Polycast Acrylic Sheets.

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1) Introduction:

One hundred and seventy sheets of acrylic have been purchased by SNO from Polycast. Polycast has performed various QC measurements on these sheets and in addition 6' by 4.5" coupons from each sheet have been shipped to CRL where additional QC measurements have been performed. Polycast has shipped the sheets to Reynolds Polymer Technology (RPT) in California who will be thermoforming and machining the sheets prior to shipment to Sudbury for vessel fabrication.

This report contains the details of the measurements performed by Polycast and by CRL on coupons from the sheets and the assumptions made about the sheets from these results. Reports of the optical [1] and radioactive [2] quality of the first 25% of the sheets have already been distributed. In addition most of the contents of this report have also been reported[3].

2) Sheet Inventory:

The sheet inventory is summarized in Table 1. Polycast has cell cast twelve batches of 2.2" material and three batches of 4.5" material. The 2.2" batches comprised 14 or 20 sheets and the 4.5" batches comprised up to 10 sheets. Table 1 lists only those sheets purchased and shipped to RPT. The gaps in the table represent sheets rejected by Polycast as failing to meet the SNO specifications. Based on sheet quality, each sheet has been assigned to the vessel (V), the qualification program (Q) or as a vessel spare (S). Batches 47, 48 and 93 were inferior from an optical point of view and batch 80 from a Th content point of view.

3) Polycast Quality Control Results.

Polycast has provided us with copies of their test results.

3.1 Thickness.

They made thickness measurements at 25 positions in each 2.2" sheet and 21 positions in each 4.5" sheet. The specifications required all measurements to be between 2.1" and 2.33" or 4.187" and 4.73". Since

Table 1. Sheet Inventory

Sheet	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Batch																				
47		Q	Q		Q															
48		Q	Q		Q			Q	Q		Q									
49	Q	V	Q	S	S		S	Q		Q	Q	Q	S							
79	V	V	V	V	V	V	S		S	V	S	V	V	V	S					
80	Q	Q	Q	Q	Q	Q	Q	Q		Q	Q	Q	Q	Q						
9	V	V	V	V	V	V	V		V	V	V	V	V	V	V					
10	V	V	V	V	V	V	V	V	V	V		V	V	V	V					
11	V	V	V	V	V	V	V	V	V	V	V	V	V	V						
12		V	V	V		V		Q	V	V	V	V	V	V	V					
13	V	V	Q	V		V	V			V				V		V		V		
14	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
15	V	V	V	V	V	V		V	V	V	V	V	V	V	V	V	V	V	V	V
93	Q	Q		Q	Q	Q	Q	S		Q										
94	V	S	V	V		S	V	V	V	V										
76		V	V		V															

Table 2. Minimum Thickness of each Sheet

bat	49	79	80	9	10	11	12	13	14	15	93	94	76
she													
1	2.157	2.174	2.141	2.175	2.192	2.16		2.185	2.19	2.199	4.508	4.478	
2	2.187	2.195	2.153	2.152	2.173	2.17	2.163	2.182	2.176	2.196	4.479	4.444	4.387
3	2.181	2.164	2.159	2.165	2.153	2.175	2.162	2.102	2.198	2.192		4.444	4.374
4	2.183	2.225	2.164	2.167	2.175	2.136	2.163	2.139	2.209	2.191	4.489	4.44	
5	2.195	2.218	2.191	2.196	2.148	2.179			2.18	2.202	4.469		4.368
6		2.198	2.188	2.17	2.16	2.151	2.18	2.173	2.214	2.212	4.433	4.413	
7	2.196	2.191	2.2	2.182	2.191	2.18		2.185	2.169		4.421	4.465	
8	2.165		2.177		2.173	2.15	2.166		2.168	2.215	4.486	4.454	
9		2.203		2.179	2.158	2.167	2.164		2.205	2.214		4.455	
10	2.173	2.224	2.157	2.188	2.169	2.178	2.179	2.157	2.194	2.201	4.433	4.342	
11	2.189	2.201	2.174	2.207		2.188	2.171		2.188	2.17			
12	2.187	2.193	2.21	2.188	2.184	2.198	2.159		2.192	2.182			
13	2.209	2.204	2.183	2.193	2.174	2.194	2.172		2.179	2.205			
14		2.19	2.201	2.202	2.193	2.189	2.193	2.202	2.187	2.201			
15		2.225		2.185	2.18		2.194		2.207	2.19			
16								2.191	2.209	2.196			
17									2.211	2.214			
18								2.198	2.201	2.2			
19									2.17	2.207			
20									2.183	2.197			

the buckling forces on the vessel are greater at the top than at the bottom it may be advantageous to placed the thicker panels in the upper hemisphere. Table 2 lists the minimum thickness measurement of each sheet as reported by Polycast. The distribution of these thicknesses are shown graphically in Figure 1.

3.2 Mechanical.

They have made five mechanical measurements on one sample from each batch. These measurements, summarized in Table 3, are all better than the specifications which are also indicated in Table 3. The mechanical properties measured were tensile strength, tensile elongation, tensile modulus, compressive deformation under load and residual monomer.

Table 3. Mechanical Properties.

