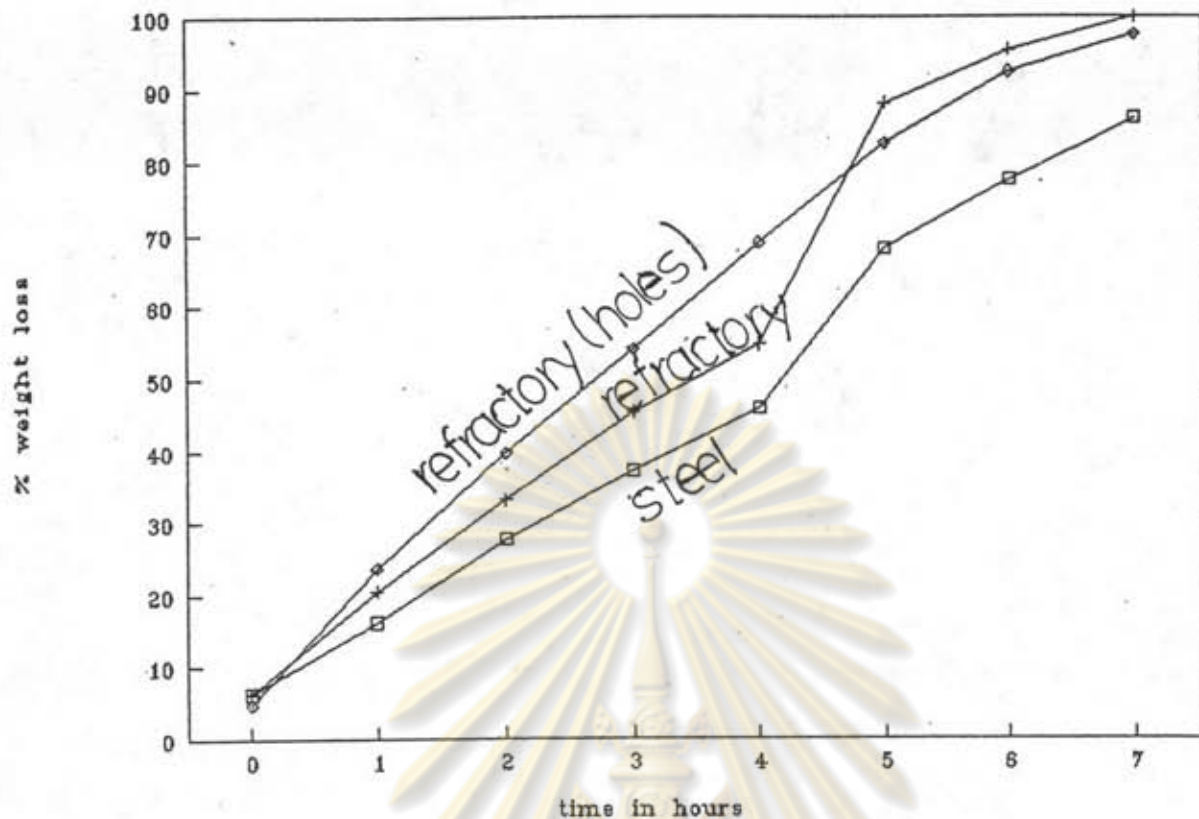


to compare weight of gel (in mold)

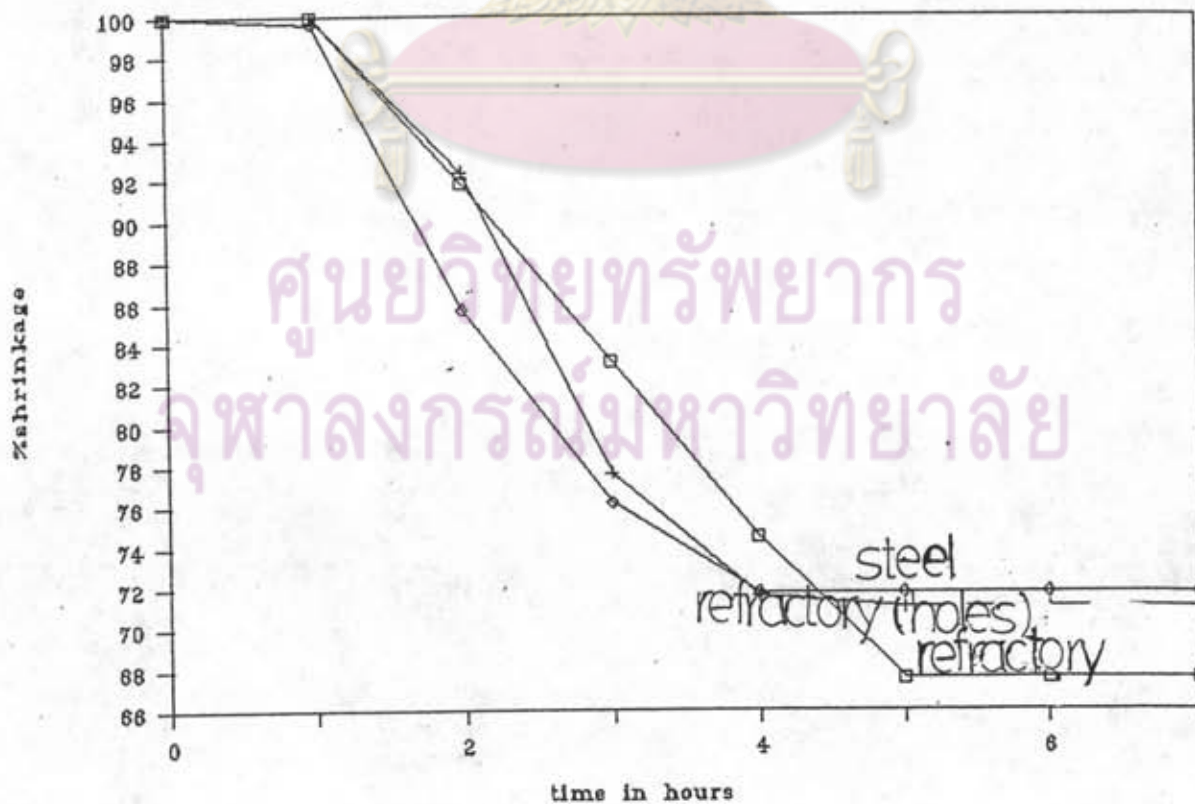


to compare weight silica in gel

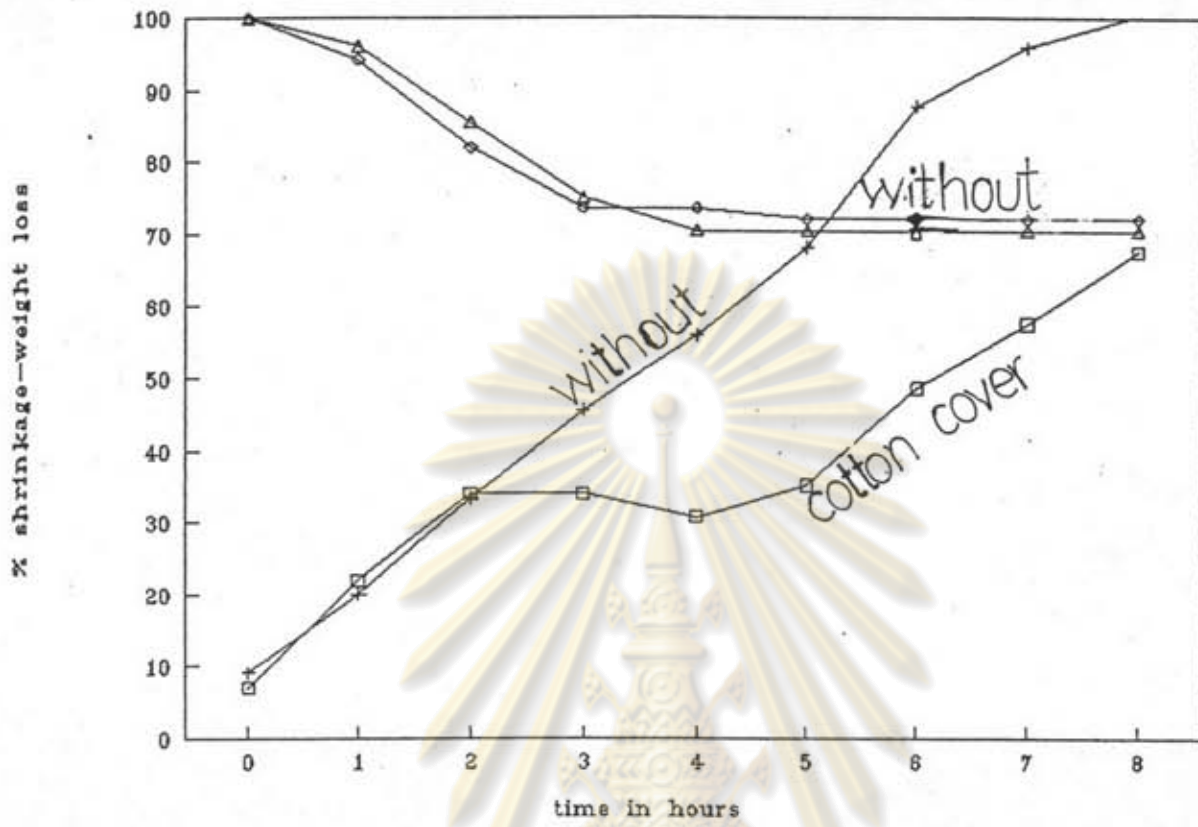




to compare kinds of support

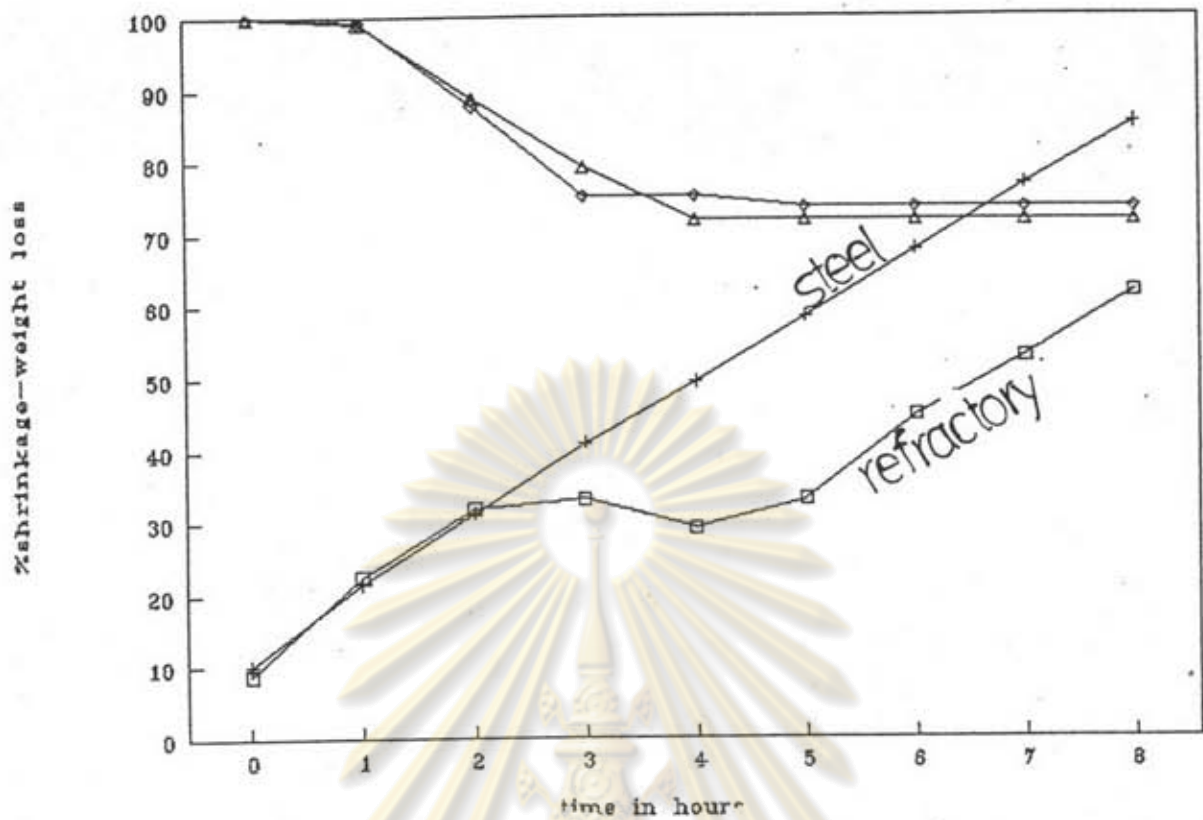


to compare cover cotton

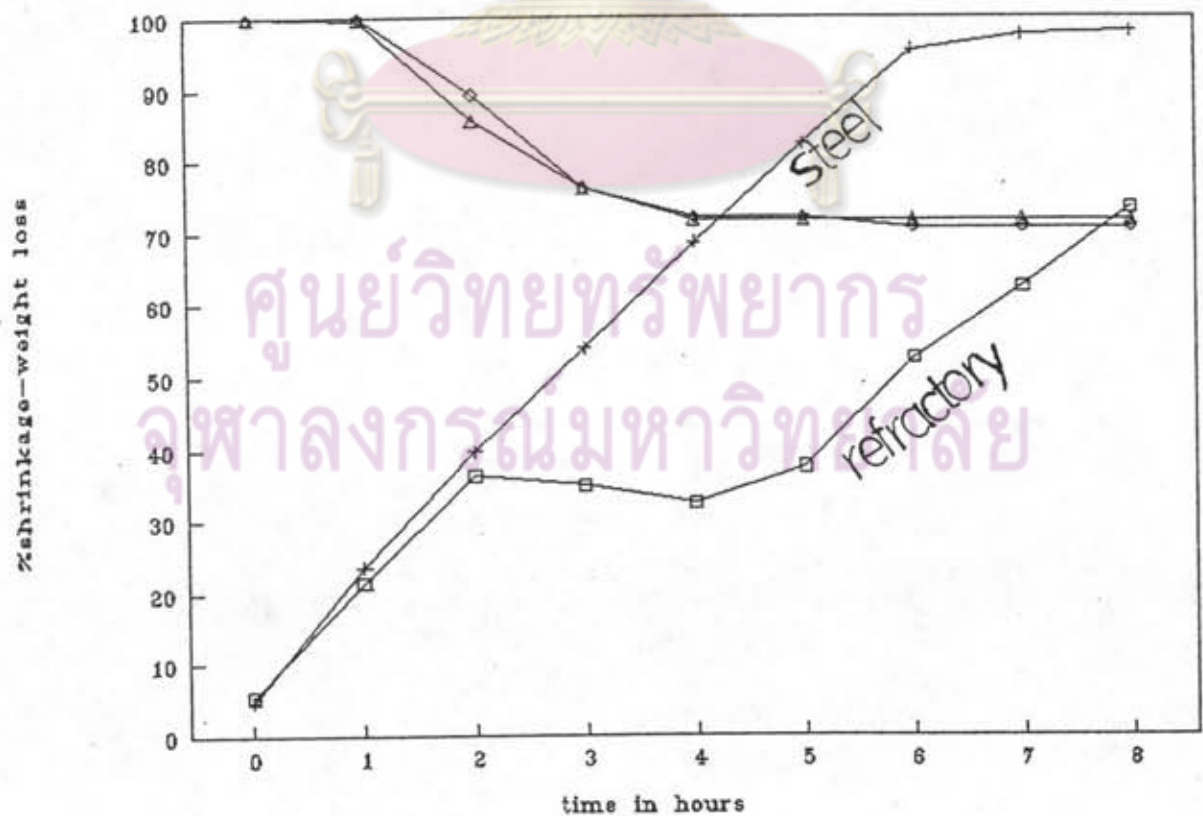


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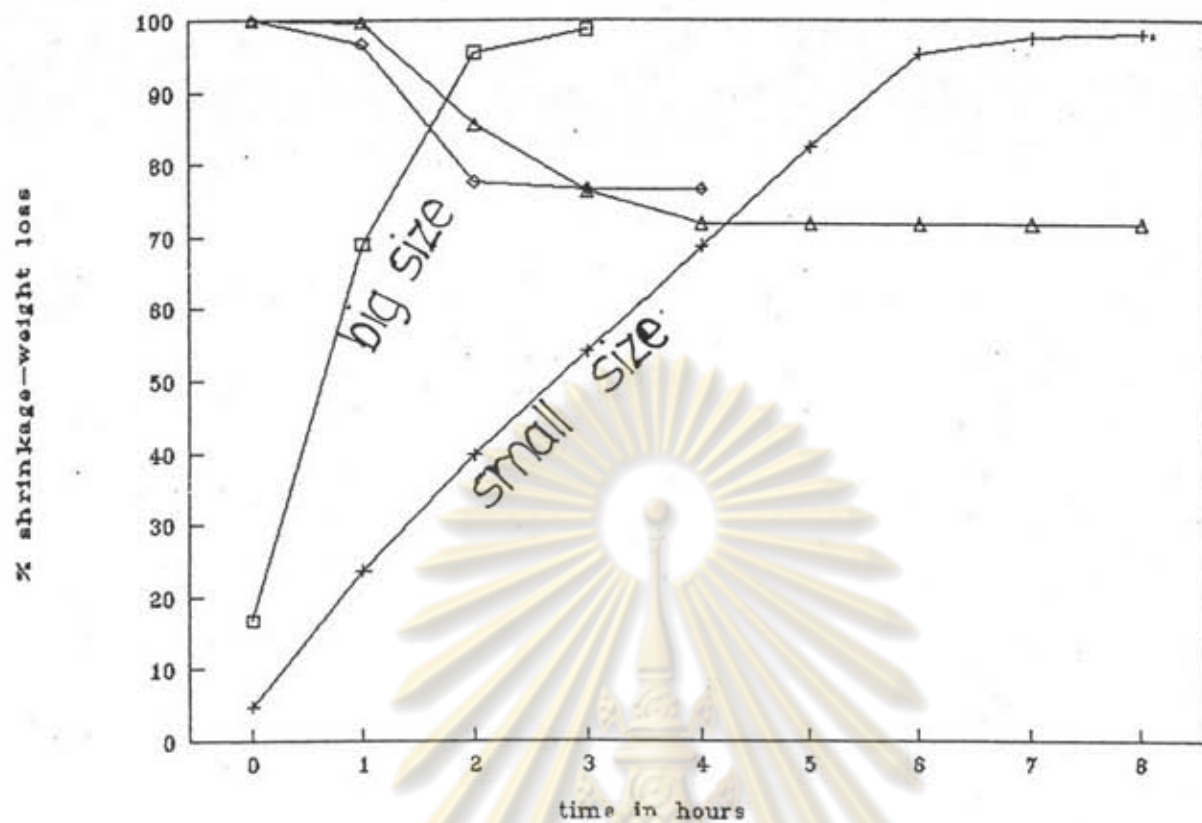
to compare high humidity(refract/steel)



to compare low humidity(refract/steel)



to compare big/small size (steel)



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CONTROL HUMIDITY
1. 70% RE.HV (water bath 70°C/62°C)

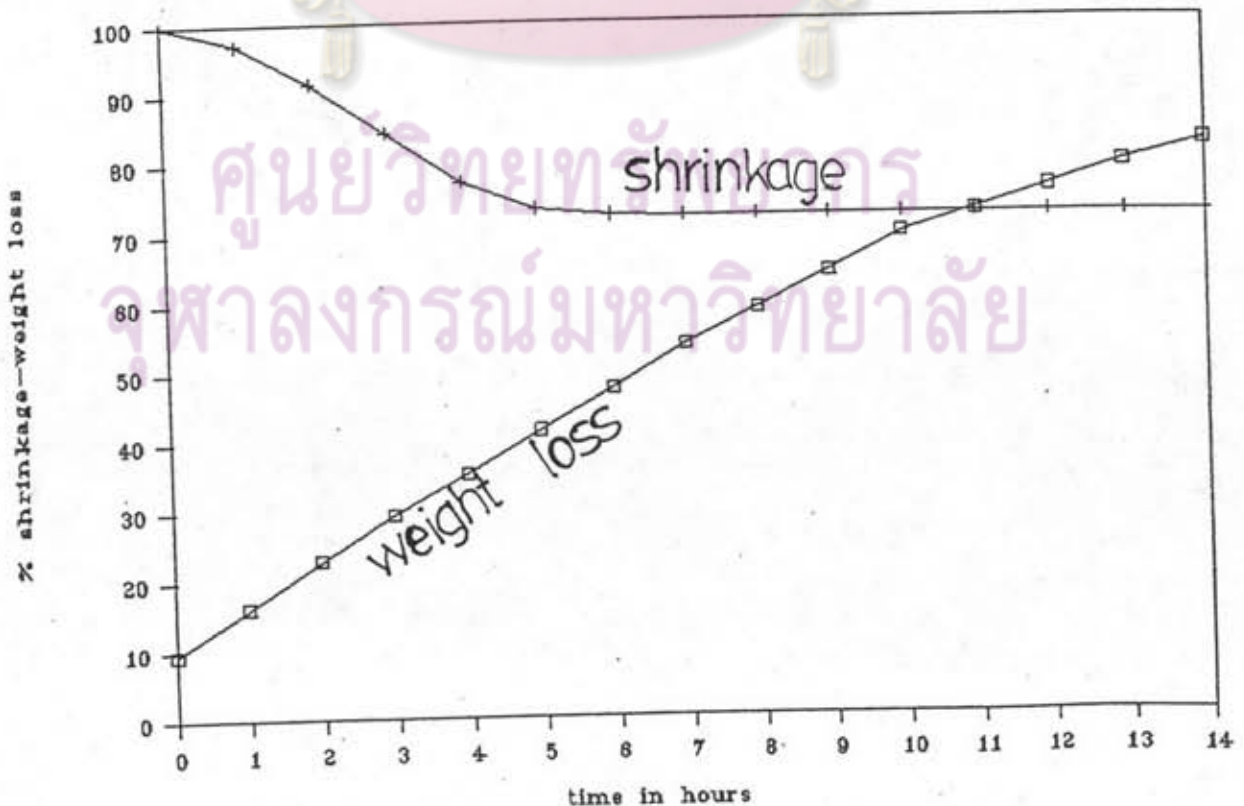
10.06019
6.257014

time	mass loss						avg	max	min	std
0	6.14	4.57	9.96	14.84	12.14	9.53	10.06	14.84	4.57	3.76
1	12.07	15.95	15.60	18.31	17.93	16.13	16.32	18.31	12.07	1.95
2	20.06	26.86	21.90	22.10	23.81	22.95	22.57	26.86	20.06	2.29
3	28.90	35.73	27.87	25.63	29.36	29.50	28.83	35.73	25.63	3.37
4	35.58	44.22	33.31	29.22	34.02	35.27	35.09	44.22	29.22	4.94
5	41.98	53.24	39.17	32.94	39.52	41.37	41.35	53.24	32.94	6.64
6	50.42	61.55	44.12	36.16	44.29	47.31	47.60	61.55	36.16	8.44
7	56.77	69.84	51.98	40.11	49.41	53.62	53.86	69.84	40.11	9.76
8	62.72	77.45	55.61	43.28	54.45	58.70	60.12	77.45	43.28	11.25
9	69.19	84.12	60.48	46.58	58.56	63.79	66.37	84.12	46.58	12.47
10	74.77	94.82	65.00	49.77	61.89	69.25	72.63	94.82	49.77	15.07
11	80.56	97.40	70.00	50.00	64.00	72.39	78.89	97.40	50.00	15.93
12	85.52	98.02	75.00	53.00	67.00	75.71	85.14	98.02	53.00	15.40
13	90.35	98.04	80.00	56.00	71.00	79.08	91.40	98.04	56.00	14.73
14	96.04	96.81	85.00	59.00	74.00	82.17	97.66	96.81	59.00	14.27
15	96.57	96.84	90.00	62.00	77.00	84.48	103.92	96.84	62.00	13.35
16	97.09	97.92	95.00	67.00	80.00	87.40	110.17	97.92	67.00	12.11
17	97.61	98.67	97.00	69.00	83.00	89.06	116.43	98.67	69.00	11.56
18	98.14	98.67	97.11	74.00	86.00	90.78	122.69	98.67	74.00	9.60
19	98.64	98.67	97.61	79.84	89.00	92.75	128.94	98.67	79.84	7.40
20	98.78	98.67	98.11	85.03	92.00	94.52	135.20	98.78	85.03	5.38

104.3333
-6.71666

linear shrinkage						avg	max	min	std	
100	100	100	100	100	100	100	104.33	100	100	0
100	100	100	95	93	95	97.17	97.62	100	93	2.91
97	95	90	89	89	89	91.50	90.90	97	89	3.25
89	87	79	84	85	82	84.33	84.18	89	79	3.25
80	76	72	77	82	76	77.17	77.47	82	72	3.18
75	72	72	71	78	71	73.17	70.75	78	71	2.54
72	72	72	71	75	71	72.17	64.03	75	71	1.34
71	72	72	71	75	71	72.00	57.32	75	71	1.41
71	72	72	71	75	71	72.00	50.60	75	71	1.41
71	72	72	71	75	71	72.00		75	71	1.41
71	72	72	71	75	71	72.00		75	71	1.41
71	72	72	71	75	71	72.00		75	71	1.41
71	72	72	71	75	71	72.00		75	71	1.41

70% re. hu. (70°C/62°C)



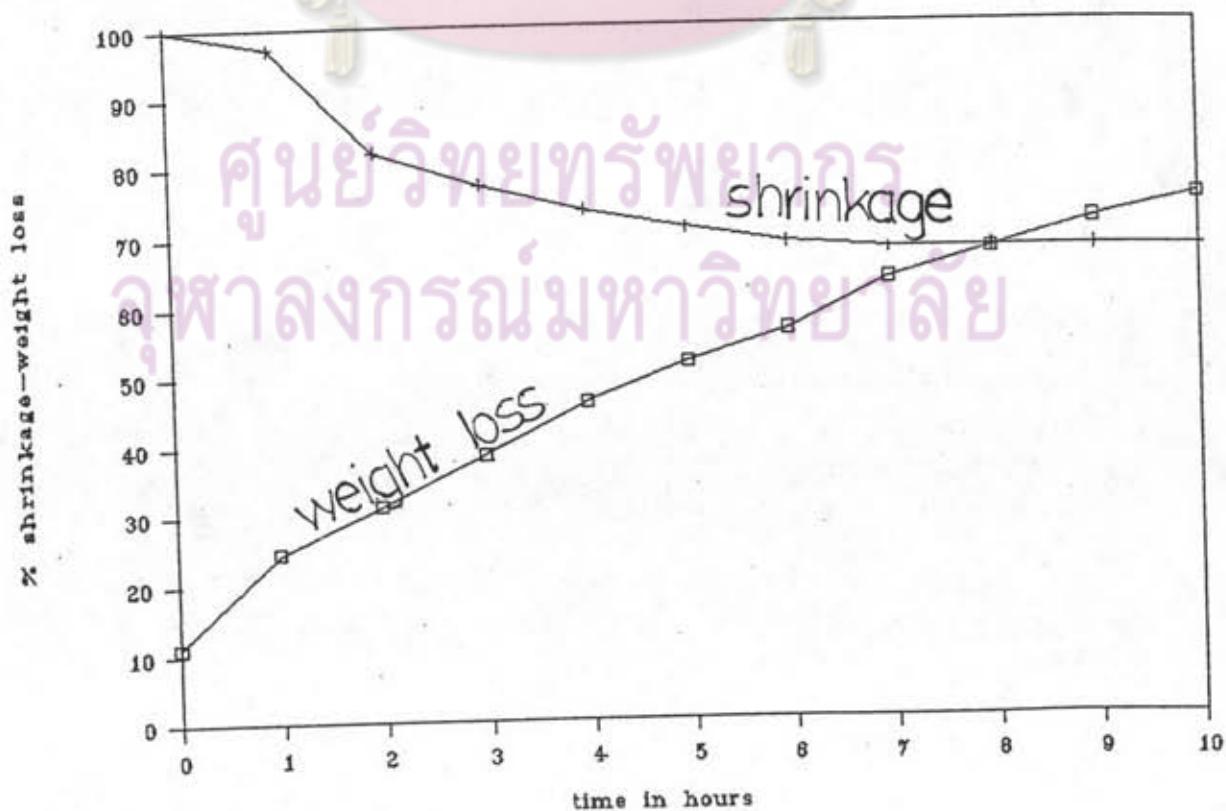
z. 70% re.hu (water bath 90°C/81°C)

time	mass loss					18.94472		max	min	std
	avg	6.366682								
0	9.90	12.29	12.55	9.87	11.14	11.15	6.37	12.55	9.90	1.19
1	26.95	29.74	23.95	20.05	22.09	24.56	12.73	29.74	26.95	1.40
2	35.03	36.53	29.21	25.50	29.98	31.25	19.10	36.53	35.03	0.75
3	45.25	46.57	33.78	30.45	36.57	38.52	25.47	46.57	45.25	0.66
4	57.10	55.72	38.56	34.97	43.11	45.89	31.43	57.10	55.72	0.69
5	65.13	63.23	42.28	38.87	48.17	51.54	38.20	65.13	63.23	0.95
6	73.80	65.33	45.22	42.36	52.98	55.94	44.57	73.80	65.33	4.24
7	80.07	67.43	53.41	50.61	64.40	63.18	50.93	80.07	67.43	6.32
8	86.80	69.64	56.75	54.14	69.19	67.30	57.30	86.80	69.64	8.58
9	93.58	71.09	60.25	58.14	74.49	71.51	63.67	93.58	71.09	11.24
10	96.65	74.73	62.73	61.36	79.30	74.95	70.03	96.65	74.73	10.96
11	97.20	78.74	65.93	64.33	83.80	78.00	76.40	97.20	78.74	9.23
12	97.20	82.00	69.77	67.94	88.67	81.12	82.77	97.20	82.00	7.60
13	97.20	86.00	73.41	72.25	93.23	84.42	89.13	97.20	86.00	5.60
14	97.20	90.00	76.60	76.30	97.82	87.58	95.50	97.20	90.00	3.60
15	97.20	94.00	79.38	79.74	99.68	90.00	101.87	99.68	94.00	1.60
16	97.20	98.00	81.37	83.01	100.05	91.93	108.23	100.05	97.20	0.40
17	97.20	98.00	84.55	86.50	100.09	93.27	114.60	100.09	97.20	0.40
18	97.20	98.00	91.27	94.13	100.09	96.14	120.97	100.09	97.20	0.40
19	97.20	98.00	95.87	97.84	100.09	97.64	127.33	100.09	97.20	0.40

linear shrinkage						-6.14		max	min	std
	avg									
100	100	100	100	100	100	98.54	100	100	0	
99	97	96	97	97	97.2	92.40	99	96	0.98	
81	76	79	87	87	82	86.26	87	76	4.38	
78	74	75	82	77	77.2	80.12	82	74	2.79	
77	74	68	76	72	73.4	73.98	77	68	3.20	
77	74	61	71	71	70.8	67.84	77	61	5.38	
77	74	58	67	66	68.4	61.70	77	58	6.65	
77	74	58	63	66	67.6	55.56	77	58	7.00	
77	74	58	63	66	67.6	49.42	77	58	7.00	
77	74	58	63	66	67.6	43.28	77	58	7.00	
77	74	58	63	66	67.6		77	58	7.00	
77	74	58	63	66	67.6		77	58	7.00	



70% re. hu. (90°C/81°C)



4. 50% re.hu. (water bath 70°C/54.80°C)

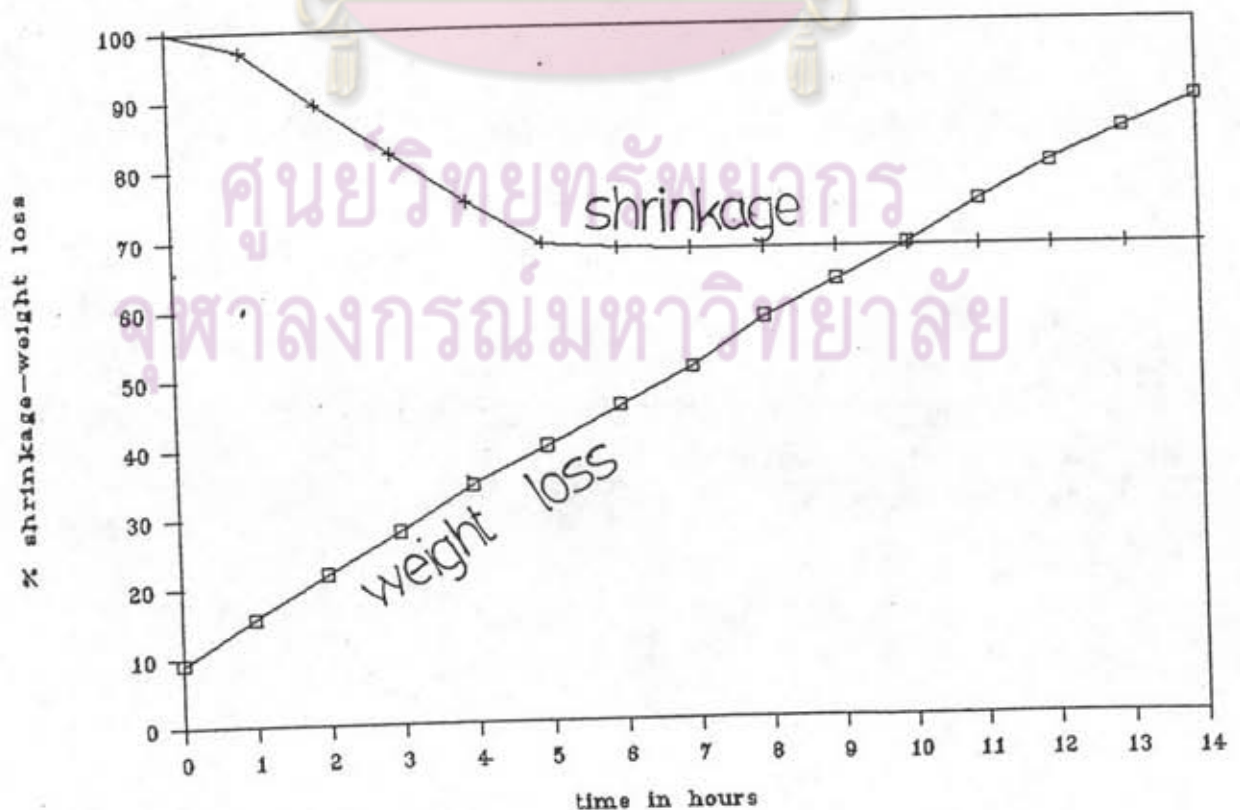
10.32398
5.794652

time	%mass loss					avg	max	min	std	
0	4.85	5.21	11.25	12.86	11.89	9.21	10.32	12.86	4.85	3.45
1	12.60	11.90	17.68	18.89	16.40	15.49	16.12	18.89	11.90	2.77
2	20.55	18.38	23.39	25.08	21.91	21.86	21.91	25.08	18.38	2.30
3	28.55	25.19	28.19	30.88	26.87	27.93	27.71	30.88	25.19	1.89
4	36.82	32.70	33.25	36.65	32.09	34.30	33.50	36.82	32.09	2.02
5	43.69	39.41	37.57	41.75	36.52	39.79	39.30	43.69	36.52	2.64
6	50.83	45.56	42.46	47.43	40.79	45.41	45.09	50.83	40.79	3.56
7	58.74	51.63	46.71	52.49	44.35	50.78	50.89	58.74	44.35	5.00
8	65.68	57.29	54.27	60.54	51.63	57.88	56.68	65.68	51.63	4.91
9	73.03	63.61	58.35	64.65	55.26	62.98	62.48	73.03	55.26	6.09
10	79.78	69.18	62.33	69.81	59.67	68.15	68.27	79.78	59.67	7.00
11	86.90	75.92	66.65	76.65	64.64	74.15	74.07	86.90	64.64	7.98
12	92.66	82.53	72.20	81.35	68.87	79.52	79.86	92.66	68.87	8.39
13	96.91	88.05	77.75	86.05	73.10	84.37	85.65	96.91	73.10	8.30
14	98.92	93.74	83.20	90.39	77.58	88.77	91.45	98.92	77.58	7.57
15	98.96	98.12	88.31	93.79	82.56	92.35	97.24	98.96	82.56	6.19
16	98.96	98.12	93.59	97.37	87.70	95.15	103.04	98.96	87.70	4.15

%linear shrinkage

		104.4166 -7.38333					avg	max	min	std
100	100	100	100	100	100	100	104.42	100	100.00	1.55
100	100	94	95	95	99	97.17	97.03	100	94.00	2.06
94	94	84	88	90	87	89.50	89.65	94	84.00	2.84
85	87	79	79	84	79	82.17	82.27	87	79.00	2.82
77	80	71	74	78	70	75.00	74.88	80	70.00	3.28
70	71	67	73	72	60	68.83	67.50	73	60.00	4.27
70	68	67	73	72	58	68.00	60.12	73	58.00	5.68
70	68	67	73	72	57	67.83	52.73	73	52.73	7.51
70	68	67	73	72	57	67.83	45.35	73	45.35	9.56
70	68	67	73	72	57	67.83	37.97	73	37.97	11.81
70	68	67	73	72	57	67.83	30.58	73	30.58	14.18
70	68	67	73	72	57	67.83	23.20	73	23.20	16.61
70	68	67	73	72	57	67.83	15.82	73	15.82	19.08

50% re. hu. (70°C/54.80°C)

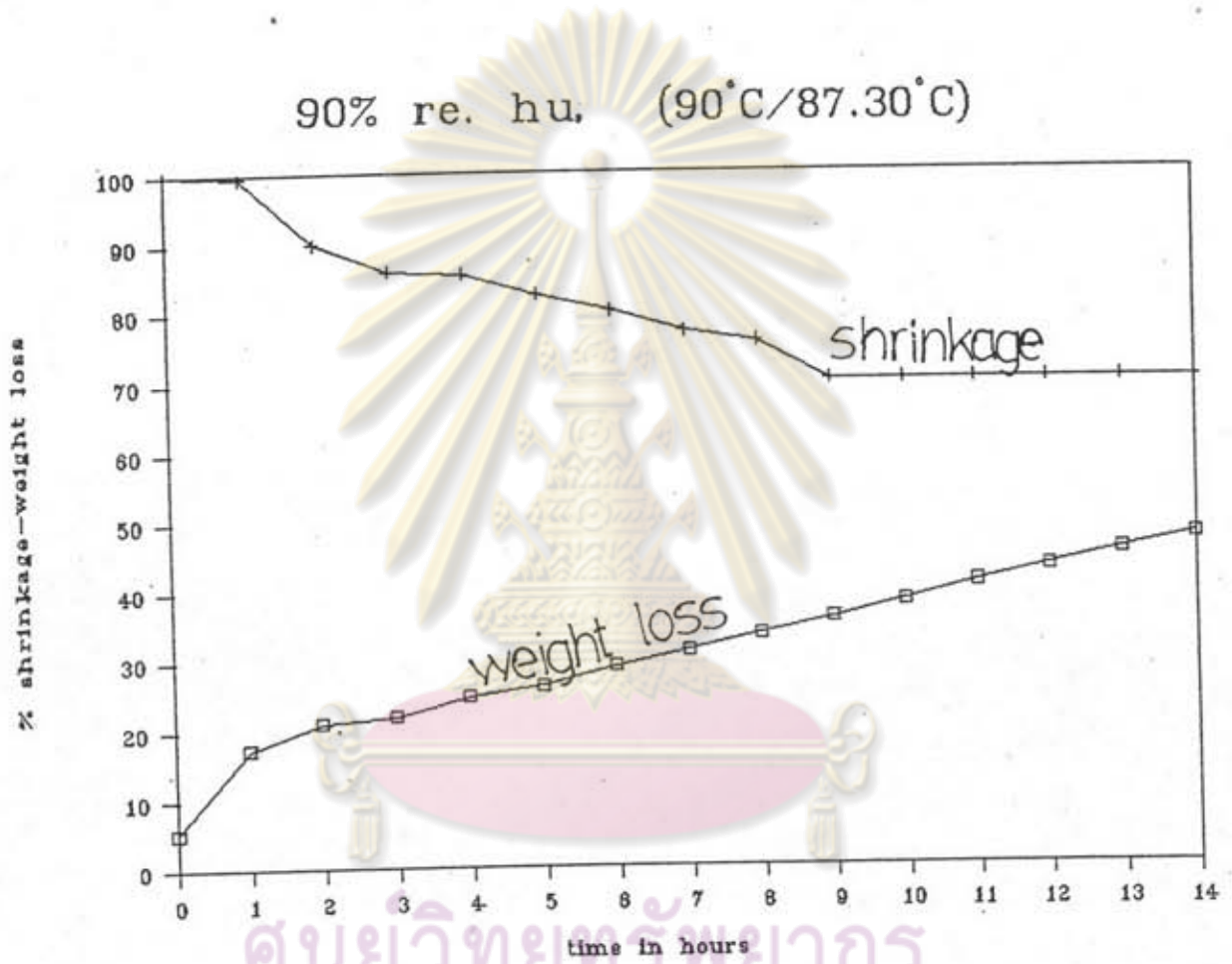


5. 90% re.hu. (water bath 90°C/87.3°C)

time	14.47160				max	min	std
%mass loss	2.365855						
0	5.48	5.14	5.31	14.47	5.48	5.14	0.17
1	18.01	16.72	17.36	28.94	18.01	16.72	0.65
2	22.17	19.79	20.98	43.41	22.17	19.79	1.19
3	24.04	19.94	21.99	57.89	24.04	19.94	2.05
4	27.10	22.33	24.72	72.36	27.10	22.33	2.39
5	27.10	25.35	26.23	86.83	27.10	25.35	0.88
6	29.91	27.81	28.86	101.30	29.91	27.81	1.05
7	33.35	28.90	31.12	115.77	33.35	28.90	2.23
8	35.38	31.40	33.39	130.24	35.38	31.40	1.99
9	37.65	33.66	35.65	144.72	37.65	33.66	2.00
10	39.91	36.16	38.04	159.19	39.91	36.16	1.88
11	42.18	39.17	40.68	173.66	42.18	39.17	1.51
12	44.45	41.42	42.94	188.13	44.45	41.42	1.51
13	46.46	43.93	45.20	202.60	46.46	43.93	1.27
14	48.48	46.18	47.33	217.07	48.48	46.18	1.15
15	50.75	48.44	49.59	231.55	50.75	48.44	1.15
16	53.77	50.69	52.23	246.02	53.77	50.69	1.54
17	56.79	53.20	55.00	260.49	56.79	53.20	.80
18	58.81	55.71	57.26	274.96	58.81	55.71	.55
19	60.82	58.21	59.52	289.43	60.82	58.21	.31
20	61.84	60.72	61.28	303.90	61.84	60.72	0.56
21	65.86	63.22	64.54	318.38	65.86	63.22	1.32
22	68.38	65.73	67.05	332.85	68.38	65.73	1.33
23	71.40	68.23	69.82	347.32	71.40	68.23	1.58
24	73.92	70.74	72.33	361.79	73.92	70.74	1.59
25	76.94	73.24	75.09	376.26	76.94	73.24	1.85
26	78.96	75.75	77.35	390.73	78.96	75.75	1.60
27	81.22	78.26	79.74	405.20	81.22	78.26	1.48
28	83.01	80.76	81.89	419.68	83.01	80.76	1.12
29	88.28	83.27	85.77	434.15	88.28	83.27	2.51
30	90.80	85.77	88.28	448.62	90.80	85.77	2.51
31	93.32	88.28	90.80	463.09	93.32	88.28	2.52
32	95.33	90.78	93.06	477.56	95.33	90.78	2.27
33	97.85	93.29	95.57	492.03	97.85	93.29	1.28
34	98.86	95.79	97.33	506.51	98.86	95.79	1.53
35	98.86	98.30	98.58	520.98	98.86	98.30	1.28

linear shrinkage 95.4 -2.55

	avg			max	min	std
100	100	100	95.40	100	100	0
99	100	99.50	92.85	100	99	0.50
89	91	90.00	90.30	91	89	1.00
84	88	86.00	87.75	88	84	2.00
83	88	85.50	85.20	88	83	2.50
79	86	82.50	82.65	86	79	3.50
76	84	80.00	80.10	84	76	4.00
73	81	77.00	77.55	81	73	4.00
72	79	75.50	75.00	79	72	3.50
70	70	70.00	72.45	70	70	0.00
70	70	70.00	69.90	70	70	0.00
70	70	70.00	67.35	70	70	0.00
70	70	70.00		70	70	0.00
70	70	70.00		70	70	0.00
70	70	70.00		70	70	0.00



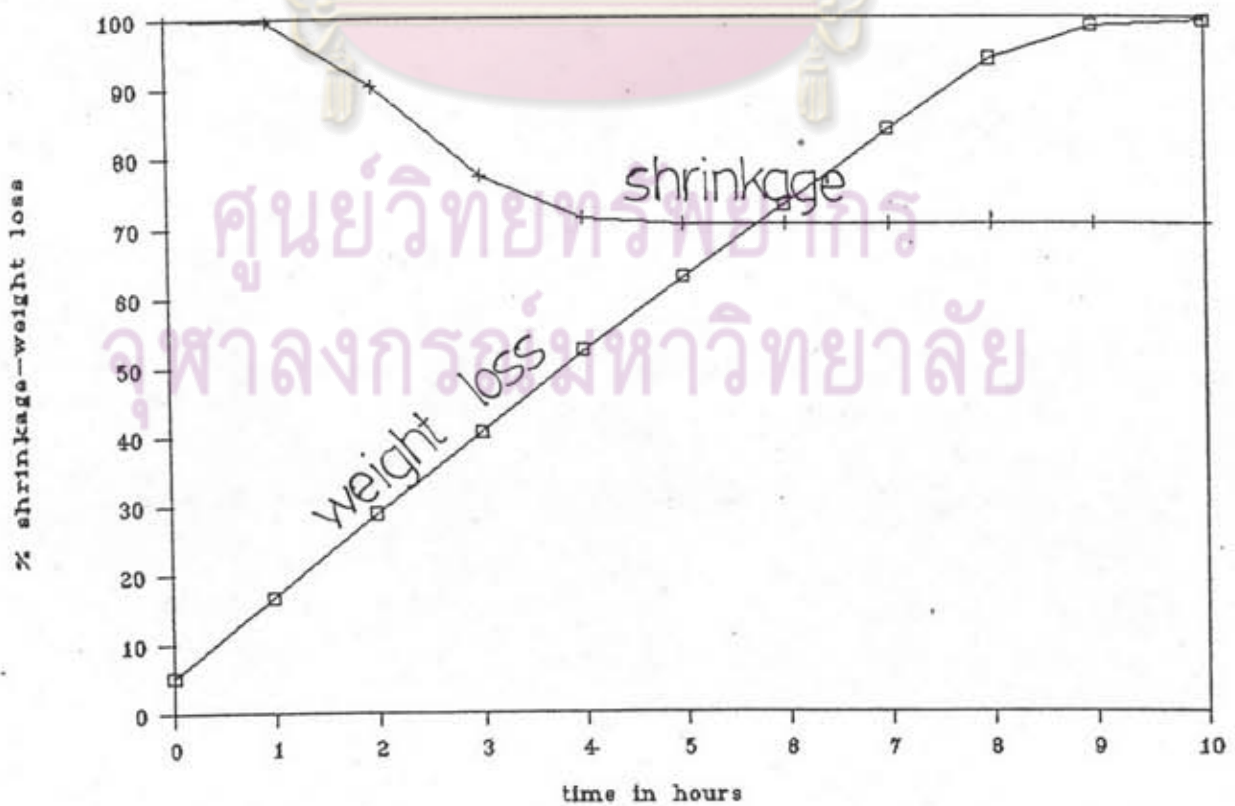
ศูนย์วิจัยทรัพยากร
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6. 30% re. hu. (water bath 90°C/61.43°C)

time	6.326131					max	min	std
	%mass loss							
0	7.42	4.03	4.14	5.20	6.33	7.42	4.03	1.57
1	21.25	15.99	12.97	16.74	17.45	21.25	12.97	3.42
2	34.97	28.71	22.80	28.83	28.58	34.97	22.80	4.97
3	49.15	40.32	32.18	40.55	39.70	49.15	32.18	6.93
4	63.12	51.85	42.07	52.35	50.83	63.12	42.07	8.60
5	71.62	63.94	52.81	62.79	61.95	71.62	52.81	7.72
6	80.28	75.58	63.46	73.11	73.08	80.28	63.46	7.08
7	88.66	86.86	76.02	83.85	84.20	88.66	76.02	5.58
8	95.39	98.15	88.59	94.04	95.33	98.15	88.59	4.02
9	99.11	99.16	97.96	98.74	106.45	99.16	97.96	0.55
10	99.87	99.40	99.28	99.52	117.58	99.87	99.28	0.25

time	109.1666					max	min	std
	%linear shrinkage							
100	100	100	100	100	109.17	100	100	0
100	100	99	99	99.67	99.37	100	99	0.47
92	94	85	90.33	89.57	94	85	3.86	
78	84	70	77.33	79.77	84	70	5.73	
71	74	69	71.33	69.97	74	69	2.05	
71	71	69	70.33	60.17	71	69	0.94	
71	71	69	70.33	50.37	71	69	0.94	
71	71	69	70.33		71	69	0.94	
71	71	69	70.33		71	69	0.94	
71	71	69	70.33		71	69	0.94	
71	71	69	70.33		71	69	0.94	

30% re. hu. (90 °C/61.43 °C)

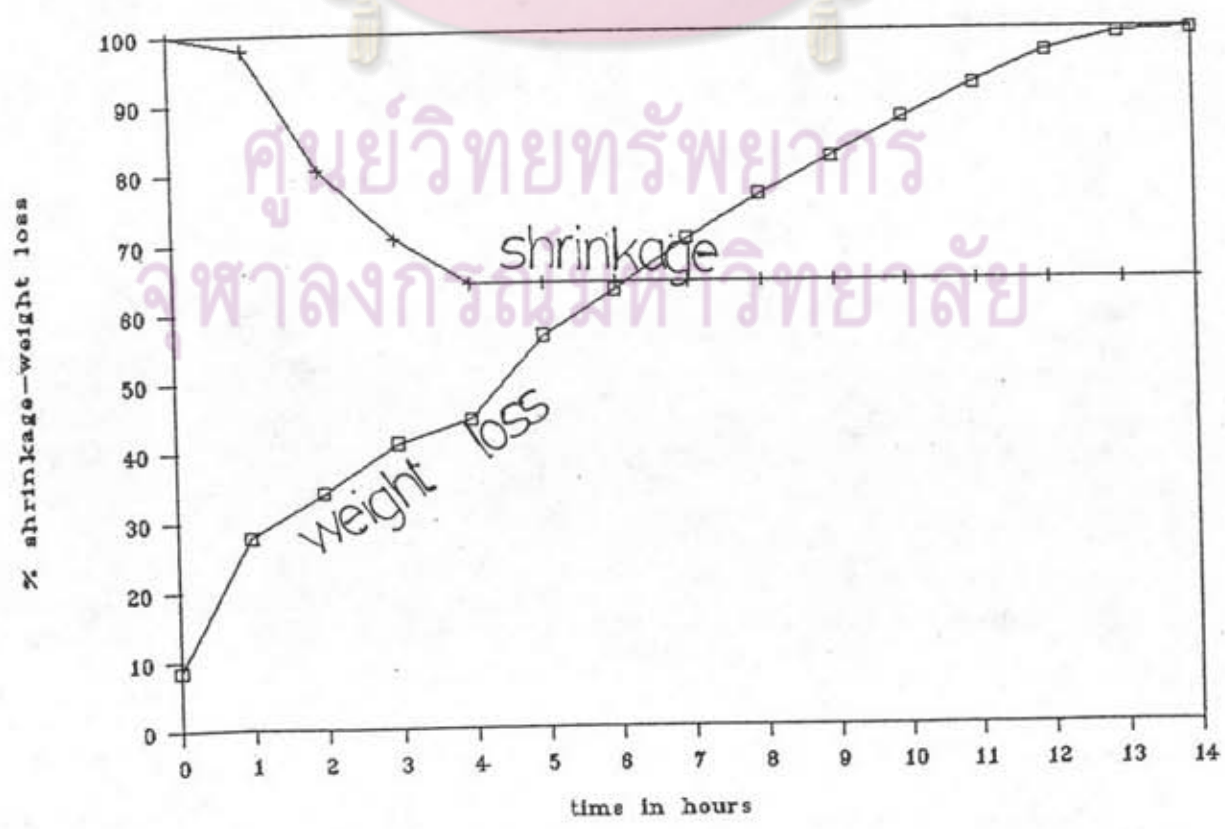


7. 30% re.hu. (water bath 70°C/44.45°C)

time	%mass loss						
	avg	max	min	std	avg	max	min
0	8.56	8.65	8.61	15.47	20.58	8.56	0.04
1	27.16	28.57	27.87	23.33	28.57	27.16	0.70
2	33.59	34.41	34.00	31.19	34.41	33.59	0.41
3	40.59	41.61	41.10	39.04	41.61	40.59	0.51
4	41.43	47.63	44.53	46.90	48.00	41.43	3.10
5	55.15	57.80	56.47	54.76	57.80	55.15	1.32
6	61.43	64.39	62.91	62.62	64.39	61.43	1.48
7	68.19	72.18	70.18	70.48	72.18	68.19	2.00
8	74.21	78.70	76.45	78.34	78.70	74.21	2.25
9	79.36	84.47	81.91	86.20	86.20	79.36	2.55
10	84.51	90.23	87.37	94.06	94.06	84.51	2.86
11	89.66	94.48	92.07	101.92	101.92	89.66	2.41
12	94.80	98.73	96.76	109.78	109.78	94.80	1.96
13	98.84	99.65	99.25	117.63	117.63	98.84	0.41
14	99.71	99.79	99.75	125.49	125.49	99.71	0.04

time	%linear shrinkage						
	avg	max	min	std	avg	max	min
0	102.5	-9.95					
100	100	100	100	102.50	100	100	0
99	97	98	98	92.55	99	97	1
83	78	80.5	80.5	82.60	83	78	2.5
73	68	70.5	70.5	72.65	73	68	2.5
66	62	64	64	62.70	66	62	2
66	62	64	64	52.75	66	62	2
66	62	64	64	42.80	66	62	2
66	62	64	64		66	62	2
66	62	64	64		66	62	2
66	62	64	64		66	62	2
66	62	64	64		66	62	2
66	62	64	64		66	62	2

30% re. hu. (70°C/44.45°C)



8. 0% re. hu. (water bath 70°C/T.room)

11.18969

% mass loss

8.036462

time	avg	max	min	std
0	10.09	11.19	10.56	0.94
1	18.34	19.23	18.06	0.86
2	27.21	27.26	27.01	0.63
3	35.91	35.30	35.37	0.48
4	43.64	43.34	42.79	0.67
5	52.93	51.37	53.36	0.77
6	60.51	59.41	60.54	0.65
7	68.15	67.44	67.98	0.80
8	75.54	75.48	74.93	0.80
9	82.49	83.52	81.52	0.86
10	90.30	91.55	88.12	2.14
11	96.26	99.59	93.89	2.23
12	99.85	107.63	98.41	1.11

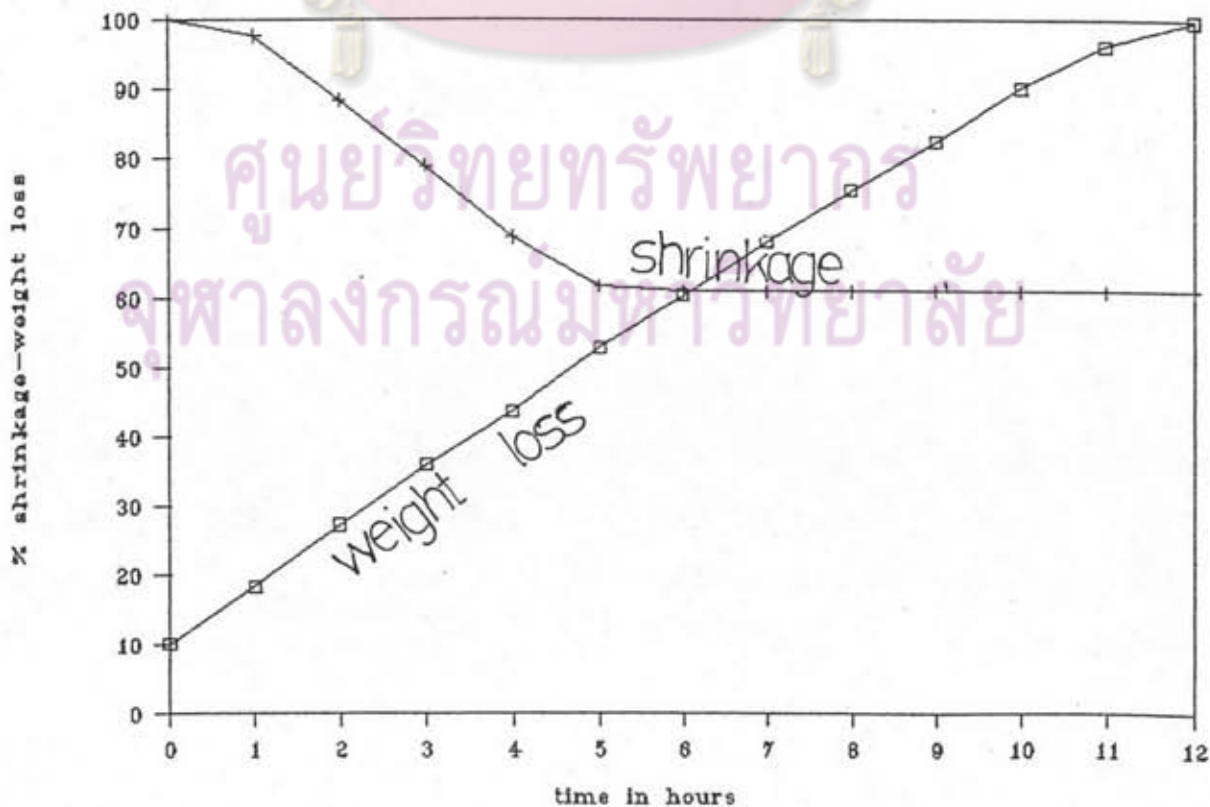
% linear shrinkage

107.625

-9.65

avg	max	min	std
100.00	100	100	0
97.75	100	95	1.92
88.50	89	87	0.87
79.00	80	78	1.00
68.75	70	68	0.83
61.75	64	60	1.48
61.00	64	59	2.12
61.00	64	59	2.12
61.00	64	59	2.12
61.00	64	59	2.12
61.00	64	59	2.12
61.00	64	59	2.12