Batch	Ten. Str.	Ten. Elon. %	Ten. Mod.	Comp. Def. %	Res. Mon. %	tot. inclus.	air parts. 0.3 /1 micron
Spec	9000	2	400000	1	1.6		2.1M / 8K
47	11500	5.9	499000	0.3	0.91	203	0.7 / 3.8
48	11600	4.9	517000	0.3	1.12	307	1.2 / 4.2
49	11600	4.6	532000	0.35	1.13	589	1.3 / 8.2
79	12000	4.9	551000	0.35	1.02	281	0.6 / 8.9
80	11100	4.6	547000	0.4	0.815	397	0.8 / 16
9	11700	5	516000	0.4	1.3	268	1.2 / 24
10	11600	5.1	555000	0.3	1.2	256	1.0 / 5.6
11	11700	5.5	590000	0.35	1.35	273	1.9 / 12
12	11600	4.3	549000	0.3	1.3	172	1.1 / 7.9
13	11500	5.4	437000	0.35	1.36	125	5.1/22
14	11700	5.84	495000	0.25	1.21	1231	0.8/8
15	11600	6.09	485000	0.2	1.23	510	0.9/7
93	11800	5.5	521000	0.25	1.43	92	1.6 / 7.5
94	11800	5.6	523000	0.4	1.2	197	1.9 / 12
76	11500	5.7	461000	0.2	1.4		3.1/14

3.3 Inclusions.

They inspected each sheet for fiber inclusions and voids and documented the number of each size from <0.125" to 1" in five increments. The total number of inclusions in each batch is listed in Table 3. Most batches had no inclusions greater than 0.5". The detail breakdown of the inclusion data is on file. SNO did not insist that Polycast adhere to the inclusion specification, choosing instead to rely on the radioactivity measurements.

3.4 Air Quality.

They measured the particulate density in the air near the casting machine when it was being assembled for each batch. The density in particles per cubic foot above 0.3 and 1 micron are listed in Table 3 where maximum values of 2.1×10^6 for 0.3 micron and 8×10^3 for 1 micron were the hoped-for limits. These limits were exceeded for a number of the batches. It was not practical for Polycast to stopped production during high dust levels and so the batches were made under potentially adverse conditions. A correlation with the particle density and the Th/U content would confirm that dust is the dominate source of radioactivity in the acrylic.

3.5 Optical Absorption.

They measured the optical absorption coefficient as a function of wavelength of samples from each sheet. Measurements were made on as cast material, on conditioned material and on material which had been heated to thermoforming temperatures and subsequently annealed. Similar measurements were made on samples from every sheet at CRL and the details of the Polycast results will be presented below with the CRL results. The optical quality of the acrylic deteriorates with every heat treatment but since the vessel must be made from thermoformed and annealed acrylic it will be those results which will be primarily of interest.

4) Th and U Content.

The Th and U content in the acrylic was measured by the three techniques [4] reported in SNO-STR-92-061 or AECL-10749. Primarily the technique of neutron activation followed by gamma ray counting of the Np and Pa was used, as this technique had been shown to be least susceptible to handling contamination [2]. Mass spectrometry measurements [5] were also made on samples from all batches and alpha spectroscopy measurements [6] were made on a few samples, to check for decay chain disequilibrium.

4.1 Neutron Activation Results.

Eight hundred gram blocks of acrylic were irradiated in the NRU reactor, the non-optical or saw cut surfaces were milled off so as to remove surface handling contamination and the block was vaporized to a residue which was then counted for Np and Pa [2]. Typically four blocks from each batch were measured. Table 4 lists the results and Fig 2 shows them graphically. Table 4 lists the CRL identification number (col. 1), the

Table 4. Neutron Activation Results.

ID		Sample	days cooling	hours of count		Th in pg/g	U in pg/g
128 done Mar 17, 1993 to 240 done Dec 6, 1994							
128		4704	13	24		0.06 ±0.02	< 0.5
129		4709	7	24		0.05 ±0.03	< 0.3
130		4712	14	24		0.07 ±0.02	< 0.6
131		4708	12	24		0.06 ±0.02	< 0.3
132		4707	7	16		<0.1	< 0.3
141		4907	44	117		0.11 ±0.02	
142		4905	18	29		<0.05	
143		4904	46	24		< 0.11	
144		4914	40	20		0.08 ±0.05	
145		4911	39	26		0.2 ±0.04	
146		4911 core	13	25		0.02 ±0.015	< 0.3
147		4904 core	15	64		< 0.02	< 0.3
148		4907 core	17	19		< 0.04	< 1.3
149		4913 core	29	38		< 0.035	
154		7907	3	24		0.04 ±0.03	< 0.1
155		7909	5	30		< 0.07	< 0.14
156		7915	8	43		0.04 ± 0.02	< 0.18
157		7902	6	28		0.84 ± 0.04	< 0.12
"		"	12	19		0.88 ± 0.05	
161		7902	5	24		0.04 ± 0.03	< 0.1
162		8003	6	37		0.12 ± 0.02	< 0.12
215		8004	4	12		0.14 ± 0.06	< 0.3
"		"	9	22		0.11 ± 0.02	< 0.3
216		8005	5	22		0.06 ± 0.03	< 0.2
163		8006	8	36		0.45 ± 0.02	< 0.13
217		8007	7	42		0.18 ± 0.02	< 0.1
164		8008	9	29		0.22 ± 0.02	< 