0% re. hu. (70 °C/T.room)



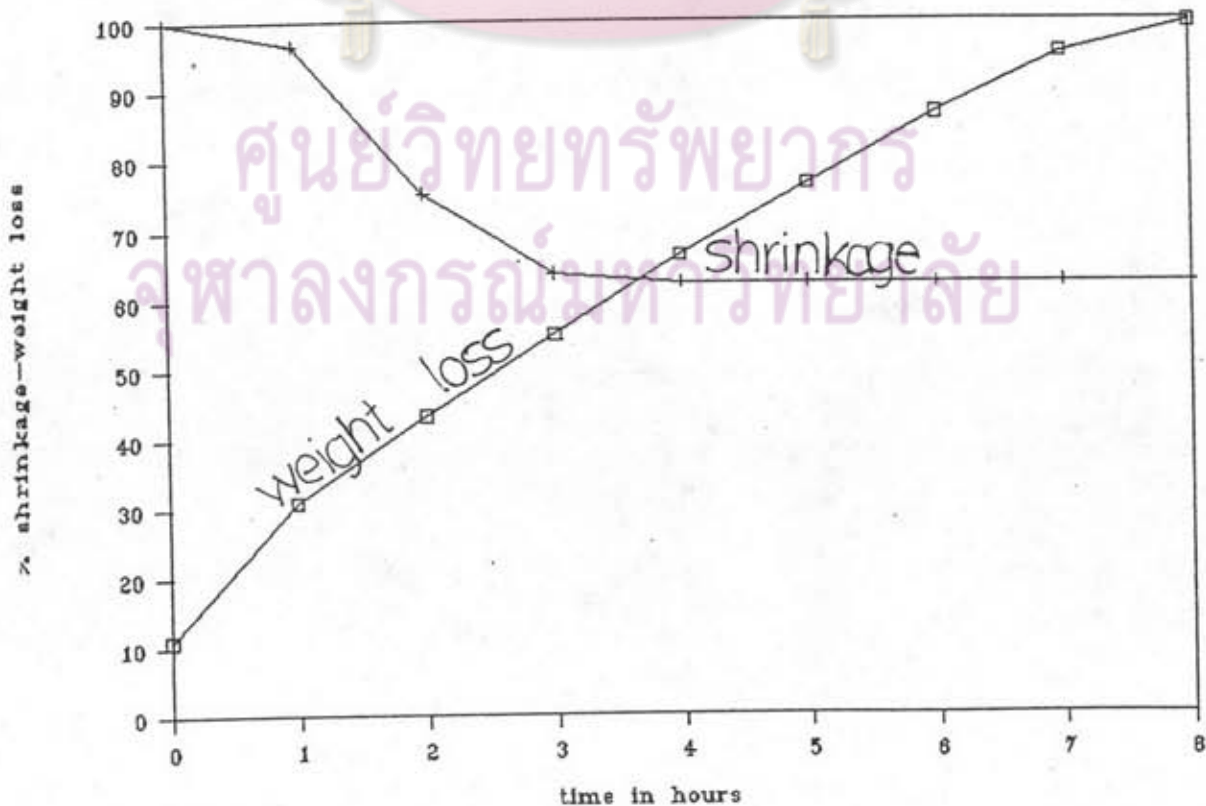
9. 0% re. hu. (water bath 90°C/T.room)

time	%mass loss				20.79926				
	avg	max	min	std	avg	max	min	std	
0	8.40	12.82	11.80	11.01	20.80	12.82	8.40	1.89	
1	30.51	31.55	30.65	30.90	31.93	31.55	30.51	0.46	
2	43.38	42.89	43.40	43.22	43.06	43.40	42.89	0.24	
3	56.17	53.56	55.23	54.99	54.19	56.17	53.56	1.08	
4	68.27	64.03	66.73	66.34	65.31	68.27	64.03	1.75	
5	78.89	73.44	76.97	76.43	76.44	78.89	73.44	2.26	
6	90.81	82.58	86.43	86.61	87.57	90.81	82.58	3.36	
7	98.88	92.31	94.64	95.28	98.70	98.88	92.31	2.72	
8	100.60	98.95	99.32	99.62	109.83	100.60	98.95	0.71	

%linear shrinkage

time	%linear shrinkage				103.1666			
	avg	max	min	std	avg	max	min	std
100	100	100	100	100	103.17	100	100	0
99	95	96	96.67	91.70	99	95	1.70	
76	76	74	75.33	80.23	76	74	0.94	
62	67	62	63.67	68.77	67	62	2.36	
59	66	62	62.33	57.30	66	59	2.87	
59	66	62	62.33	45.83	66	59	2.87	
59	66	62	62.33	66	59	2.87		
59	66	62	62.33	66	59	2.87		
59	66	62	62.33	66	59	2.87		

0% re. hu. (90°C/T.room)

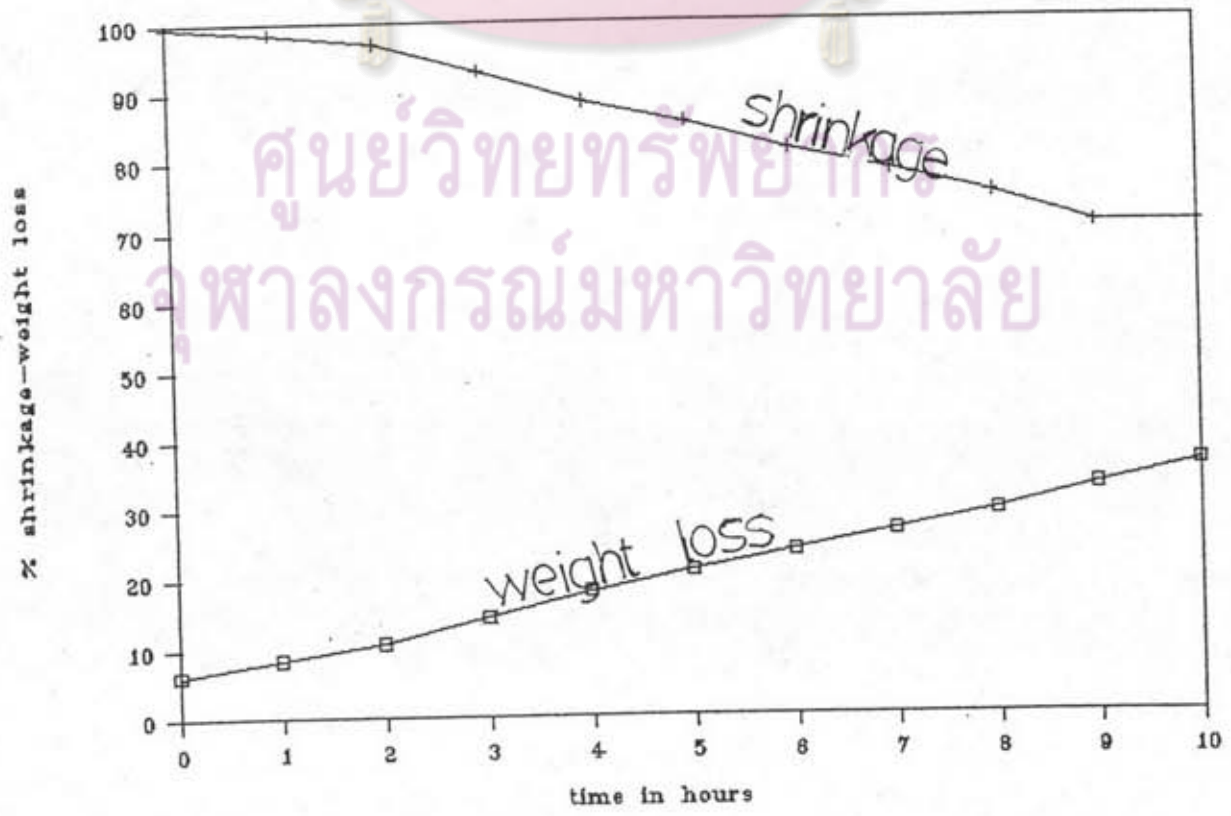


av. 90% re.hu. (water bath 70°C/67°C)

%mass loss		5.593333				
time	avg	2.997619	max	min		
0	6.09	6.28	6.19	5.59	6.28	6.09
1	8.45	8.45	8.45	8.59	8.45	8.45
2	10.88	10.63	10.76	11.59	10.88	10.63
3	14.56	14.15	14.36	14.59	14.56	14.15
4	18.25	17.71	17.98	17.58	18.25	17.71
5	21.68	19.99	20.84	20.58	21.68	19.99
6	25.10	22.26	23.68	23.58	25.10	22.26
7	28.05	24.83	26.44	26.58	28.05	24.83
8	31.00	27.41	29.21	29.57	31.00	27.41
9	34.69	30.93	32.81	32.57	34.69	30.93
10	37.69	34.45	36.07	35.57	37.69	34.45
11	41.38	37.97	39.68	38.57	41.38	37.97
12	45.07	41.49	43.28	41.56	45.07	41.49
13	48.76	45.01	46.89	44.56	48.76	45.01
14	52.45	48.53	50.49	47.56	52.45	48.53
15	56.14	52.05	54.10	50.56	56.14	52.05

%linear shrinkage		104.0476			
	avg	-3.71428	max	min	
100	99	99.50	104.05	100	99
99	98	98.50	100.33	99	98
97	97	97.00	96.62	97	97
94	92	93.00	92.90	94	92
90	87	88.50	89.19	90	87
85	86	85.50	85.48	86	85
80	83	81.50	81.76	83	80
77	80	78.50	78.05	80	77
74	76	75.00	74.33	76	74
69	72	70.50	70.62	72	69
69	72	70.50	66.90	72	69

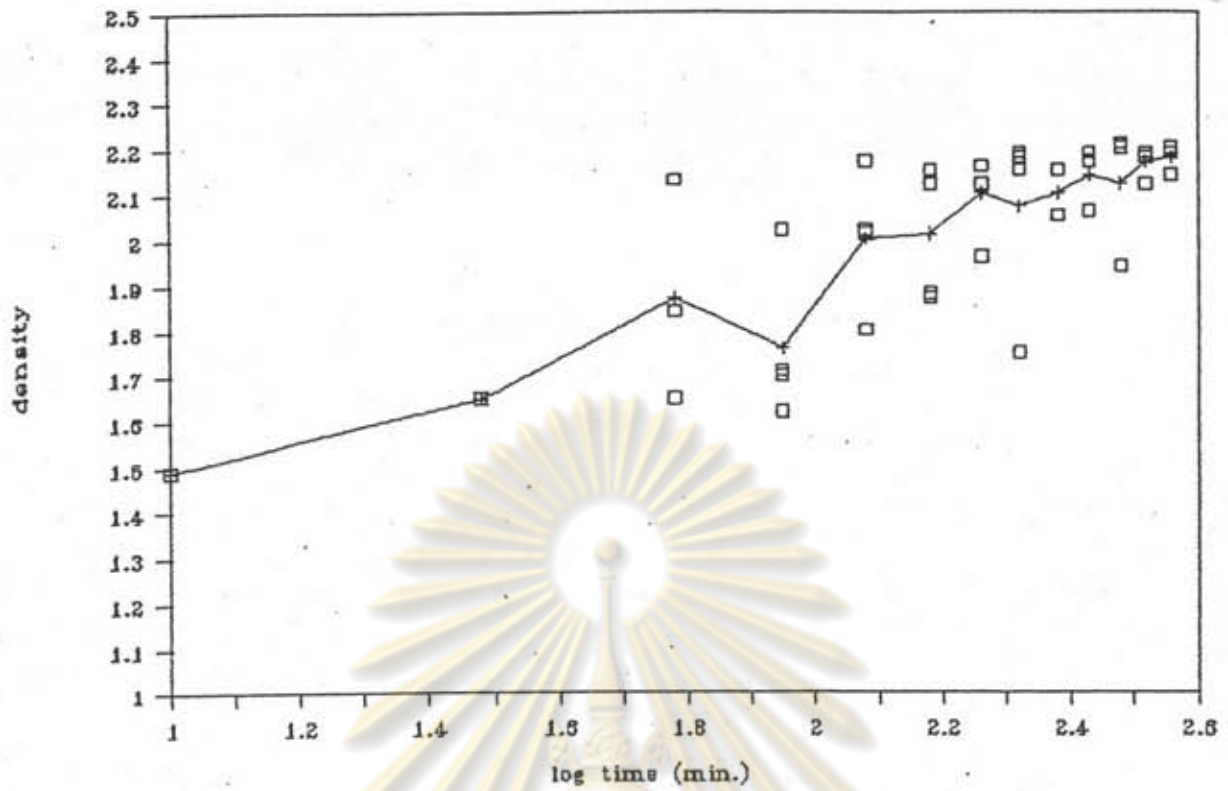
90% re. hu. (70°C/67°C)



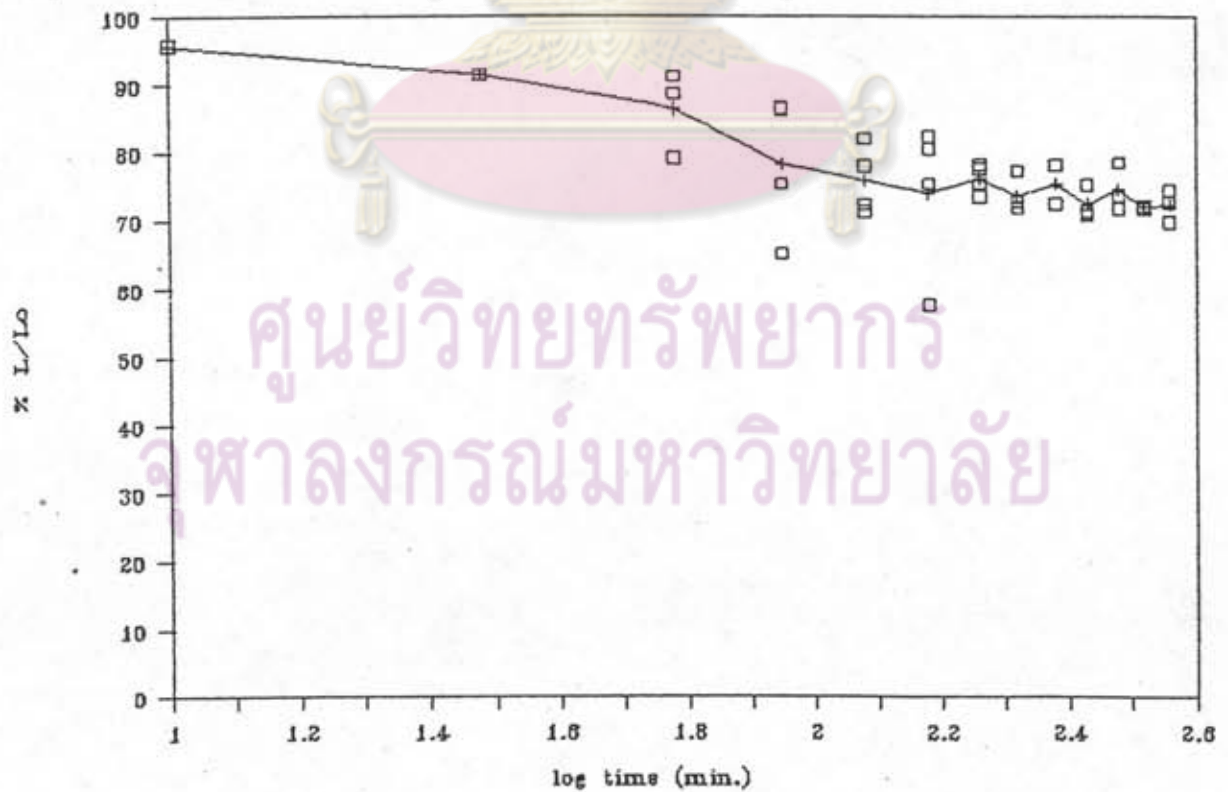
1100°C							
time(min)	log time	wt. density	avg. (den.11/10	avg. (1/10	avg. (1/10	XRD	
10	1.00	0.3781	1.49	1.49	95.71	95.71	0
30	1.48	0.3854	1.65	1.65	91.27	91.27	0
60	1.78	0.4765	1.65	1.87	88.56	86.28	0
	1.78	0.4250	2.13	1.87	91.09	86.28	0
90	1.78	0.3956	1.84	1.87	79.18	86.28	0
	1.95	0.5000	1.70	1.76	86.44	78.30	0
	1.95	0.3481	1.62	1.76	65.14	78.30	0
	1.95	0.4093	1.71	1.76	75.31	78.30	0
	1.95	0.3782	2.02	1.76	86.32	78.30	0
120	2.08	0.4803	1.80	2.00	82.01	75.93	0
	2.08	0.3874	2.02	2.00	72.37	75.93	0
	2.08	0.3538	2.01	2.00	78.04	75.93	0
	2.08	0.3509	2.17	2.00	71.30	75.93	0
150	2.18	0.4864	1.88	2.01	80.57	73.94	0
	2.18	0.3730	2.15	2.01	57.50	73.94	0
	2.18	0.3937	2.12	2.01	75.34	73.94	0
	2.18	0.3506	1.87	2.01	82.33	73.94	0
180	2.26	0.4633	1.96	2.10	78.18	76.16	0
	2.26	0.3734	2.16	2.10	75.34	76.16	0
	2.26	0.4032	2.12	2.10	73.50	76.16	0
	2.26	0.3847	2.16	2.10	77.63	76.16	0
210	2.32	0.4240	1.75	2.07	77.38	73.49	0
	2.32	0.3645	2.19	2.07	71.79	73.49	0
	2.32	0.4486	2.15	2.07	72.87	73.49	0
	2.32	0.4165	2.18	2.07	71.91	73.49	0
240	2.38	0.4620	2.05	2.10	78.24	75.39	0
	2.38	0.4018	2.15	2.10	72.54	75.39	0
270	2.43	0.4745	2.06	2.14	75.27	72.48	0
	2.43	0.3989	2.17	2.14	71.31	72.48	0
	2.43	0.4279	2.19	2.14	70.85	72.48	0
300	2.48	0.4482	1.94	2.12	78.49	74.57	0
	2.48	0.4040	2.20	2.12	71.67	74.57	0
	2.48	0.4576	2.21	2.12	73.54	74.57	0
330	2.52	0.4513	2.12	2.11	72.01	71.93	0
	2.52	0.4181	2.19	2.11	72.06	71.93	0
	2.52	0.4332	2.18	2.11	72.05	71.93	0
	2.52	0.4080	2.18	2.11	71.69	71.93	0
360	2.56	0.3210	2.14	2.18	74.42	72.27	0
	2.56	0.3580	2.19	2.18	69.74	72.27	0
	2.56	0.3469	2.20	2.18	72.65	72.27	0

ศูนย์วิจัยเทคโนโลยี
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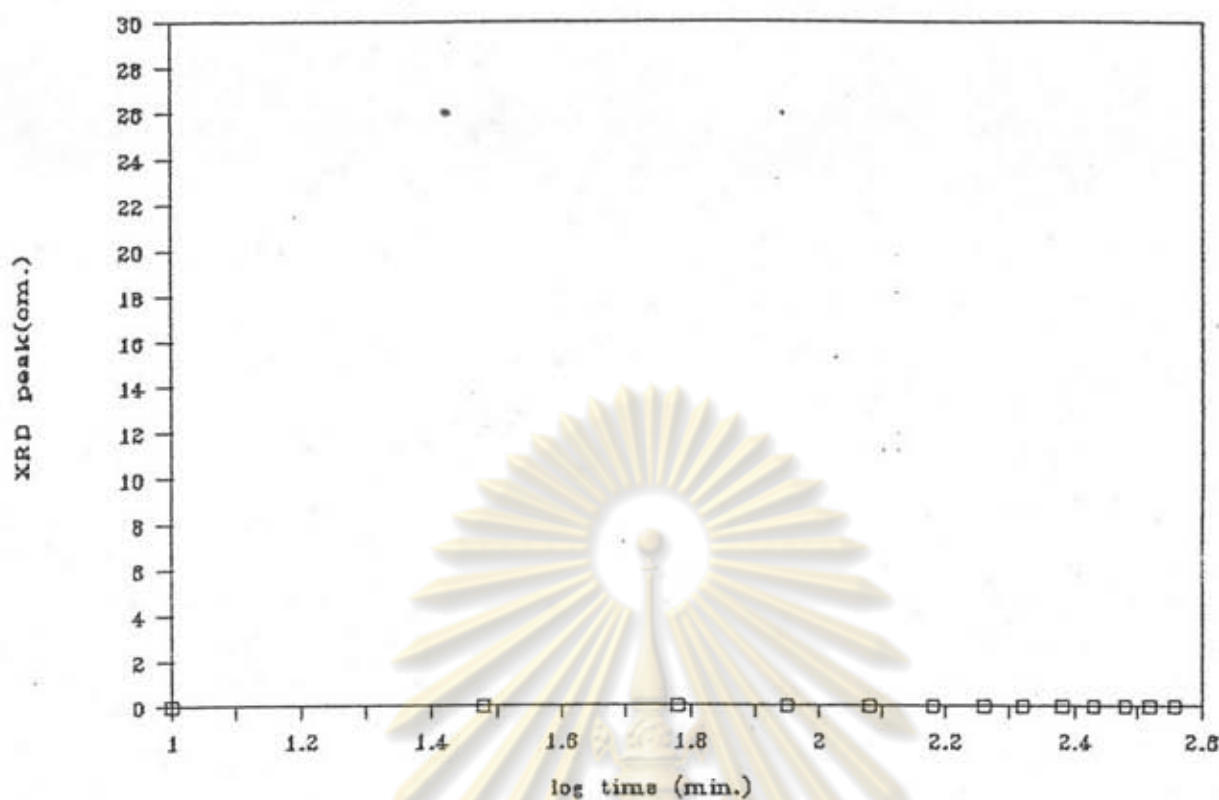
sintering 1100°C



sintering 1100°C

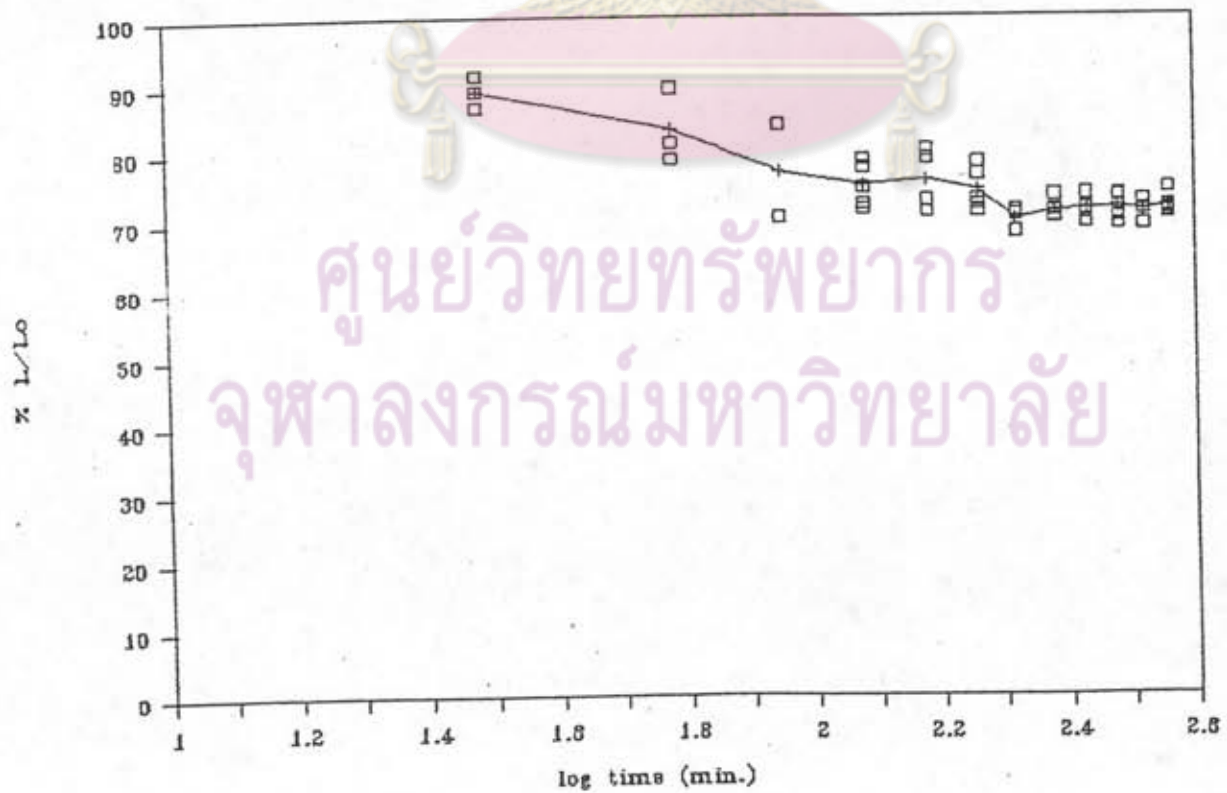
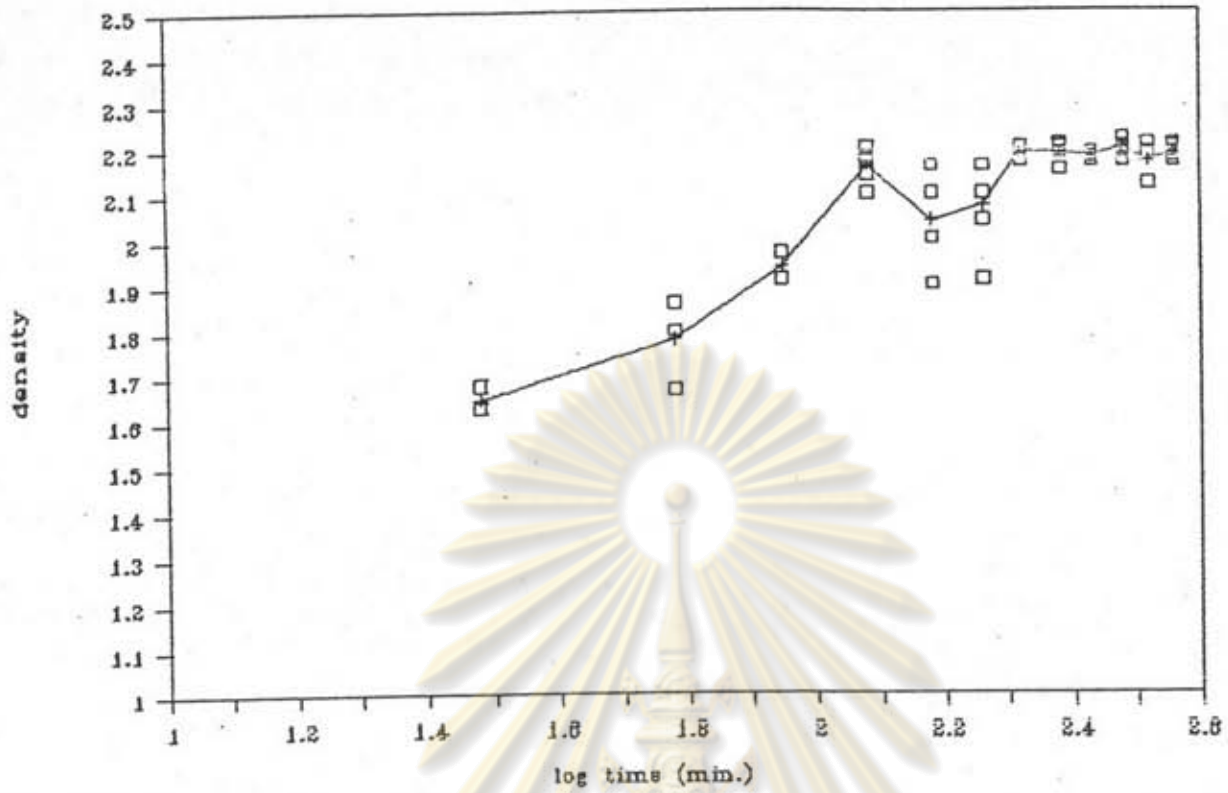


ศูนย์วิทยทรัพยากร
ศาลงกรณ์มหาวิทยาลัย

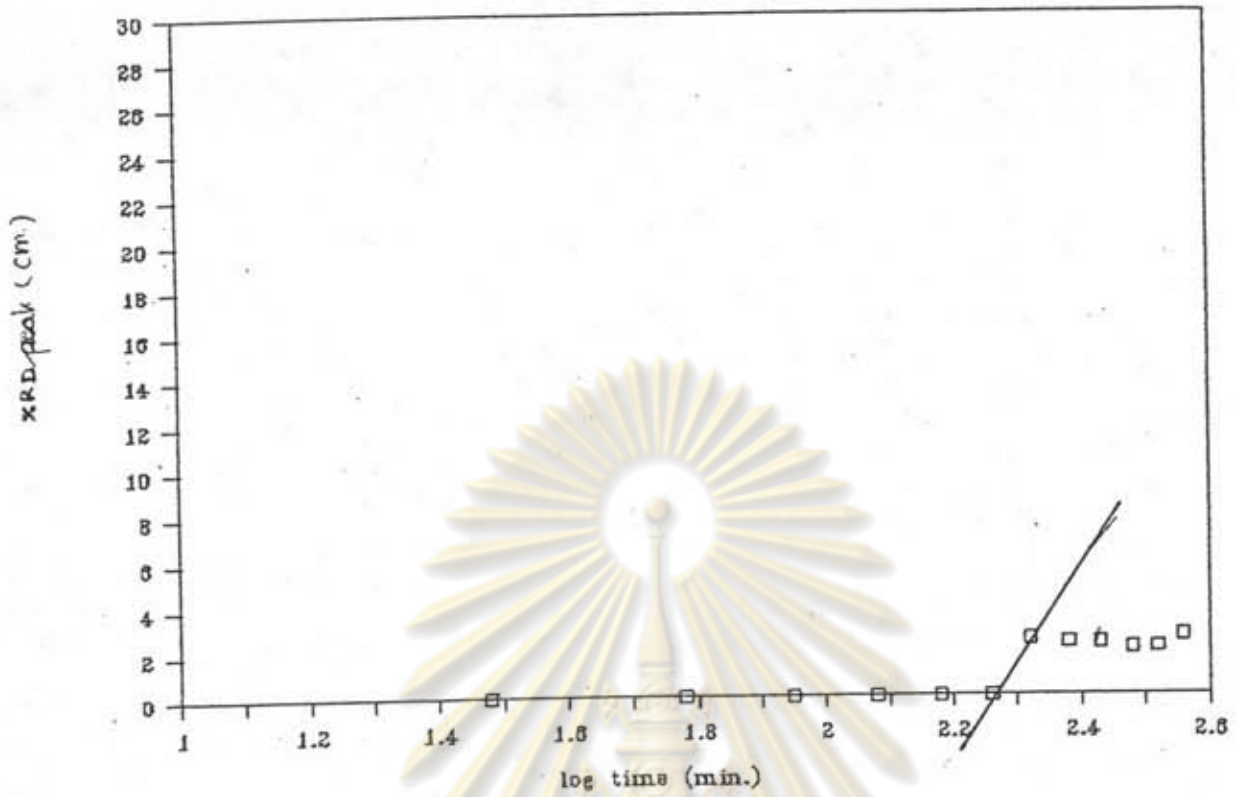


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1150°C							
time(min,log	time	wt. density	avg(den.)	Zl/lo	avg(Zl/lo	XRD	
10	1.00	0.5641	2.04	2.04	94.96	94.96	0.00
30	1.48	0.5997	1.63	1.65	89.12	89.12	0.00
	1.48	0.4608	1.63	1.65	91.44	89.12	0.00
	1.48	0.4677	1.68	1.65	86.81	89.12	0.00
60	1.78	0.5606	1.80	1.78	81.32	83.20	0.00
	1.78	0.4193	1.86	1.78	78.85	83.20	0.00
	1.78	0.4380	1.67	1.78	89.42	83.20	0.00
90	1.95	0.5302	1.97	1.94	70.37	77.13	0.00
	1.95	0.4659	1.91	1.94	83.88	77.13	0.00
120	2.08	0.4581	2.18	2.16	78.89	75.06	0.00
	2.08	0.5291	2.20	2.16	74.70	75.06	0.00
	2.08	0.5219	2.14	2.16	77.74	75.06	0.00
	2.08	0.4889	2.10	2.16	72.41	75.06	0.00
	2.08	0.5668	2.17	2.16	71.56	75.06	0.00
150	2.18	0.4593	2.10	2.04	80.20	75.82	0.00
	2.18	0.5053	2.16	2.04	71.24	75.82	0.00
	2.18	0.5396	2.00	2.04	72.84	75.82	0.00
	2.18	0.5643	1.90	2.04	79.01	75.82	0.00
180	2.26	0.4683	1.91	2.07	78.40	74.29	0.00
	2.26	0.6064	2.10	2.07	76.64	74.29	0.00
	2.26	0.5276	2.04	2.07	72.98	74.29	0.00
	2.26	0.5409	2.16	2.07	71.25	74.29	0.00
	2.26	0.5482	2.16	2.07	72.17	74.29	0.00
210	2.32	0.5618	2.17	2.19	71.34	70.07	
	2.32	0.5608	2.20	2.19	68.17	70.07	
	2.32	0.5075	2.20	2.19	70.70	70.07	2.50
240	2.38	0.4487	2.21	2.19	70.40	71.32	
	2.38	0.5628	2.15	2.19	71.38	71.32	
	2.38	0.6161	2.20	2.19	73.46	71.32	2.35
	2.38	0.4890	2.19	2.19	71.17	71.32	
	2.38	0.5480	2.20	2.19	70.21	71.32	
270	2.43	0.5336	2.18	2.18	73.64	71.36	
	2.43	0.5272	2.19	2.18	69.53	71.36	
	2.43	0.5321	2.19	2.18	70.79	71.36	
	2.43	0.4812	2.17	2.18	71.48	71.36	2.30
300	2.48	0.4776	2.20	2.20	70.47	71.72	
	2.48	0.4984	2.17	2.20	69.23	71.72	
	2.48	0.5459	2.22	2.20	71.92	71.72	
	2.48	0.5593	2.22	2.20	73.37	71.72	2.05
	2.48	0.5650	2.19	2.20	73.61	71.72	
330	2.52	0.5073	2.12	2.17	72.82	71.12	
	2.52	0.5073	2.19	2.17	71.43	71.12	
	2.52	0.5445	2.21	2.17	69.10	71.12	2.10
360	2.56	0.4588	2.21	2.19	74.55	71.95	
	2.56	0.5390	2.17	2.19	71.43	71.95	
	2.56	0.5648	2.19	2.19	71.88	71.95	



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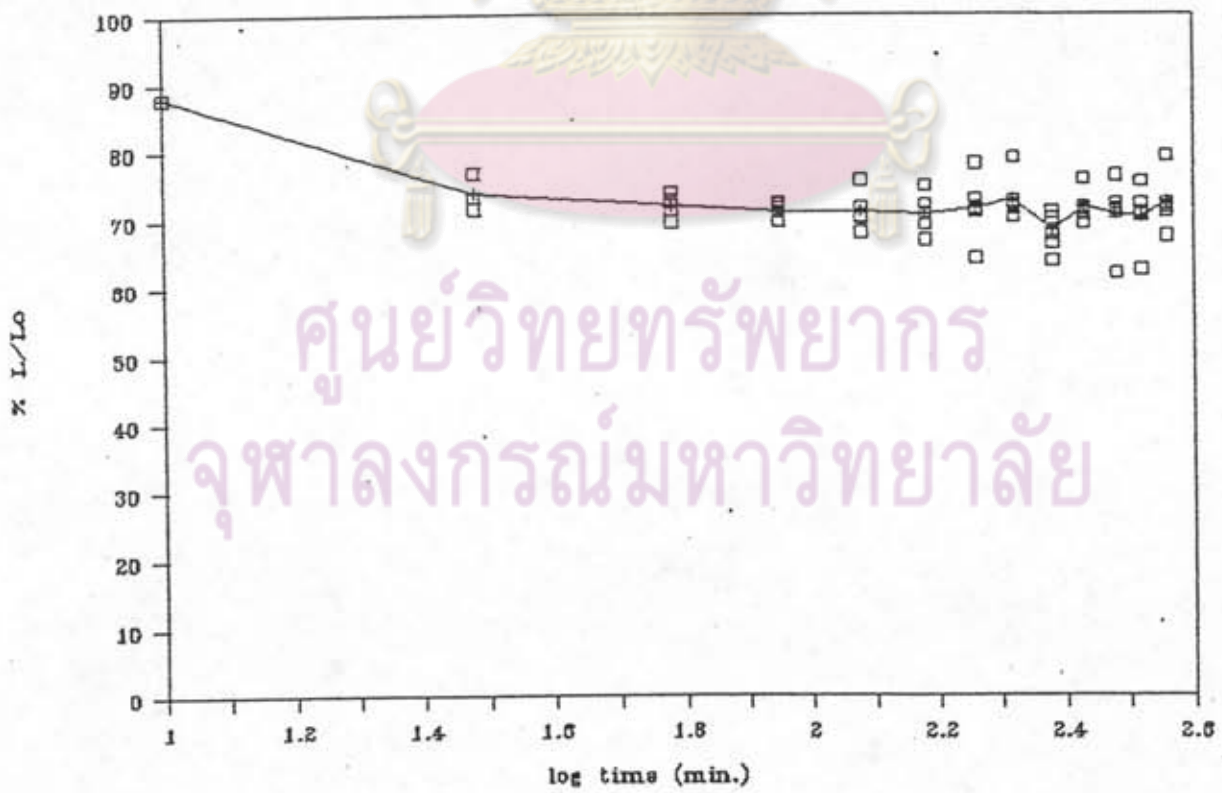
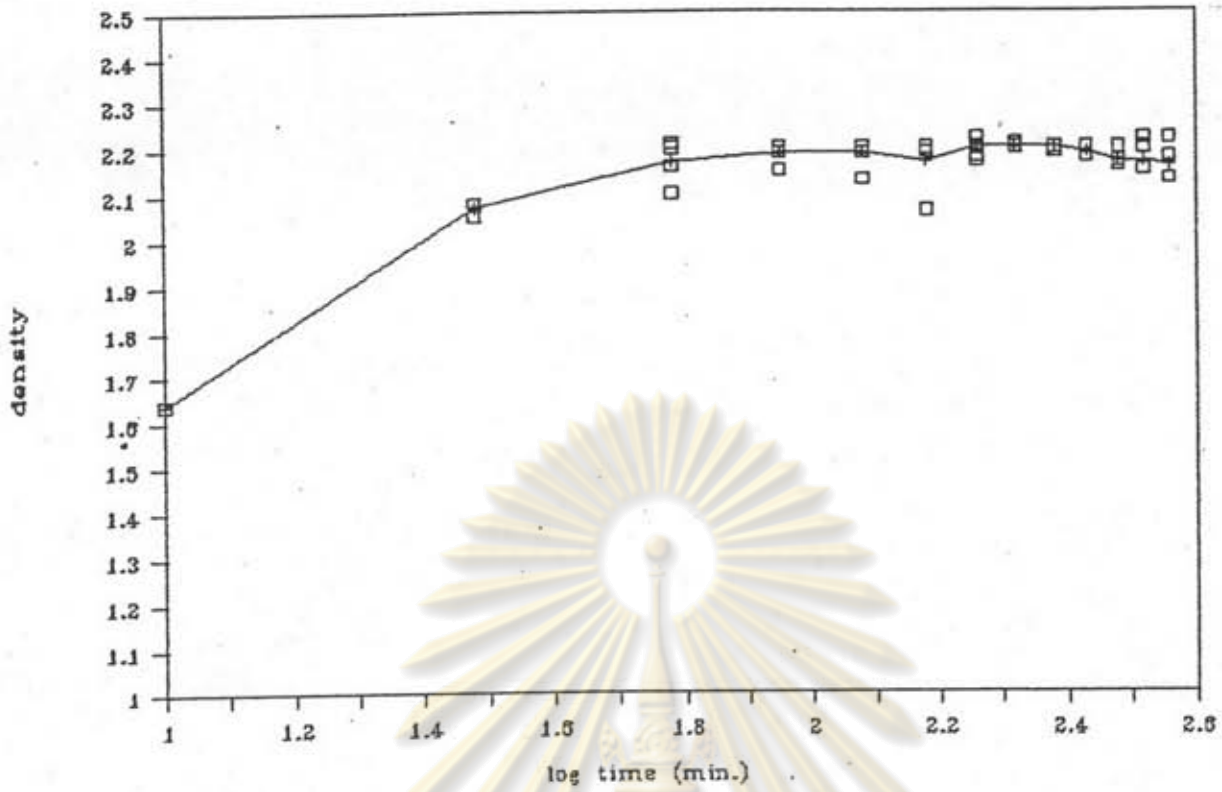


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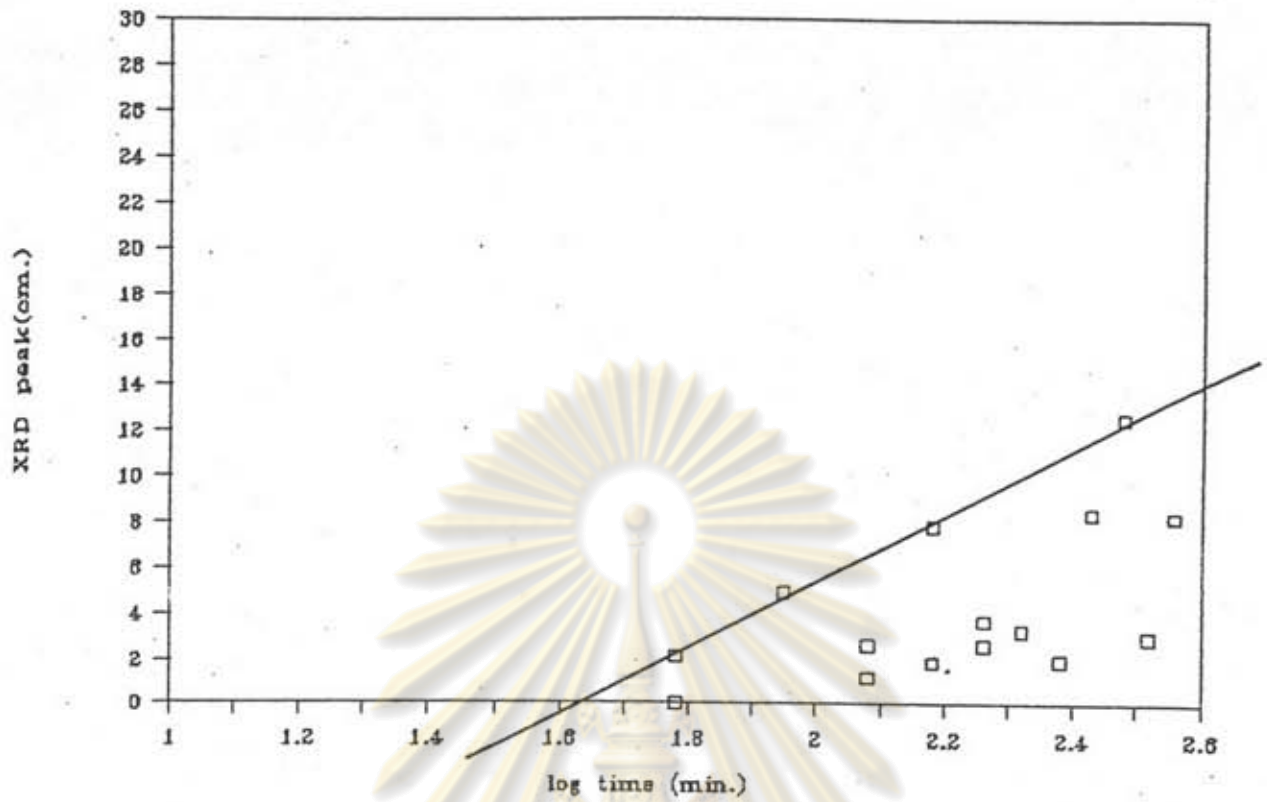
1200 °C

time(min)	log time	wt. density	avg(den.)	I1/I0	avg(I1/I0)	IRD
10	1.00	0.5474	1.64	1.64	87.87	87.87
30	1.48	0.4445	2.08	2.07	73.21	73.78
	1.48	0.5170	2.08	2.07	76.67	73.78
	1.48	0.5833	2.05	2.07	71.47	73.78
60	1.78	0.3669	2.21	2.17	69.51	71.91
	1.78	0.5495	2.10	2.17	73.64	71.91
	1.78	0.5448	2.20	2.17	72.73	71.91
	1.78	0.5483	2.16	2.17	72.42	71.91
	1.78	0.5821	2.20	2.17	71.26	71.91
90	1.95	0.4202	2.15	2.19	72.09	71.00
	1.95	0.5447	2.19	2.19	69.60	71.00
	1.95	0.5425	2.19	2.19	69.60	71.00
	1.95	0.4420	2.20	2.19	71.48	71.00
	1.95	0.4744	2.20	2.19	71.00	71.00
	1.95	0.4579	2.19	2.19	72.22	71.00
120	2.08	0.4289	2.19	2.19	70.30	70.99
	2.08	0.4974	2.13	2.19	75.65	70.99
	2.08	0.5508	2.20	2.19	67.94	70.99
	2.08	0.4264	2.20	2.19	70.34	70.99
	2.08	0.5328	2.20	2.19	70.12	70.99
	2.08	0.5662	2.20	2.19	71.60	70.99
150	2.18	0.5699	2.19	2.17	74.70	70.63
	2.18	0.5513	2.19	2.17	71.99	70.63
	2.18	0.5136	2.06	2.17	69.09	70.63
	2.18	0.5346	2.20	2.17	66.77	70.63
	2.18	0.4873	2.20	2.17	70.59	70.63
180	2.26	0.4238	2.20	2.20	71.32	71.47
	2.26	0.5635	2.20	2.20	64.18	71.47
	2.26	0.4808	2.18	2.20	71.48	71.47
	2.26	0.4653	2.20	2.20	78.01	71.47
	2.26	0.5404	2.22	2.20	71.15	71.47
	2.26	0.5090	2.17	2.20	72.70	71.47
210	2.32	0.4345	2.20	2.20	71.48	72.79
	2.32	0.4566	2.20	2.20	70.32	72.79
	2.32	0.4732	2.20	2.20	72.55	72.79
	2.32	0.4684	2.20	2.20	71.83	72.79
	2.32	0.4621	2.21	2.20	78.87	72.79
	2.32	0.5300	2.21	2.20	71.66	72.79
240	2.38	0.3851	2.20	2.20	69.54	68.24
	2.38	0.4393	2.23	2.20	70.90	68.24
	2.38	0.3975	2.20	2.20	70.90	68.24
	2.38	0.5236	2.20	2.20	67.69	68.24
	2.38	0.4531	2.19	2.20	67.69	68.24
	2.38	0.4797	2.20	2.20	66.43	68.24
270	2.43	0.4616	2.18	2.19	69.22	71.62
	2.43	0.4289	2.20	2.19	71.15	71.62
	2.43	0.4549	2.18	2.19	71.64	71.62
	2.43	0.4339	2.15	2.19	75.75	71.62
	2.43	0.4387	2.20	2.19	71.19	71.62
	2.43	0.4655	2.19	2.19	70.72	71.62
300	2.46	0.4217	2.17	2.17	70.98	70.23
	2.46	0.4935	2.20	2.17	72.17	70.23
	2.46	0.4713	2.17	2.17	71.22	70.23
	2.46	0.4395	2.17	2.17	71.77	70.23
	2.46	0.4367	2.16	2.17	71.77	70.23
	2.46	0.5179	2.18	2.17	69.60	70.23
330	2.52	0.3855	2.15	2.17	71.77	70.23
	2.52	0.4644	2.17	2.17	70.75	70.23
	2.52	0.4116	2.17	2.17	72.07	70.23
	2.52	0.4351	2.17	2.17	75.35	70.23
	2.52	0.5017	2.22	2.17	62.50	70.23
360	2.54	0.3992	2.15	2.16	72.10	72.25
	2.56	0.4365	2.13	2.16	71.15	72.25
	2.56	0.4592	2.13	2.16	79.09	72.25
	2.56	0.4509	2.22	2.16	67.77	72.25

ศูนย์วิจัยเทคโนโลยี
จุฬาลงกรณ์มหาวิทยาลัย

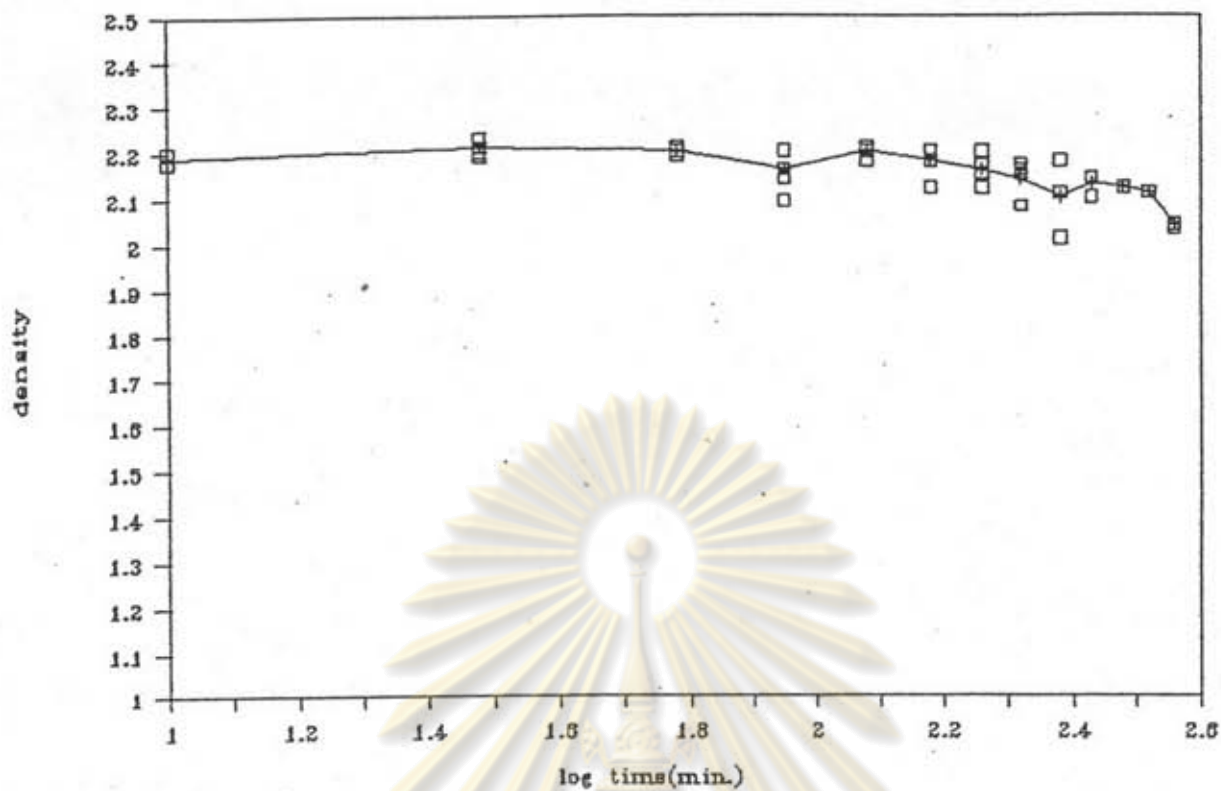


ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

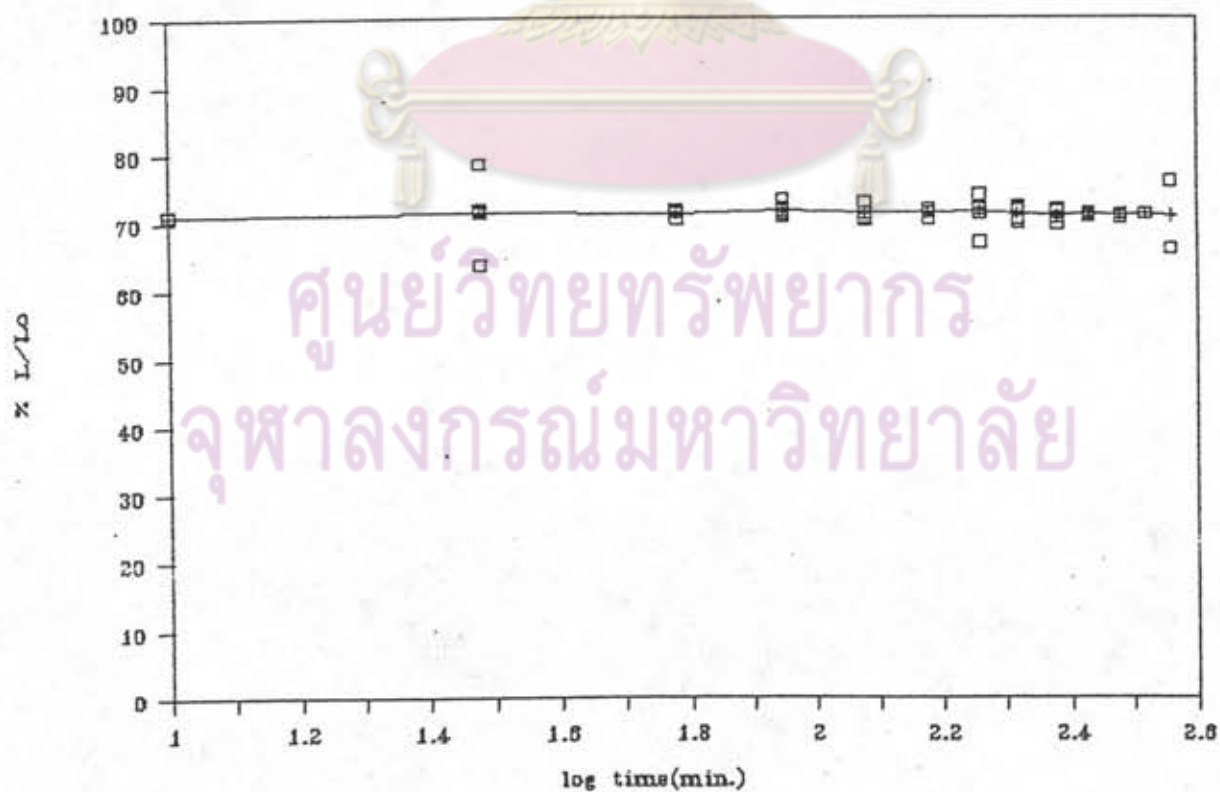


ศูนย์วิจัยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

1250 °C									
time(sec)	log time	wt. density	ρ _g (den.)	Zl/lo	avg(Zl/lo)			XRD	
10	1.00	0.5065	2.19	2.19	70.93	71.05		0	
	1.00	0.4505	2.20	2.19	71.17	71.05			
30	1.48	0.5120	2.20	2.21	63.70	71.45		0	
	1.47	0.4532	2.19	2.21	78.55	71.45			
	1.48	0.5335	2.21	2.21	71.39	71.45			
	1.48	0.5341	2.20	2.21	71.59	71.45			
	1.48	0.5448	2.23	2.21	72.01	71.45			
60	1.78	0.4771	2.20	2.20	70.49	71.32			
	1.78	0.5812	2.20	2.20	71.77	71.32			
	1.78	0.5568	2.21	2.20	71.43	71.32	2.3		
	1.78	0.5237	2.20	2.20	71.43	71.32	3.35		
	1.78	0.6261	2.19	2.20	71.47	71.32			
90	1.95	0.4695	2.16	2.16	72.20	71.86			
	1.95	0.4374	2.20	2.16	70.90	71.86			
	1.95	0.5847	2.20	2.16	71.17	71.86	2.4		
	1.95	0.5329	2.09	2.16	73.35	71.86			
	1.95	0.5519	2.14	2.16	71.69	71.86	2.4		
120	2.08	0.5205	2.20	2.20	71.33	71.34			
	2.08	0.4977	2.18	2.20	72.96	71.34			
	2.08	0.4966	2.20	2.20	70.75	71.34			
	2.08	0.5521	2.21	2.20	70.35	71.34	3.25		
	2.08	0.5179	2.20	2.20	71.33	71.34	6.05		
150	2.12	0.4455	2.12	2.12	71.92	71.41			
	2.12	0.4549	2.12	2.13	70.42	71.41			
	2.12	0.5711	2.20	2.12	71.43	71.41	4.1		
	2.12	0.4936	2.20	2.12	71.83	71.41			
	2.12	0.5007	2.20	2.12	71.43	71.41	2.6		
180	2.26	0.4420	2.15	2.15	71.93	71.59			
	2.26	0.4520	2.12	2.16	71.23	71.59			
	2.26	0.5816	2.17	2.16	66.98	71.59			
	2.26	0.4811	2.17	2.16	73.21	71.59			
	2.26	0.5154	2.20	2.16	74.01	71.59	2.75		
210	2.32	0.4760	2.17	2.14	59.97	71.26			
	2.32	0.4426	2.16	2.14	71.76	71.26			
	2.32	0.5014	2.16	2.14	71.91	71.26			
	2.32	0.4696	2.15	2.14	72.32	71.26			
	2.32	0.5755	2.08	2.14	70.45	71.26	23.4	18.35	
240	2.38	0.4351	2.11	2.10	72.00	70.96			
	2.38	0.4977	2.11	2.10	71.59	70.96			
	2.38	0.5137	2.13	2.10	70.34	70.96	1.6	2.75	
	2.38	0.6008	2.01	2.10	69.60	70.96			
270	2.43	0.4770	2.14	2.13	70.85	71.14			
	2.43	0.4497	2.14	2.13	71.18	71.14			
	2.43	0.5356	2.10	2.13	71.39	71.14			
300	2.48	0.4813	2.12	2.12	71.18	70.93			
	2.48	0.4409	2.12	2.12	70.67	70.93			
330	2.52	0.4873	2.11	2.11	71.23	71.24			
	2.52	0.5131	2.11	2.11	71.24	71.24			
360	2.56	0.4424	2.04	2.04	66.08	70.92			
	2.56	0.4329	2.03	2.04	75.76	70.92			

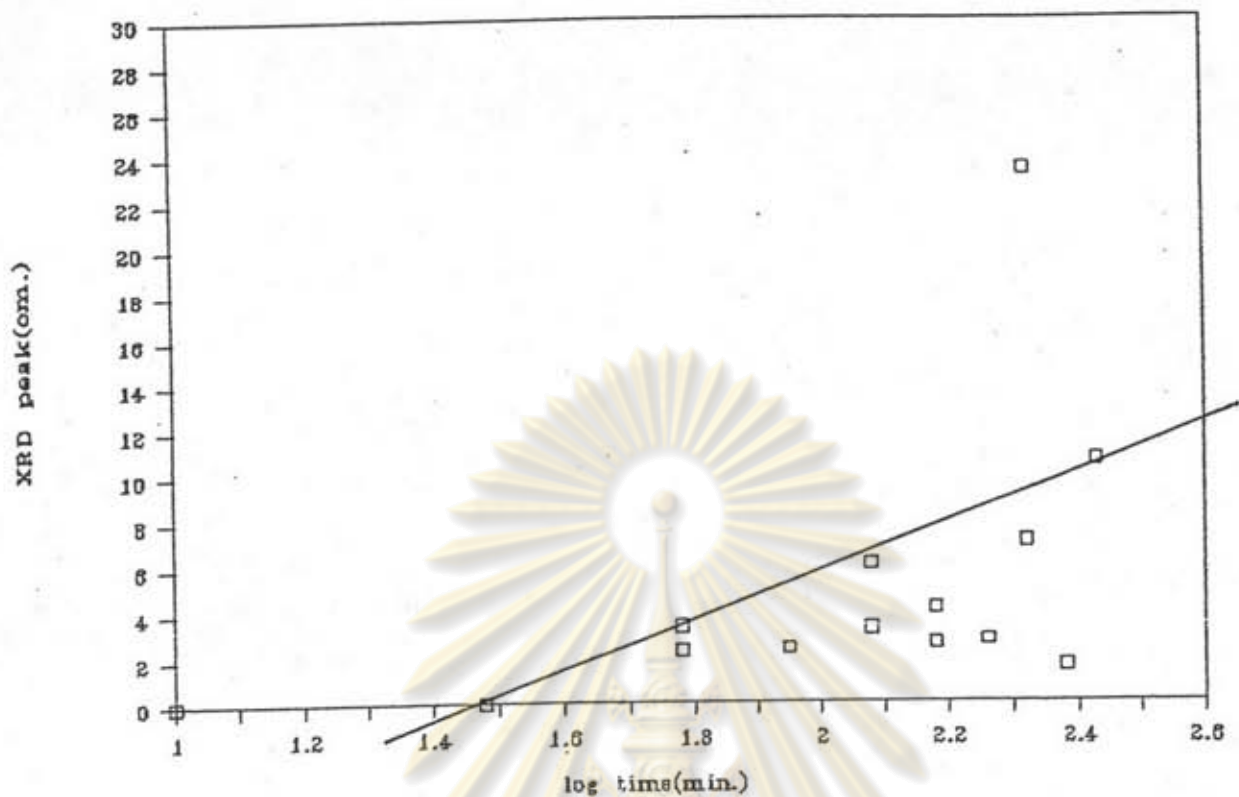


sintering 1250 °C



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

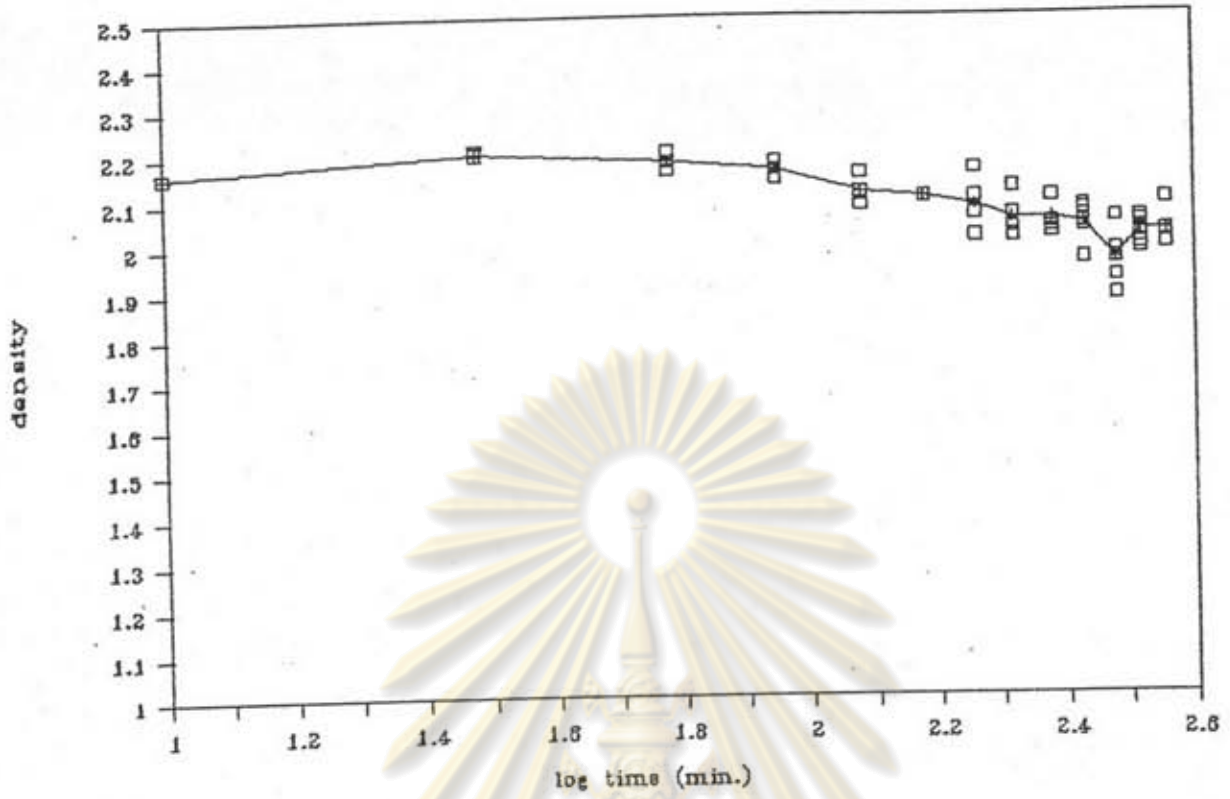
sintering 1250 °C



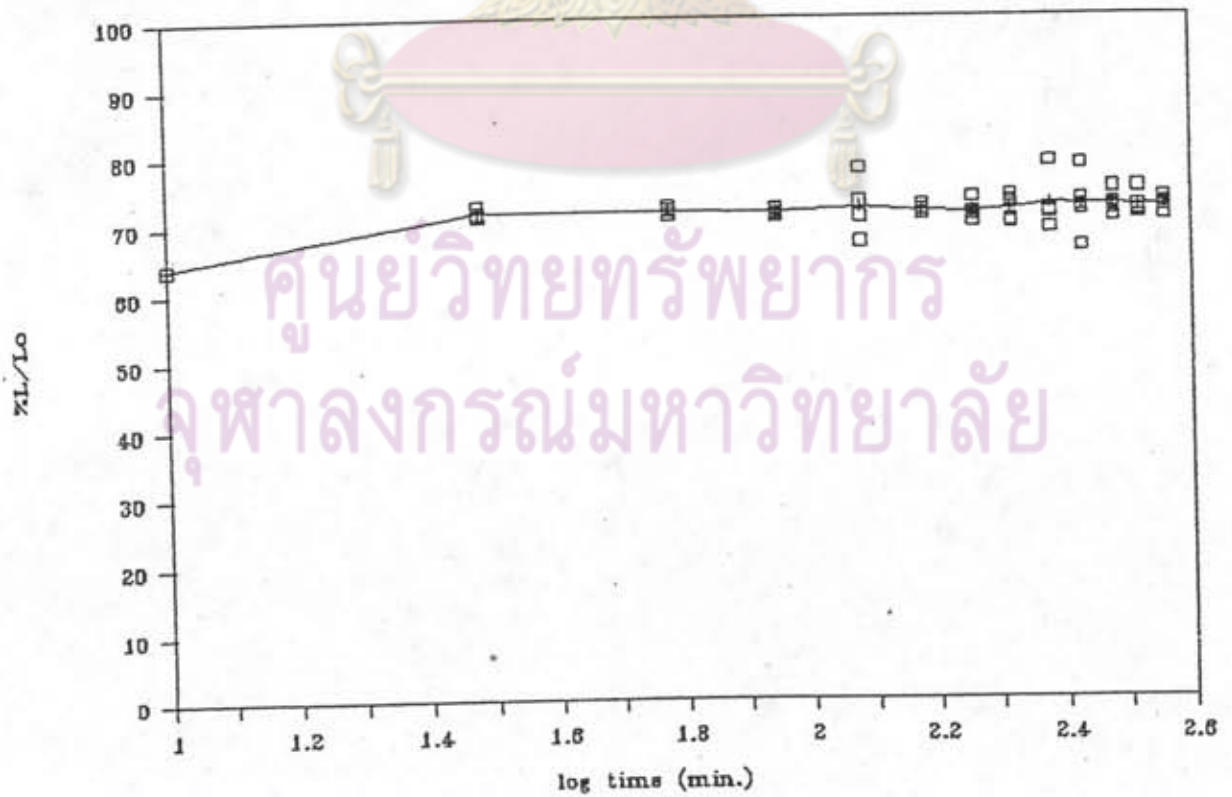
ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

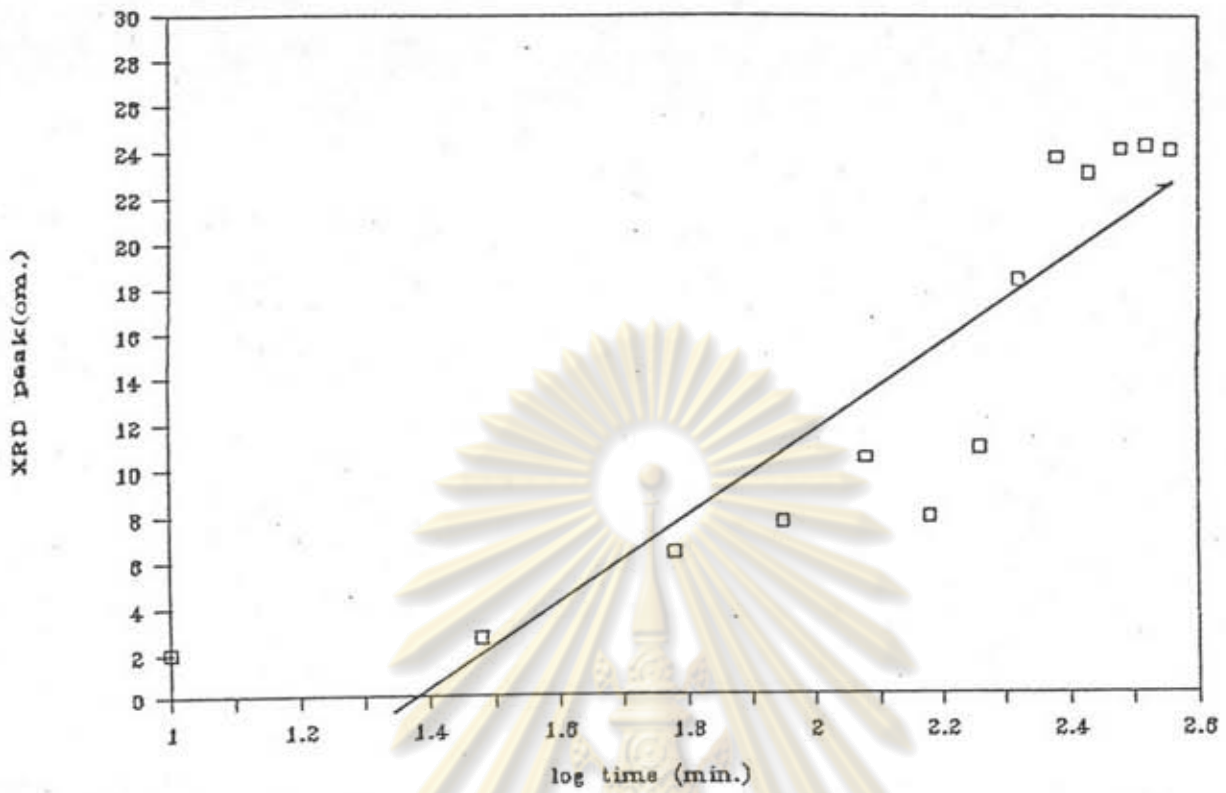
1300 °C	time (min)	log time	wt. density	avg(den.)	Il/Io	avg(Il/Io)	XRD	
10	1.00		0.5865	2.16	2.16	63.90	63.90	2
30	1.48		0.5914	2.20	2.20	71.47	71.65	
	1.48		0.6102	2.20	2.20	72.57	71.65	
	1.48		0.5974	2.21	2.20	71.47	71.65	
	1.48		0.5978	2.20	2.20	71.10	71.65	2.6
60	1.78		0.5420	2.16	2.18	71.05	71.69	
	1.78		0.5777	2.18	2.18	71.71	71.69	
	1.78		0.5557	2.18	2.18	72.22	71.69	
	1.78		0.5652	2.20	2.18	71.77	71.69	6.25
90	1.95		0.6178	2.16	2.16	70.85	71.41	
	1.95		0.5455	2.14	2.16	71.87	71.41	
	1.95		0.5857	2.18	2.16	71.69	71.41	
	1.95		0.5992	2.16	2.16	71.23	71.41	7.55
120	2.08		0.5168	2.11	2.11	70.75	72.09	
	2.08		0.5975	2.15	2.11	67.04	72.09	10.3
	2.08		0.5487	2.11	2.11	77.74	72.09	
	2.08		0.5545	2.08	2.11	72.84	72.09	
150	2.18		0.5754	2.10	2.10	71.64	71.48	
	2.18		0.5951	2.10	2.10	71.01	71.48	
	2.18		0.5328	2.10	2.10	70.99	71.48	7.75
	2.18		0.5352	2.10	2.10	72.26	71.48	
180	2.26		0.5376	2.10	2.08	70.77	71.32	
	2.26		0.6029	2.16	2.08	73.35	71.32	
	2.26		0.5289	2.01	2.08	69.97	71.32	
	2.26		0.5395	2.06	2.08	71.19	71.32	10.68
210	2.32		0.4817	2.03	2.05	72.82	71.67	18.5
	2.32		0.4654	2.03	2.05	69.65	71.67	
	2.32		0.5166	2.06	2.05	73.51	71.67	
	2.32		0.4703	2.01	2.05	72.39	71.67	
240	2.32		0.4979	2.12	2.05	69.97	71.67	
	2.38		0.4640	2.04	2.05	71.33	72.43	23.8
	2.38		0.5653	2.03	2.05	71.01	72.43	19.3
	2.38		0.5524	2.10	2.05	76.55	72.43	
270	2.38		0.6228	2.02	2.05	68.83	72.43	
	2.43		0.5808	2.04	2.04	72.94	72.11	23.1
	2.43		0.5339	1.96	2.04	71.47	72.11	
	2.43		0.5354	2.07	2.04	71.98	72.11	
300	2.43		0.5415	2.03	2.04	78.11	72.11	
	2.43		0.5721	2.09	2.04	66.05	72.11	
	2.48		0.5233	1.96	1.96	71.98	72.16	24.15
	2.48		0.5575	1.92	1.96	71.47	72.16	
330	2.48		0.5438	1.98	1.96	74.69	72.16	
	2.48		0.5873	1.88	1.96	72.37	72.16	
	2.48		0.5115	2.05	1.96	70.39	72.16	
	2.52		0.5141	1.99	2.02	74.68	71.96	24.3
360	2.52		0.4981	2.02	2.02	70.96	71.96	
	2.52		0.5683	2.05	2.02	71.87	71.96	
	2.52		0.5149	1.98	2.02	71.23	71.96	
	2.52		0.5400	2.04	2.02	71.05	71.96	
360	2.56		0.5282	1.99	2.02	70.73	72.03	24.1
	2.56		0.5163	1.99	2.02	73.13	72.03	18.15
	2.56		0.4990	2.02	2.02	71.86	72.03	
	2.56		0.5193	2.09	2.02	72.38	72.03	

sintering 1300°C



sintering 1300°C





ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

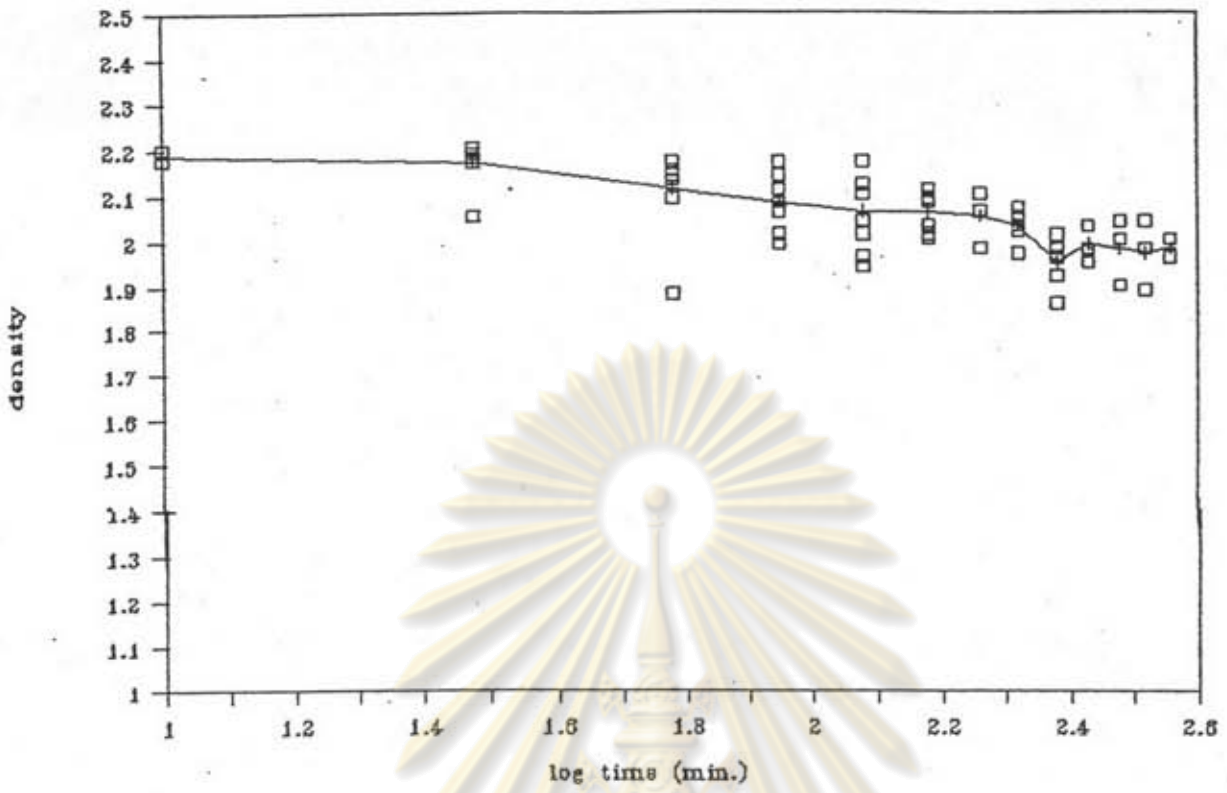
1350 °C

time(min)	log time	wt. density	avg(dens.)	II/Io	avg(II/Io)	IRD
10	1.00	0.5514	2.18	2.19	70.15	71.11
	1.00	0.5735	2.20	2.19	70.91	71.11
	1.00	0.5427	2.20	2.19	72.26	71.11
30	1.48	0.5271	2.18	2.17	70.78	73.42
	1.48	0.5349	2.17	2.17	69.35	73.42
	1.48	0.4789	2.18	2.17	73.11	73.42
	1.48	0.5561	2.05	2.17	71.04	73.42
	1.48	0.5188	2.19	2.17	71.56	73.42
	1.48	0.5212	2.19	2.17	72.37	73.42
	1.48	0.5920	2.20	2.17	86.94	73.42
	1.48	0.5205	2.20	2.17	72.20	73.42
60	1.78	0.4645	2.15	2.11	69.64	72.18
	1.78	0.4470	2.14	2.11	81.39	72.18
	1.78	0.5414	2.17	2.11	71.25	72.18
	1.78	0.5105	2.13	2.11	70.97	72.18
	1.78	0.4942	2.09	2.11	68.79	72.18
	1.78	0.5741	2.13	2.11	72.75	72.18
	1.78	0.5625	2.15	2.11	71.80	72.18
	1.78	0.5427	1.88	2.11	70.87	72.18
90	1.95	0.5334	1.99	2.08	69.18	72.57
	1.95	0.4757	2.08	2.08	71.94	72.57
	1.95	0.4837	2.01	2.08	77.03	72.57
	1.95	0.5043	2.14	2.08	73.05	72.57
	1.95	0.4923	2.11	2.08	70.78	72.57
	1.95	0.5469	2.17	2.08	72.24	72.57
	1.95	0.4946	2.06	2.08	73.79	72.57
120	2.08	0.5028	2.01	2.06	67.66	71.10
	2.08	0.5296	1.94	2.06	71.48	71.10
	2.08	0.5058	2.12	2.06	70.96	71.10
	2.08	0.4923	2.10	2.06	70.96	71.10
	2.08	0.4938	2.04	2.06	72.19	71.10
	2.08	0.5551	1.95	2.06	71.33	71.10
	2.08	0.5442	2.17	2.06	72.76	71.10
	2.08	0.5003	2.10	2.06	70.96	71.10
150	2.18	0.5353	2.03	2.06	71.56	71.09
	2.18	0.5162	2.09	2.06	71.25	71.09
	2.18	0.5027	2.11	2.06	70.31	71.09
	2.18	0.5354	2.00	2.06	74.12	71.09
	2.18	0.5421	2.01	2.06	67.99	71.09
	2.18	0.5677	2.08	2.06	70.27	71.09
	2.18	0.5399	2.09	2.06	72.12	71.09
180	2.26	0.5369	1.98	2.05	71.25	70.99
	2.26	0.5176	2.10	2.05	71.04	70.99
	2.26	0.4797	2.06	2.05	70.68	70.99
210	2.72	0.5415	2.05	2.03	70.44	70.78
	2.32	0.5327	2.37	2.03	70.13	70.78
	2.32	0.5740	2.03	2.03	71.47	70.78
	2.32	0.5232	2.02	2.03	69.58	70.78
	2.32	0.5463	1.97	2.03	72.26	70.78
240	2.38	0.5236	1.96	1.95	72.40	71.46
	2.38	0.5188	1.92	1.95	71.82	71.46
	2.38	0.5083	1.98	1.95	72.73	71.46
	2.38	0.5251	1.96	1.95	69.87	71.46
	2.38	0.5475	1.86	1.95	71.25	71.46
	2.38	0.5350	2.01	1.95	71.95	71.46
	2.38	0.4938	1.96	1.95	70.22	71.46
270	2.43	0.5040	2.03	1.99	71.16	71.58
	2.43	0.6128	1.98	1.99	71.76	71.58
	2.43	0.6128	1.95	1.99	71.81	71.58
300	2.48	0.5645	2.04	1.98	70.77	71.80
	2.48	0.5419	1.90	1.98	72.08	71.80
	2.48	0.6107	2.00	1.98	72.56	71.80
330	2.52	0.5222	2.04	1.97	69.81	70.66
	2.52	0.5258	1.98	1.97	70.16	70.66
	2.52	0.4506	1.89	1.97	72.00	70.66
360	2.56	0.4320	2.00	1.98	69.53	72.64
	2.56	0.4276	1.9	1.98	75.75	72.64

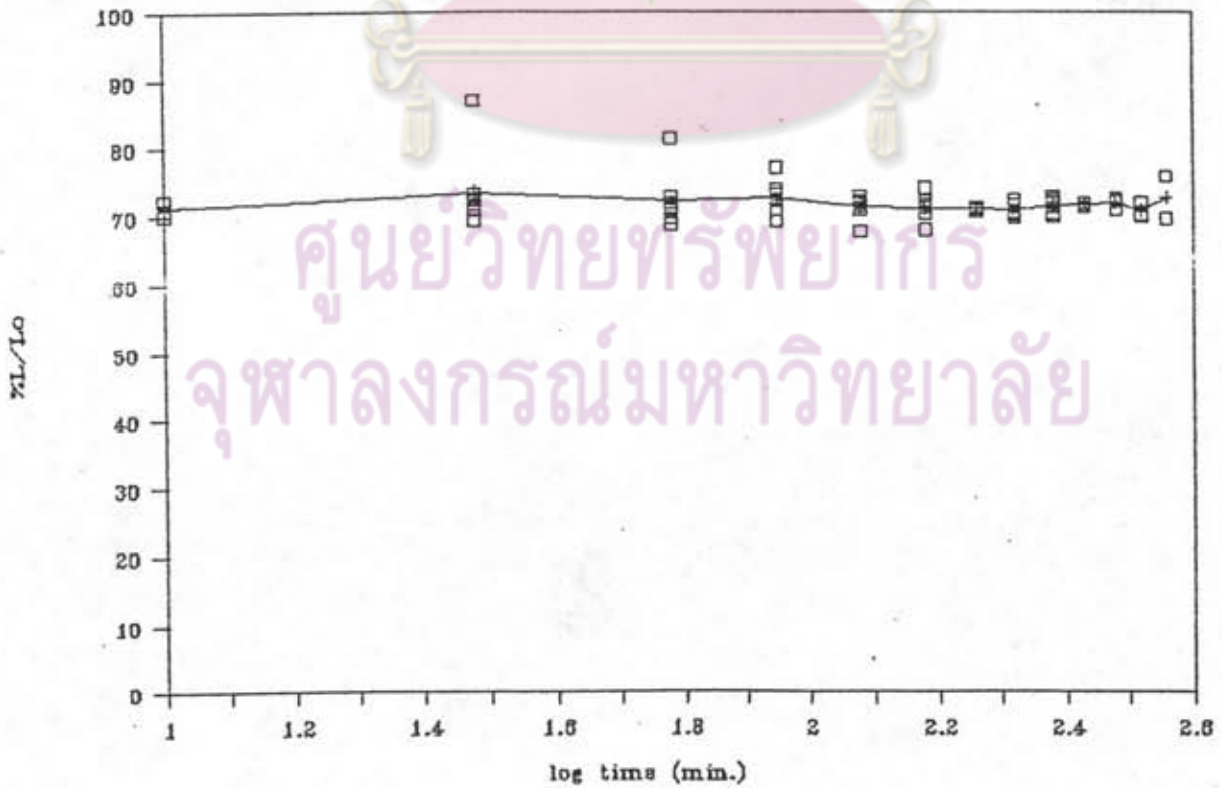
ศูนย์ปฏิบัติการ
จุฬาลงกรณ์มหาวิทยาลัย

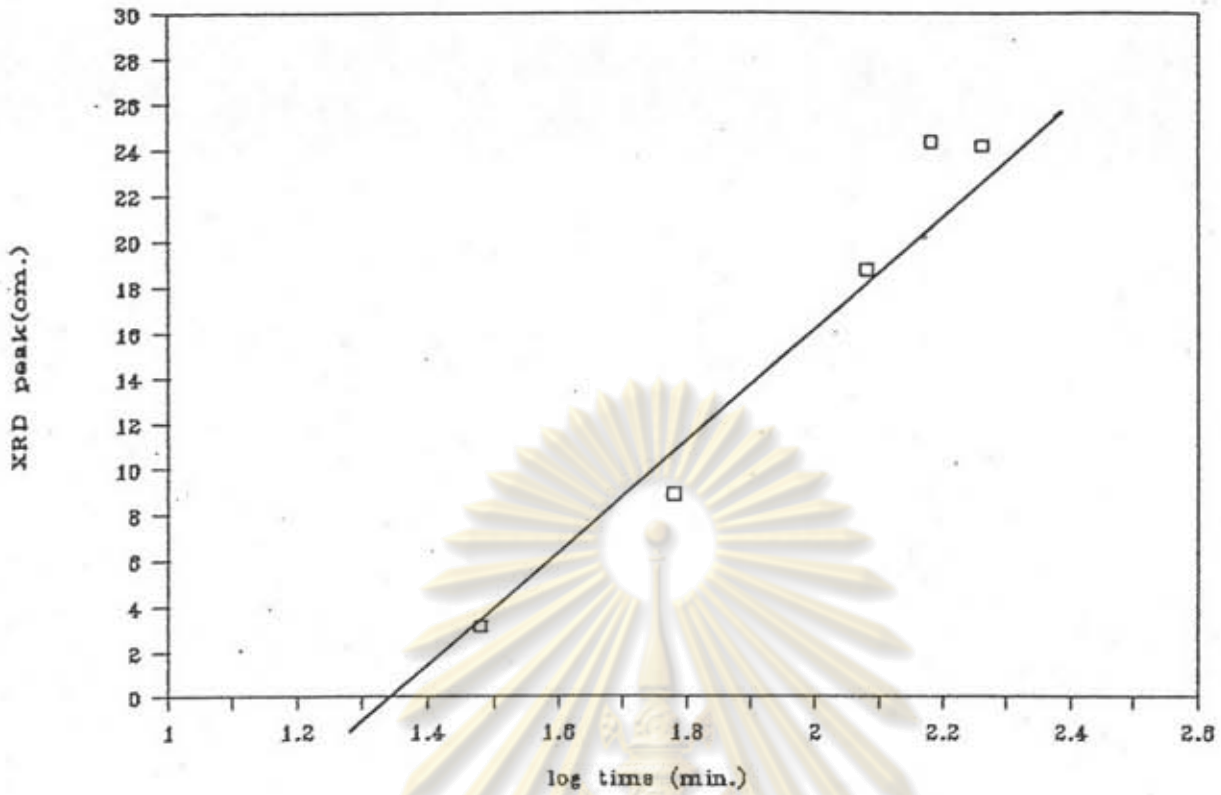
sintering 1350 °C

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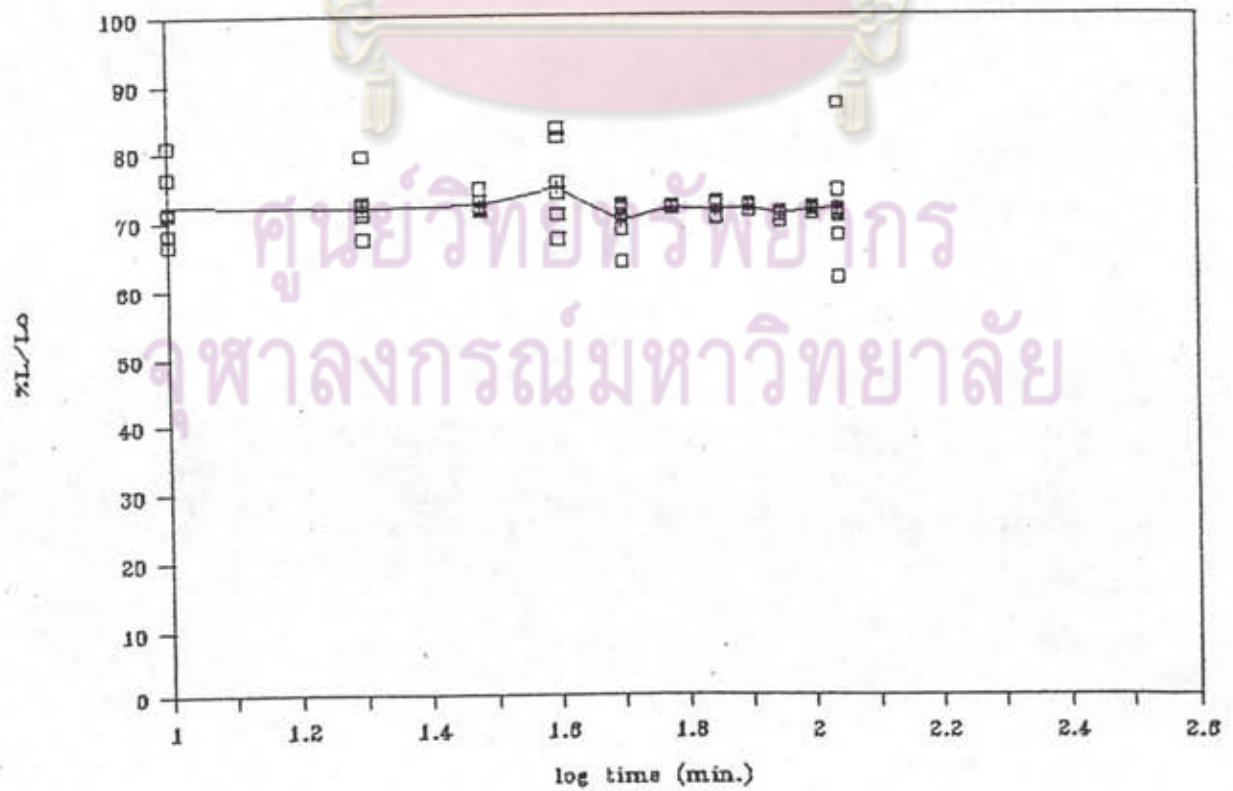
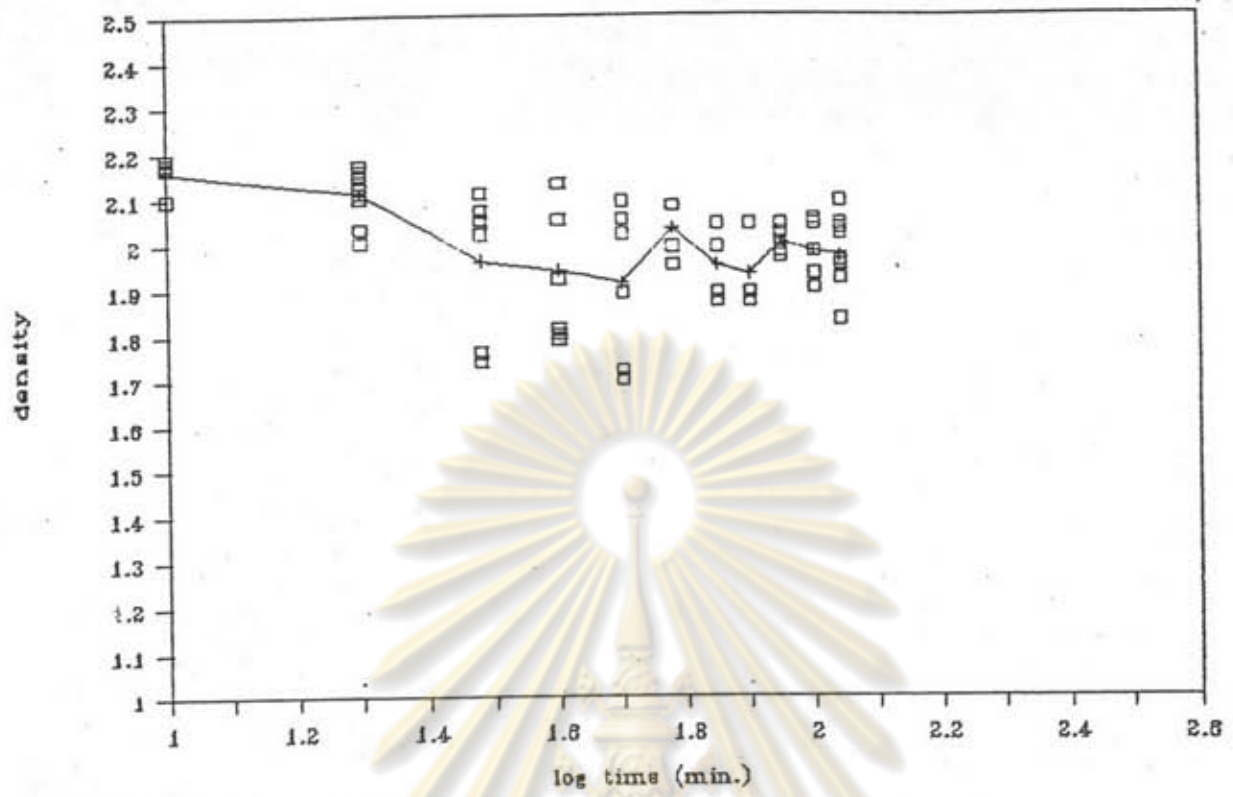
sintering 1350 °C

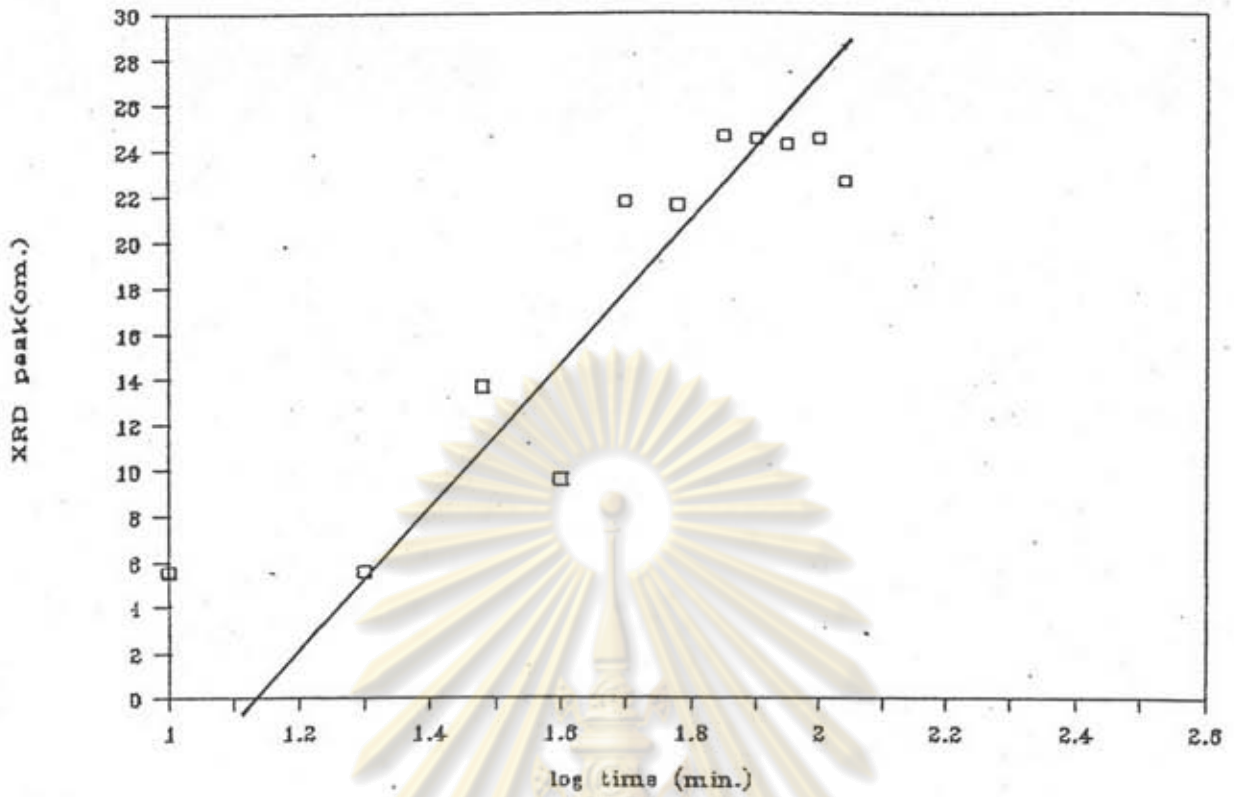




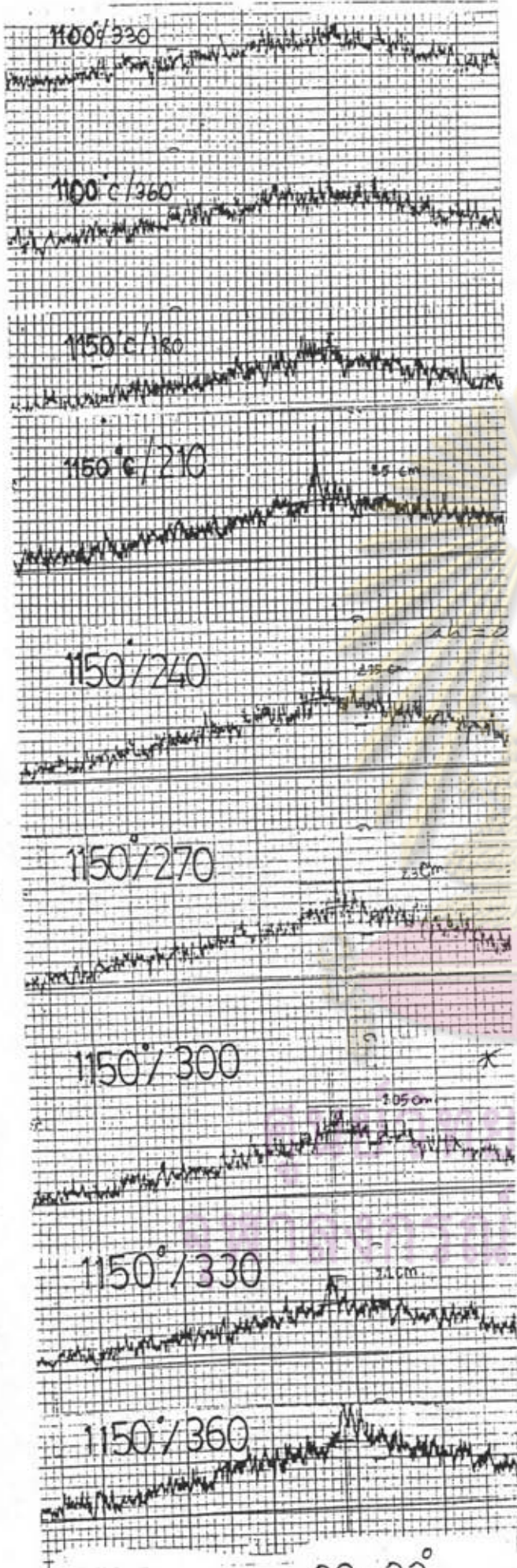
ศูนย์วิจัยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

1400 °C							
time(min)	log time	wt. density	avg(den.)	I1/I0	avg(I1/I0)	IRD	
10	1.00	0.5216	2.17	2.16	71.57	72.50	
	1.00	0.4284	2.18	2.16	68.27	72.50	
	1.00	0.3946	2.17	2.16	81.03	72.50	
	1.00	0.5836	2.17	2.16	71.26	72.50	5.6
	1.00	0.5500	2.19	2.16	76.39	72.50	
	1.00	0.5212	2.10	2.16	66.46	72.50	
20	1.30	0.5110	2.15	2.11	71.04	72.06	
	1.30	0.5022	2.17	2.11	71.00	72.06	
	1.30	0.4259	2.11	2.11	71.59	72.06	
	1.30	0.4237	2.16	2.11	70.77	72.06	
	1.30	0.4868	2.12	2.11	79.52	72.06	5.55
	1.30	0.5220	2.10	2.11	72.36	72.06	
	1.30	0.5674	2.00	2.11	72.78	72.06	
	1.30	0.5536	2.03	2.11	67.38	72.06	
30	1.48	0.5448	2.07	1.96	72.84	72.42	
	1.48	0.4176	2.02	1.96	71.43	72.42	
	1.48	0.4368	2.11	1.96	71.75	72.42	
	1.48	0.5525	2.05	1.96	71.83	72.42	
	1.48	0.5422	1.76	1.96	71.99	72.42	
	1.48	0.6020	1.74	1.96	74.69	72.42	13.65
40	1.60	0.4695	1.81	1.94	75.44	74.79	
	1.60	0.4572	1.80	1.94	82.01	74.79	
	1.60	0.5134	1.79	1.94	67.12	74.79	
	1.60	0.5431	2.13	1.94	70.82	74.79	
	1.60	0.4698	2.05	1.94	83.33	74.79	
	1.60	0.5641	2.05	1.94	73.91	74.79	
	1.60	0.5008	1.92	1.94	70.91	74.79	9.55
50	1.70	0.5053	1.70	1.91	68.55	69.80	
	1.70	0.5212	2.09	1.91	63.84	69.80	
	1.70	0.4293	2.05	1.91	70.77	69.80	
	1.70	0.5711	1.72	1.91	71.88	69.80	
	1.70	0.5652	2.02	1.91	72.29	69.80	21.70
	1.70	0.4712	1.89	1.91	71.48	69.80	
60	1.78	0.4003	2.08	2.03	71.67	71.86	
	1.78	0.5334	1.99	2.03	71.94	71.86	21.55
	1.78	0.5165	1.95	2.03	71.69	71.86	
	1.78	0.5235	2.08	2.03	72.13	71.86	
70	1.85	0.4067	1.99	1.95	70.36	71.36	
	1.85	0.4561	1.87	1.95	70.00	71.36	24.60
	1.85	0.4895	2.04	1.95	72.35	71.36	
	1.85	0.5307	1.89	1.95	72.73	71.36	
80	1.90	0.5891	1.87	1.93	72.04	71.88	24.50
	1.90	0.5381	2.04	1.93	72.33	71.88	
	1.90	0.5731	1.89	1.93	71.26	71.88	
90	1.95	0.4392	2.04	2.00	69.61	70.78	
	1.95	0.4525	2.02	2.00	70.67	70.78	
	1.95	0.5216	2.00	2.00	71.19	70.78	
	1.95	0.5792	1.93	2.00	71.17	70.78	24.25
	1.95	0.5720	1.97	2.00	71.25	70.78	
100	2.00	0.4929	2.05	1.98	71.58	71.45	
	2.00	0.4592	2.04	1.98	71.48	71.45	
	2.00	0.5316	1.90	1.98	71.43	71.45	
	2.00	0.5399	1.98	1.98	70.87	71.45	
	2.00	0.6001	1.93	1.98	71.87	71.45	24.50
110	2.04	0.4717	1.96	1.97	67.72	71.71	
	2.04	0.4736	2.02	1.97	61.38	71.71	
	2.04	0.4374	2.09	1.97	71.22	71.71	
	2.04	0.4010	2.04	1.97	86.94	71.71	
	2.04	0.5404	1.95	1.97	70.92	71.71	
	2.04	0.5355	1.92	1.97	71.47	71.71	
	2.04	0.5531	2.03	1.97	74.29	71.71	22.60
	2.04	0.4778	1.83	1.97	70.51	71.71	
	2.04	0.5668	1.92	1.97	70.90	71.71	

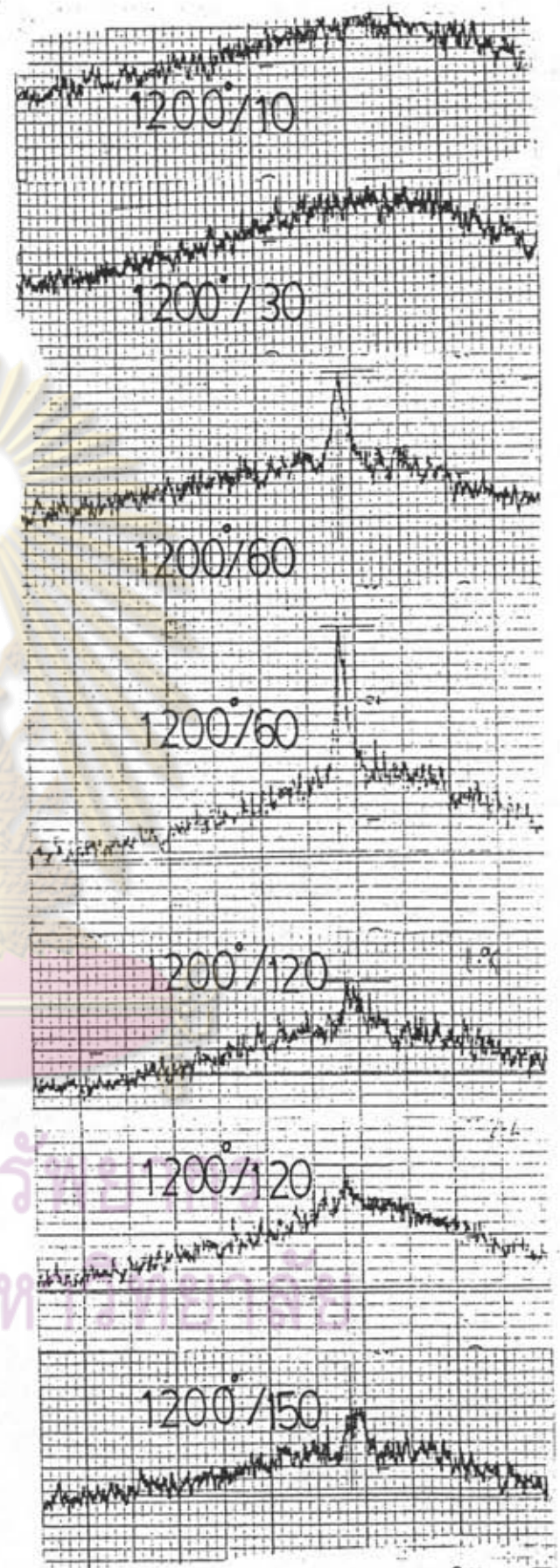




ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



$2\theta = 22^\circ$

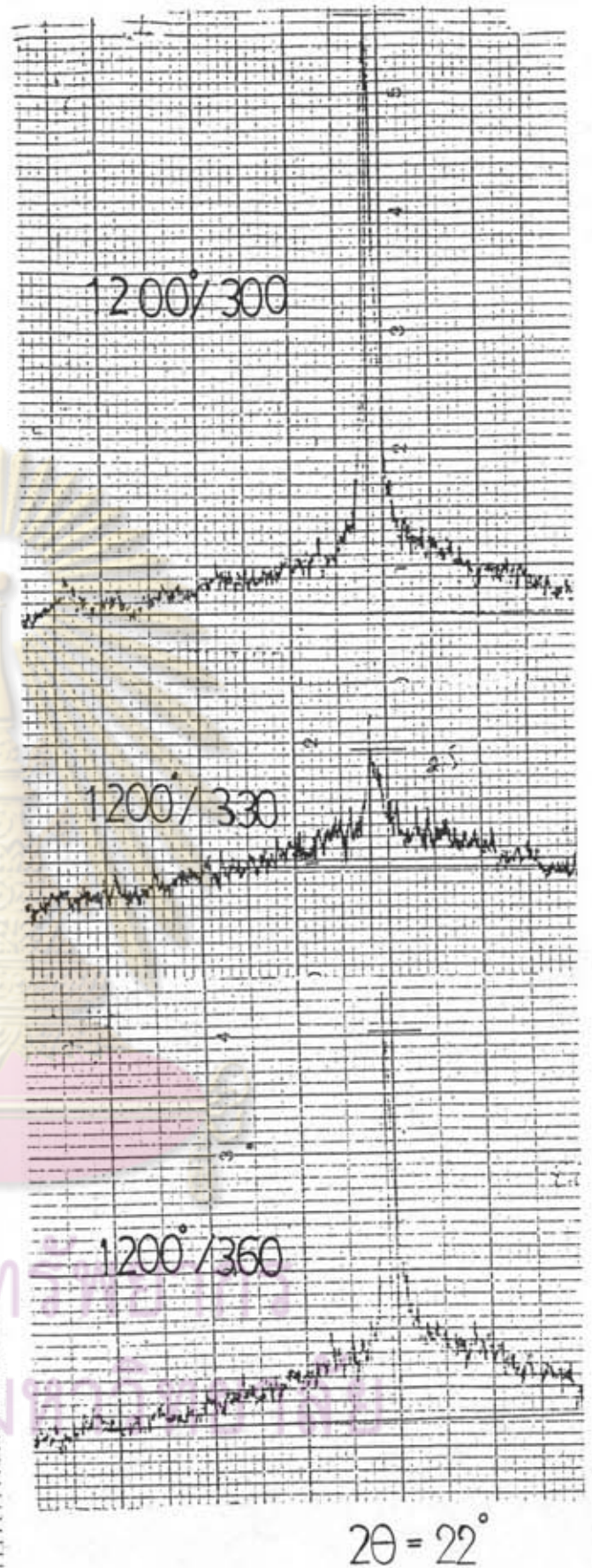
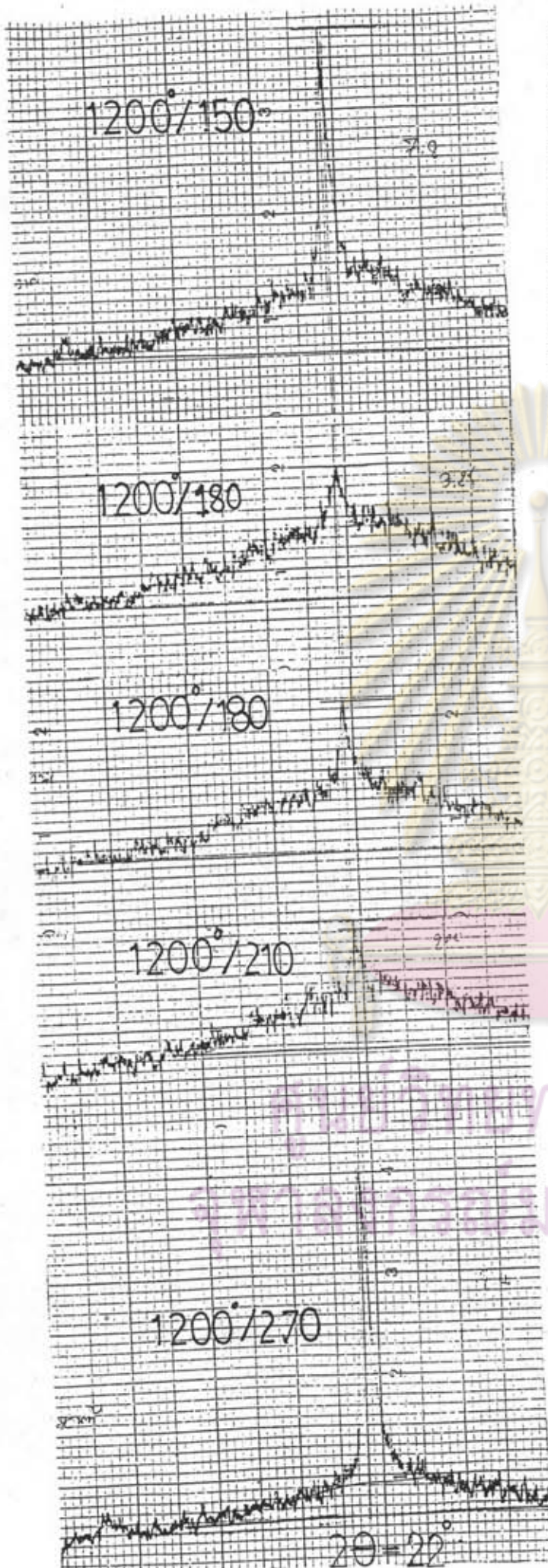


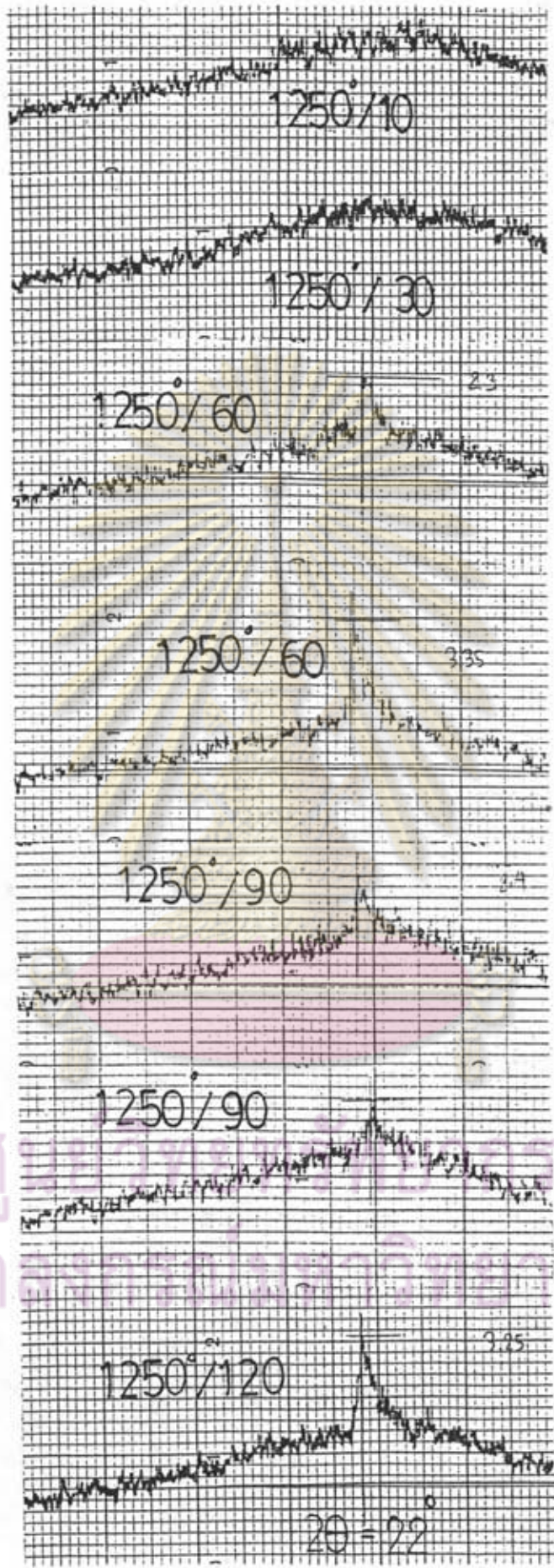
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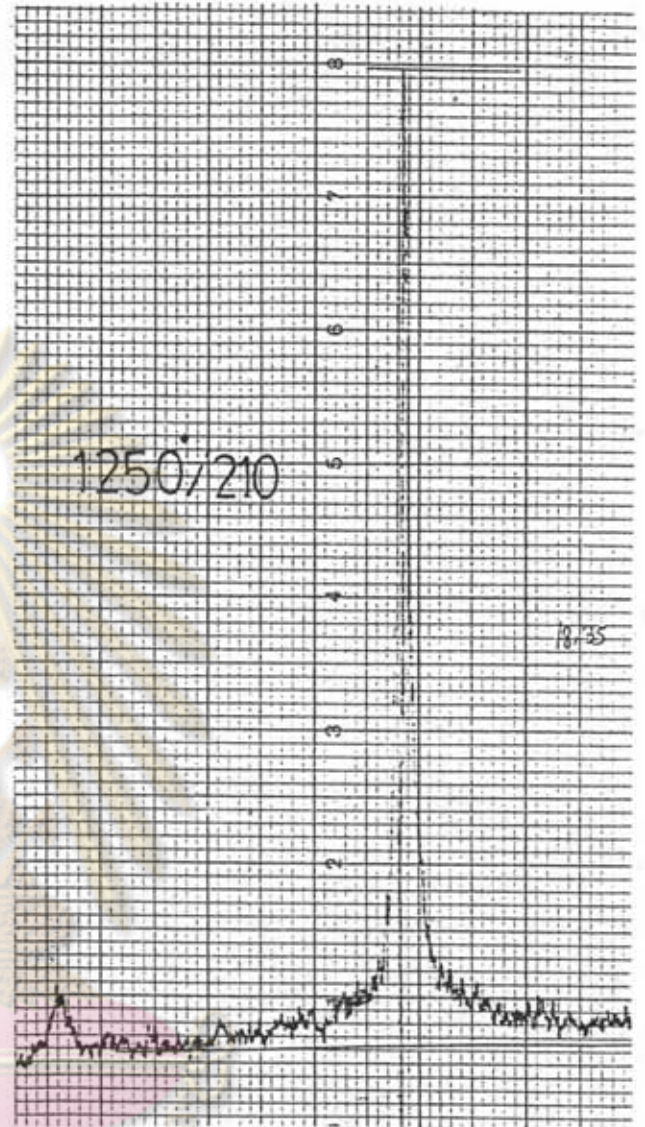
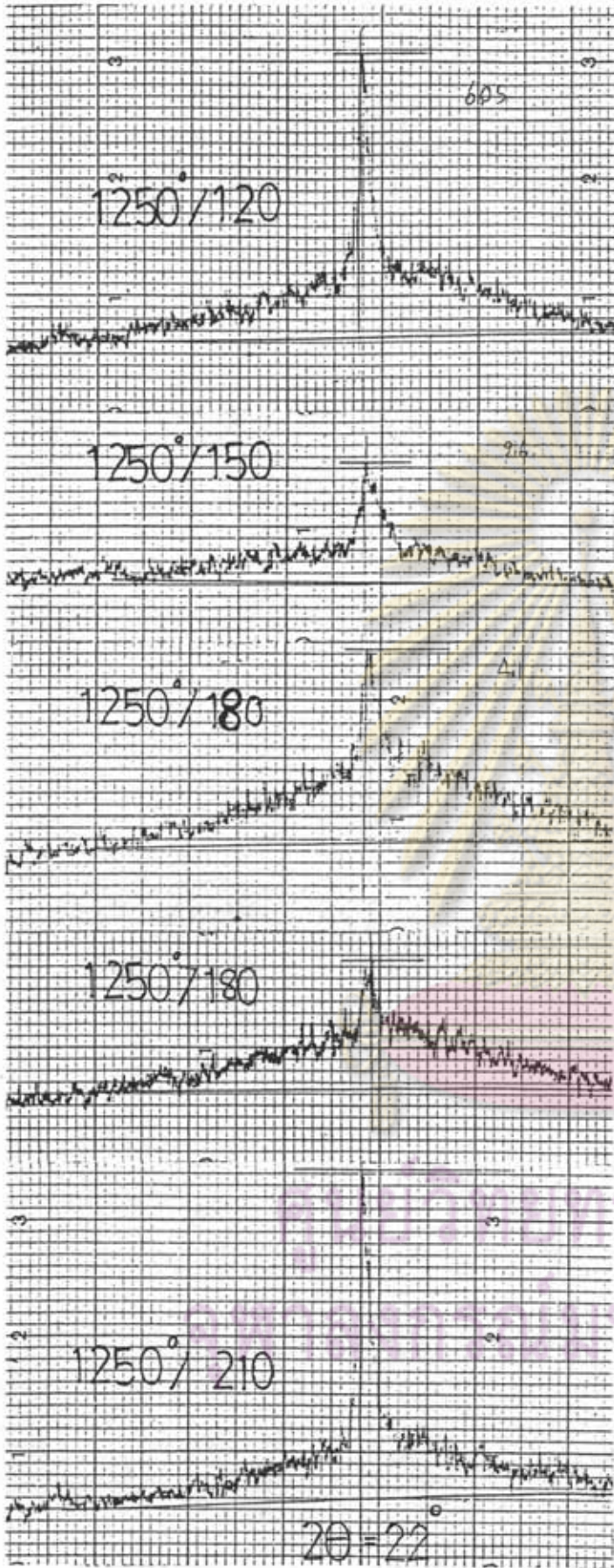
มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

ศูนย์วิจัยและพัฒนาเทคโนโลยี





คูหาจุฬาฯ
จุฬาลงกรณ์มหาวิทยาลัย

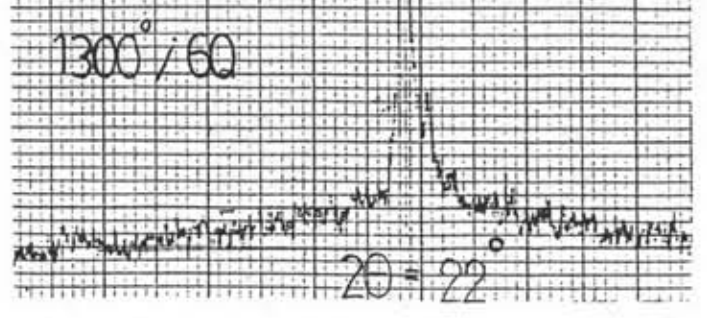
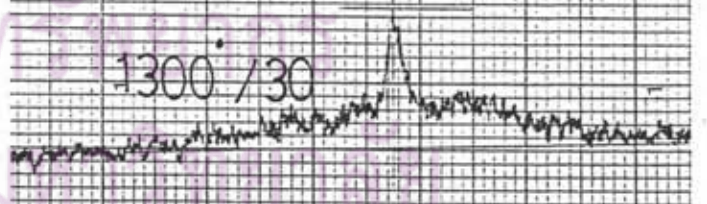
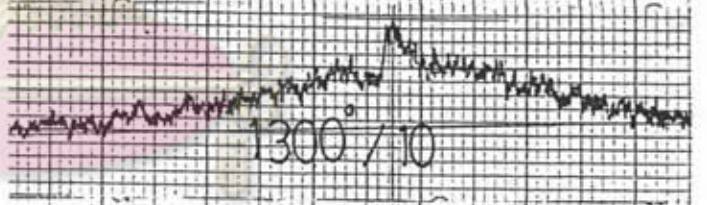
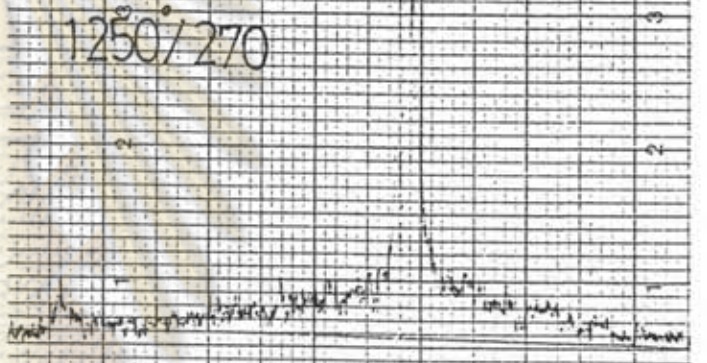
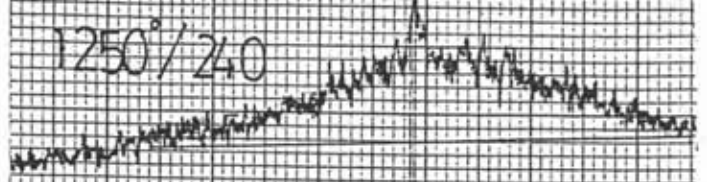
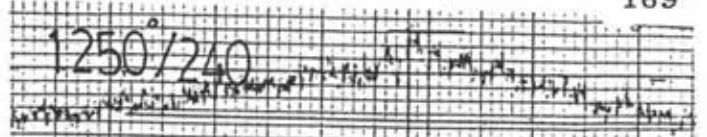


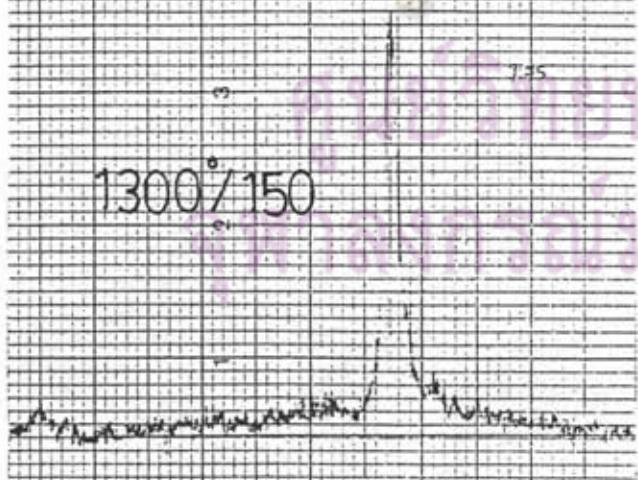
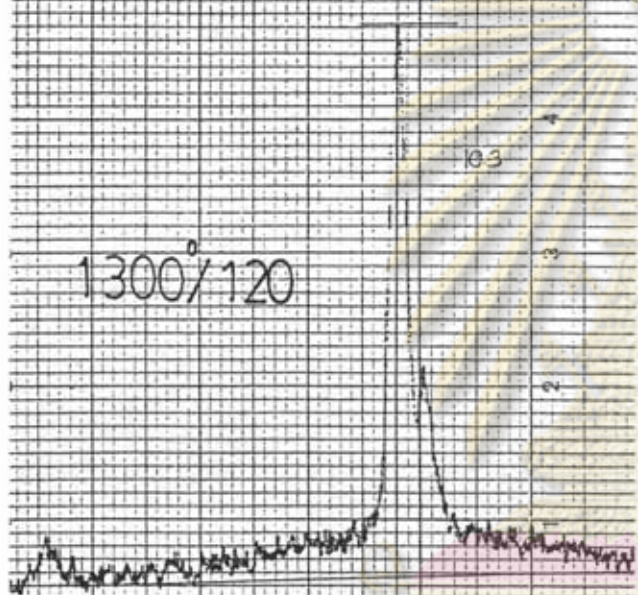
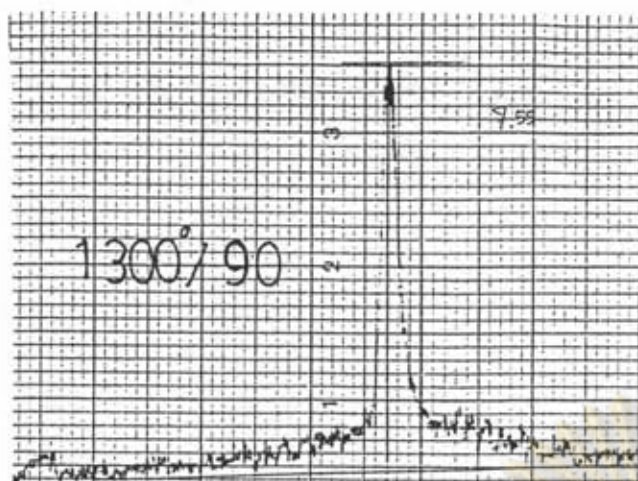
$2\theta = 22^\circ$

ศูนย์วิจัยทรัพยากร
ชีววิทยาและพันธุศาสตร์ มหาวิทยาลัย

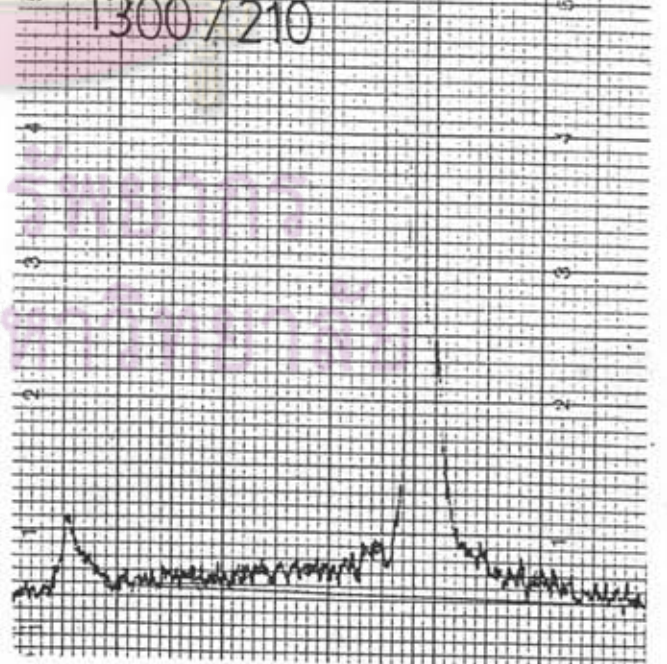
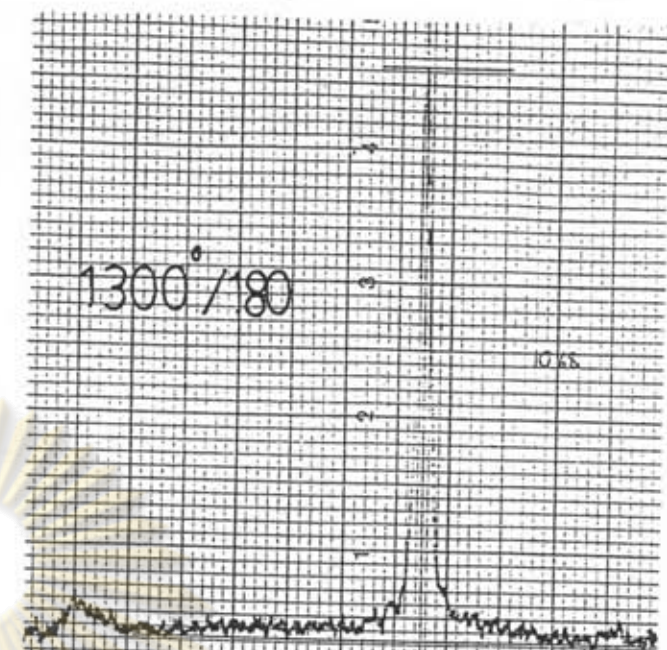


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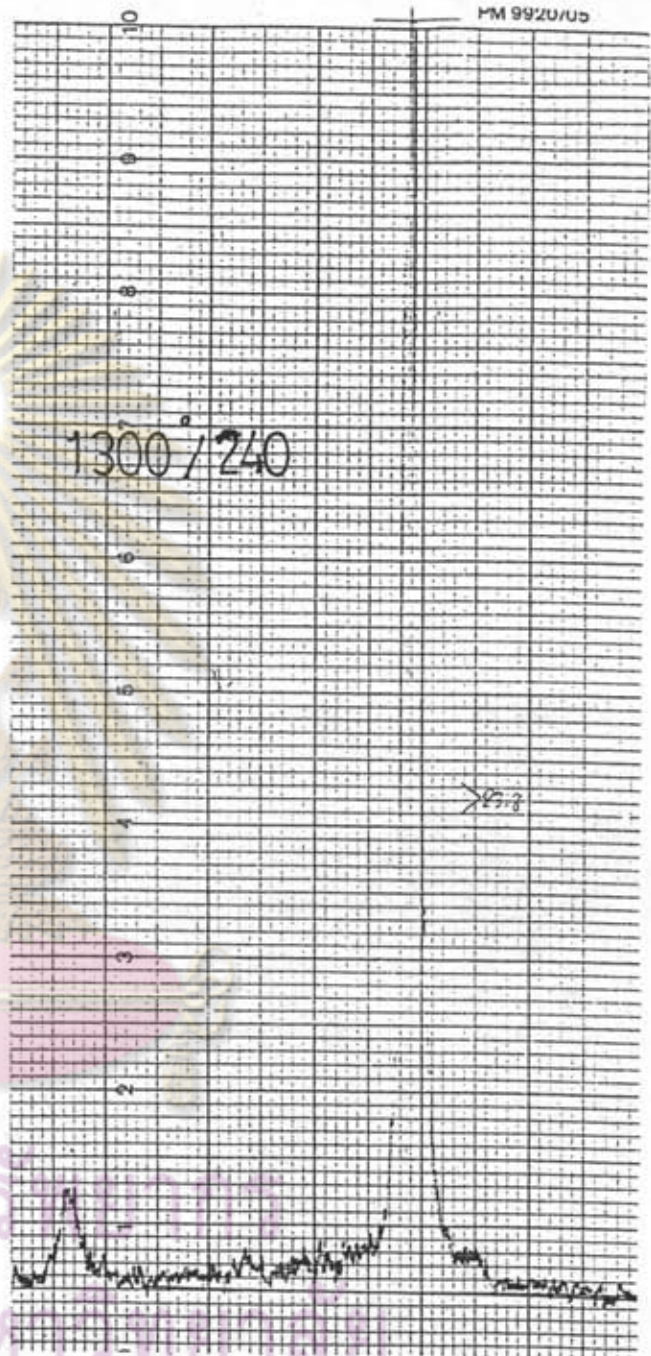
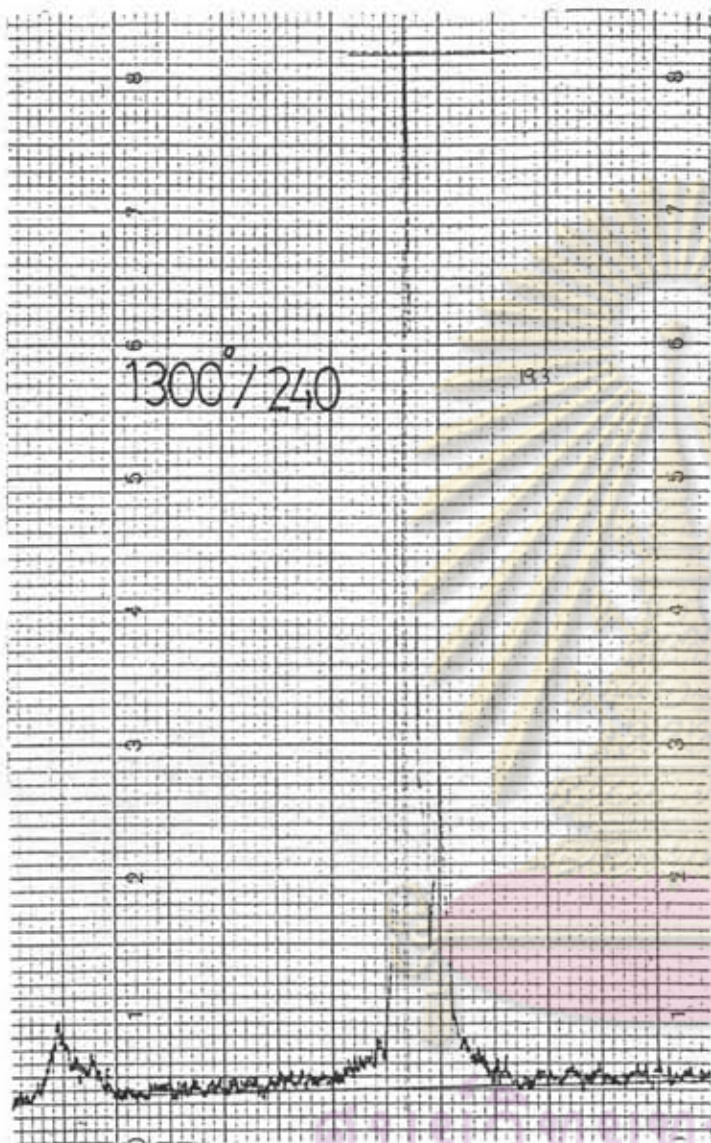


$$2\theta = 22^\circ$$



$$2\theta = 22^\circ$$

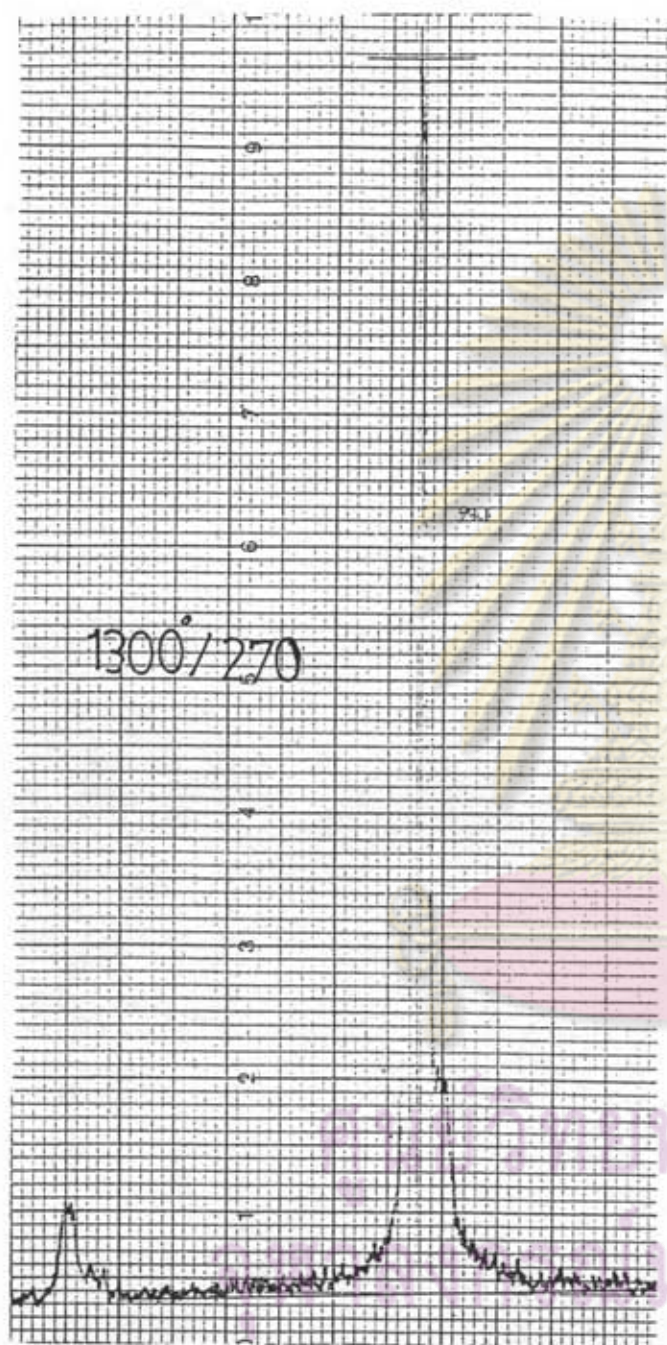
PM 9920/05



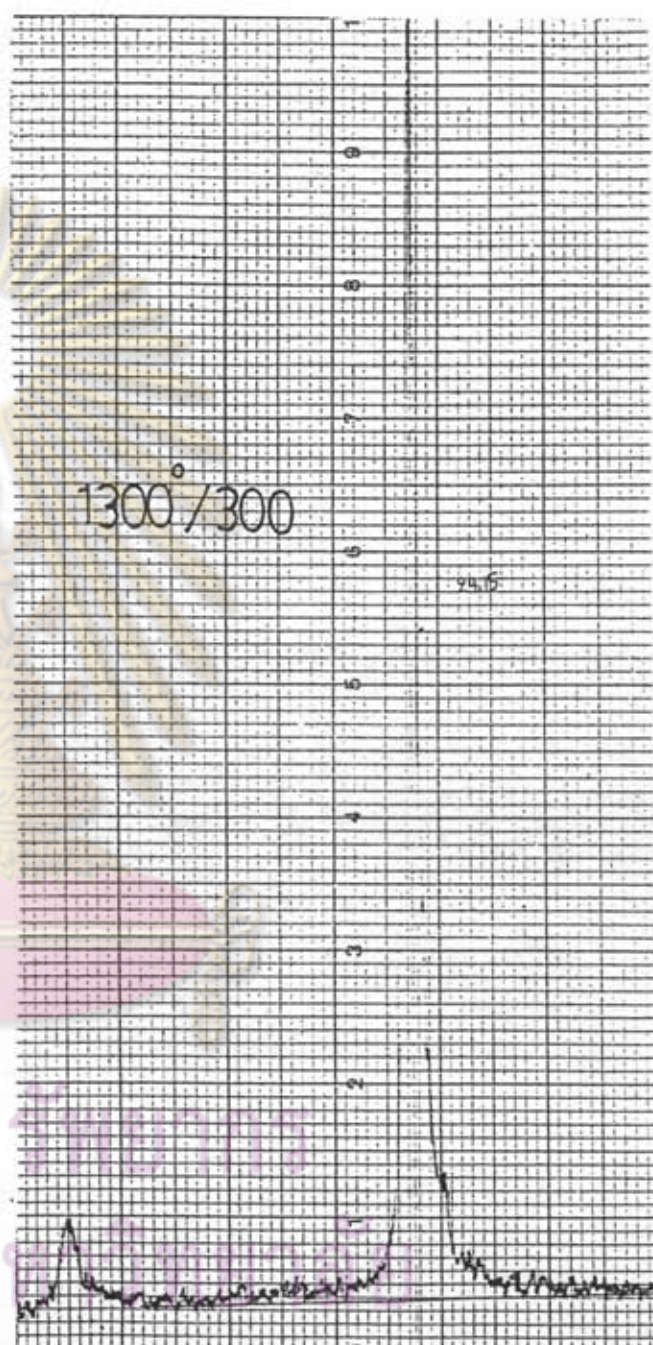
ศูนย์เทคโนโลยี
จุฬาลงกรณ์มหาวิทยาลัย

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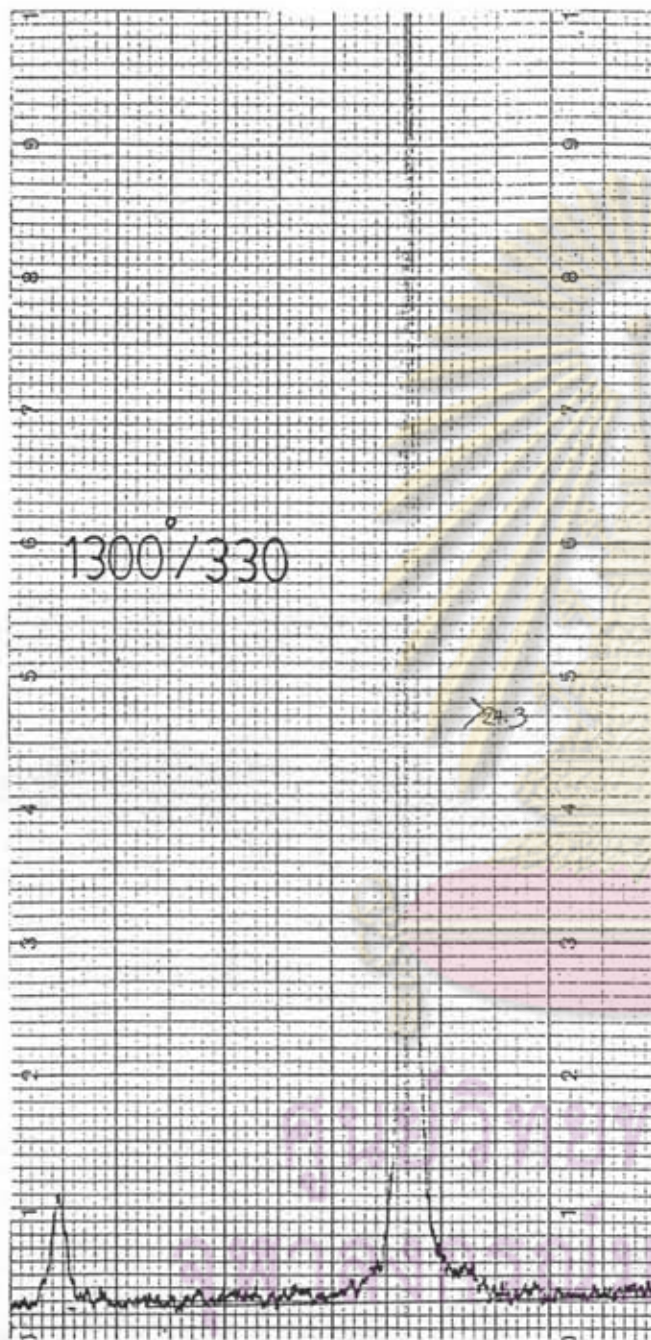
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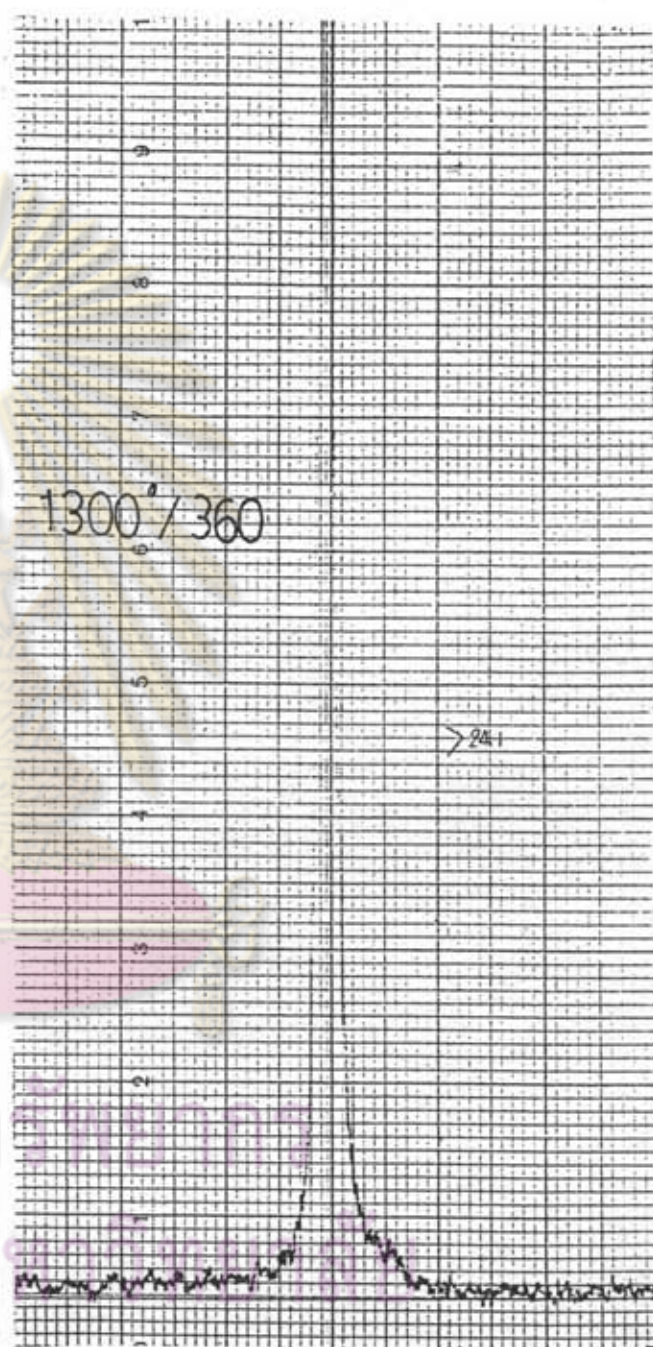
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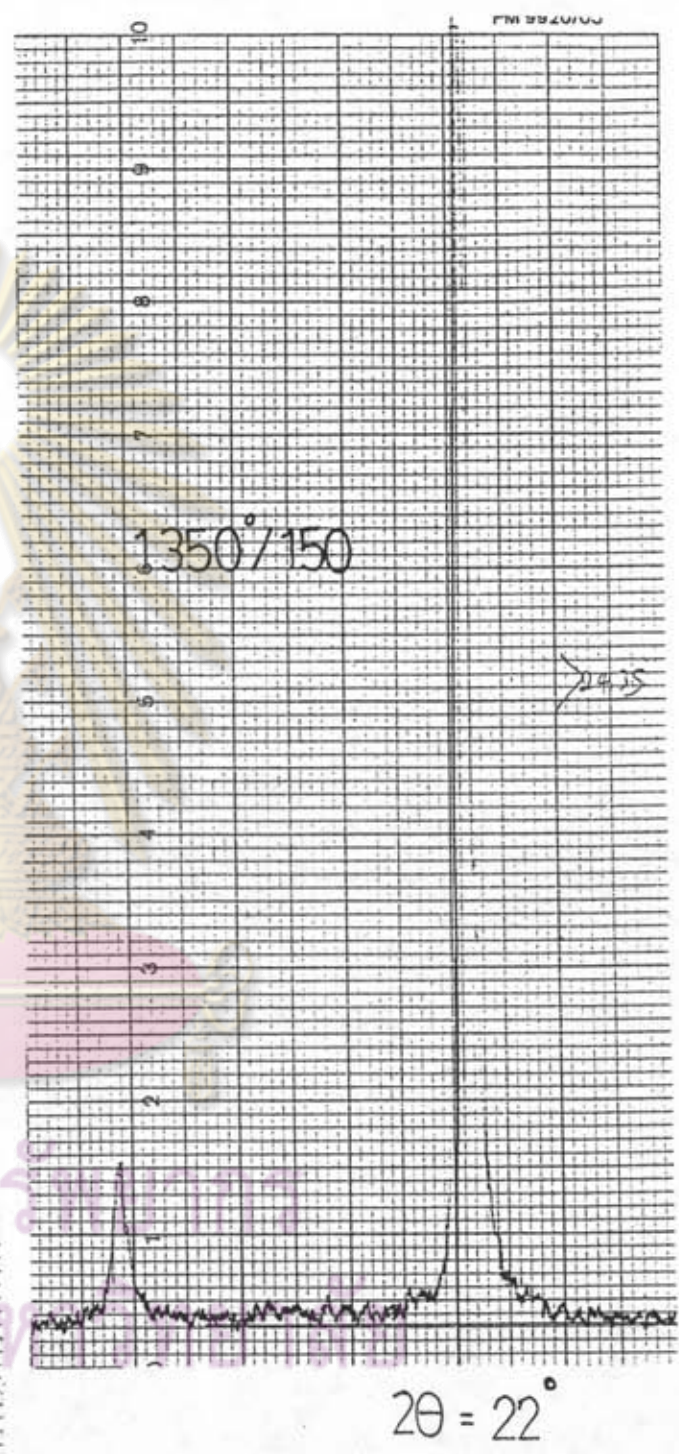
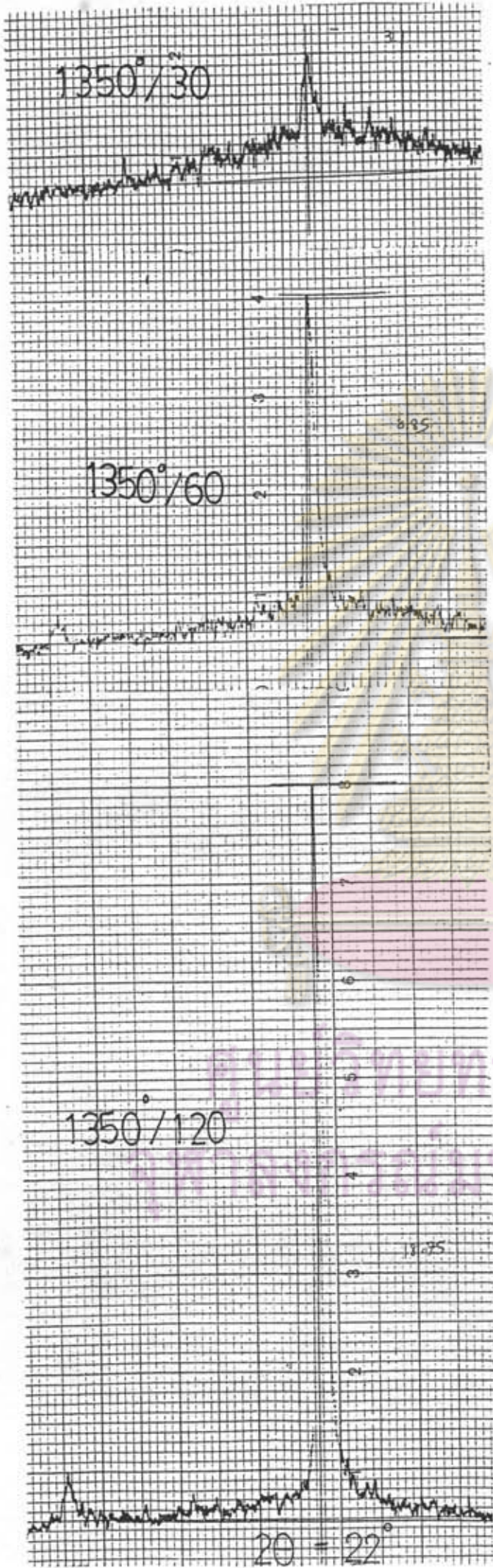
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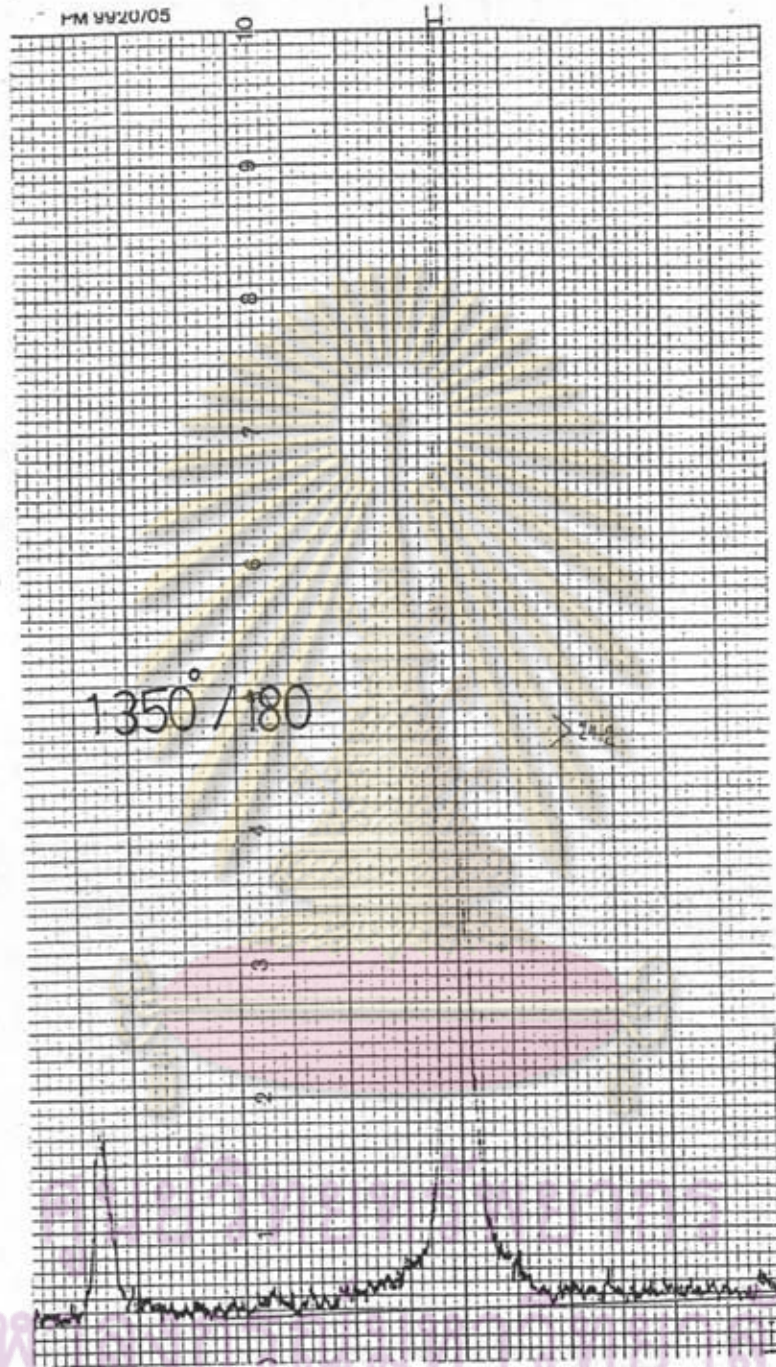


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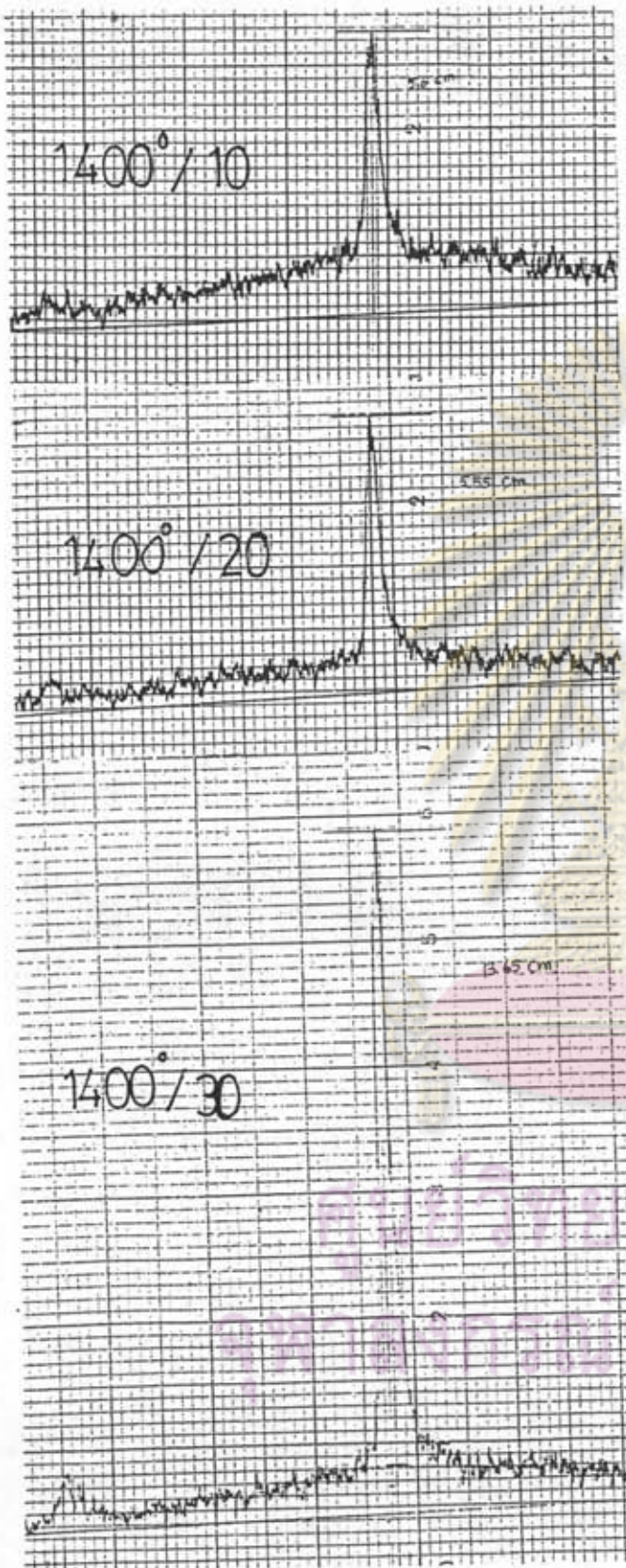


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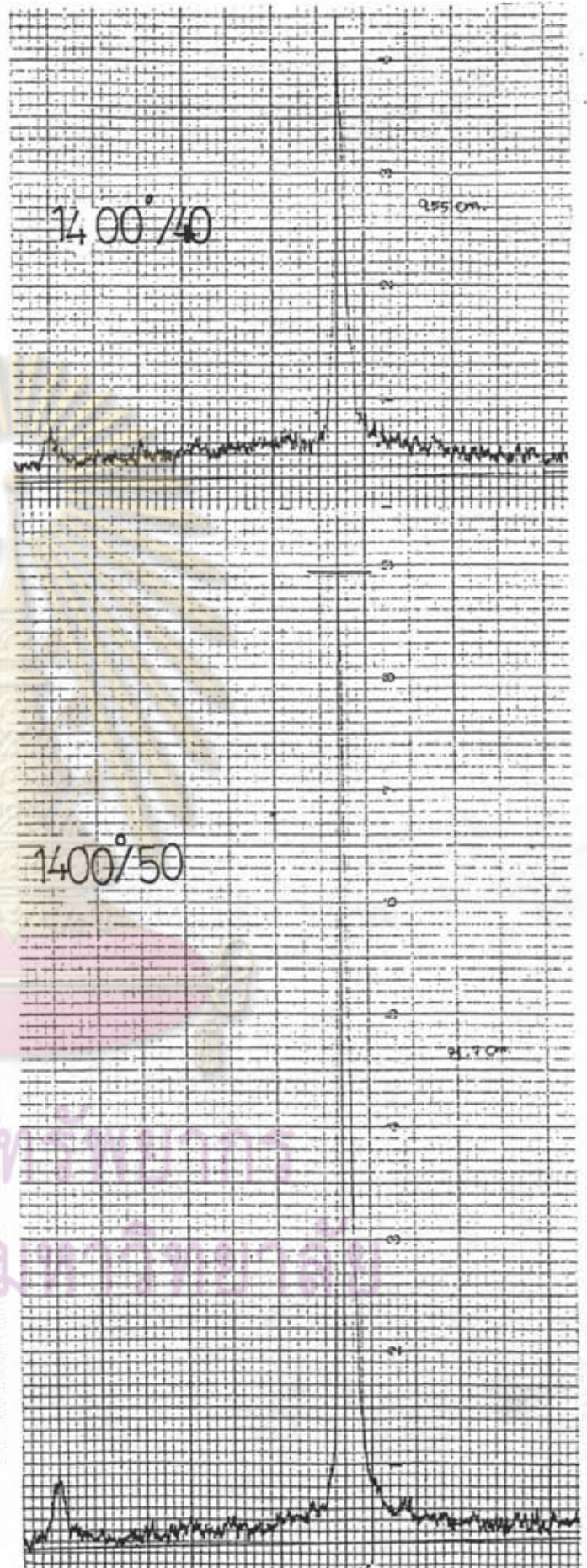




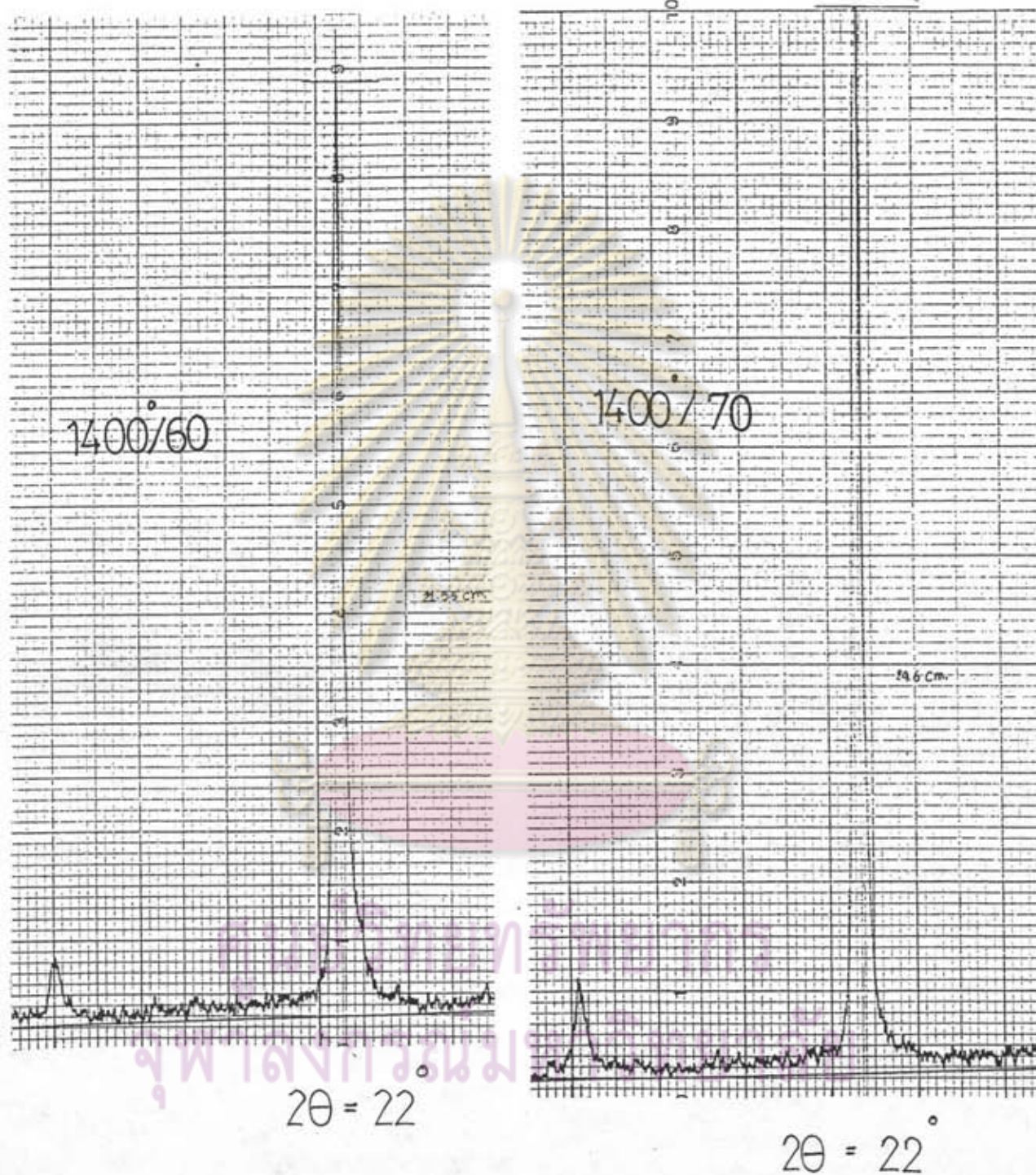
$$2\theta = 22^\circ$$



$$2\theta = 22^\circ$$

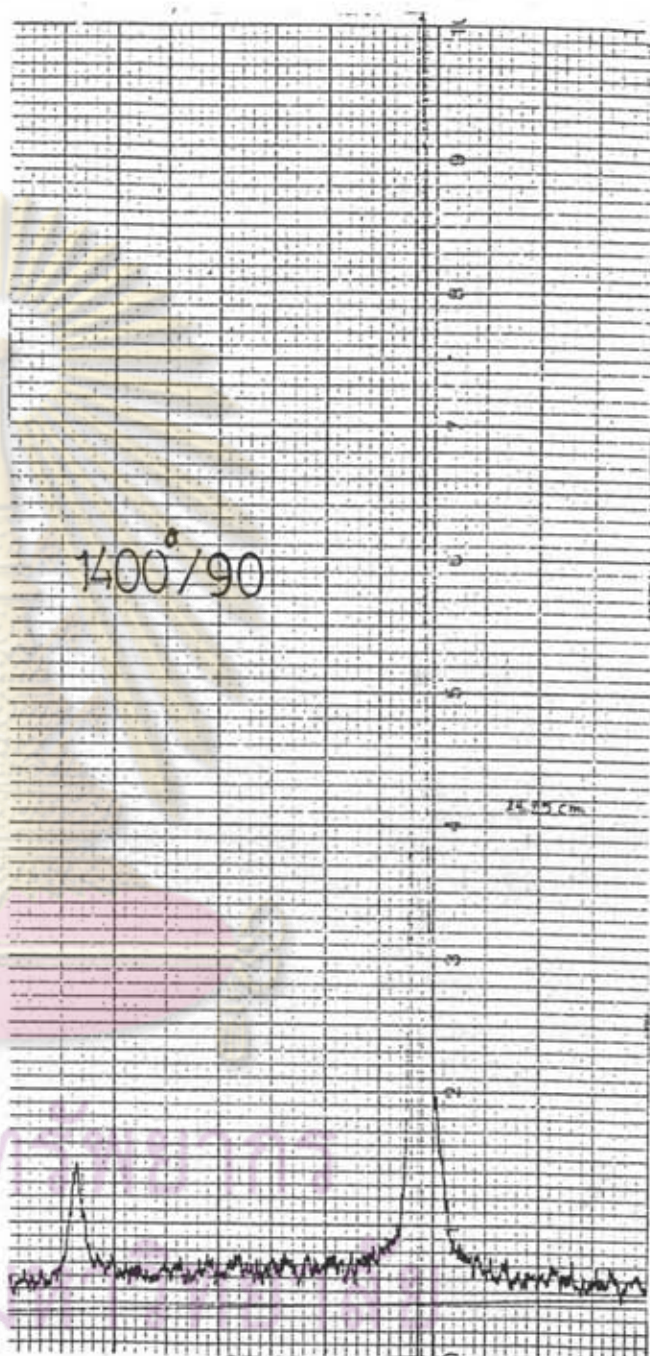


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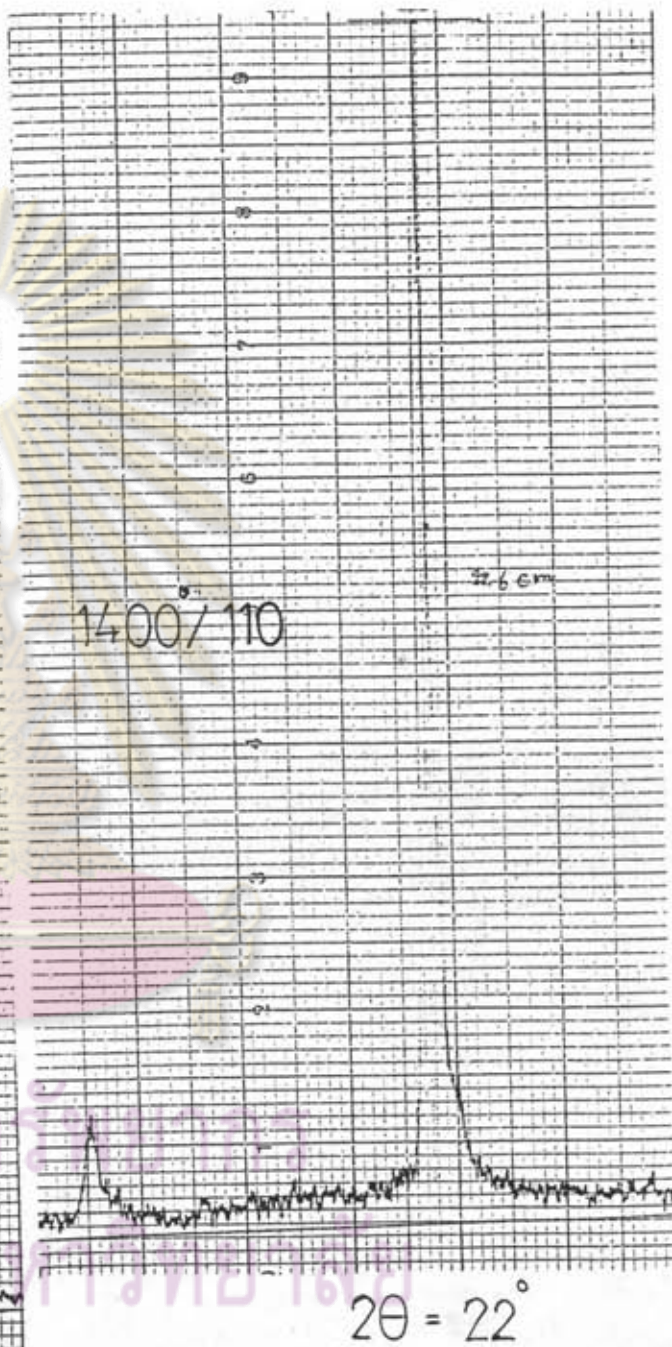


$$2\theta = 22^\circ$$



$$2\theta = 22^\circ$$

PHILIPS PM 9920/05



Vita

My name is Miss Nuchnapa Tungboriboon. I was born on 14th August, 1968 at Nakhonnayok province. I earned a B.S. in Chemistry from Srinakharinwirot University, Bangsaen, Chonburi, Thailand in 1988. My senior project research work entitled "Development of a method to determine the uranium and oxygen ratio in uranium oxides by volumetric titration" during June 1989-February 1990 at the Office of Atomic Energy for Peace, Bangkok, Bangkok, Thailand. Then I started to study M.S. in the Department of Materials Science at the Faculty of Science of Chulalongkorn University in June 1990. I finished M.S. in April 1993.



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย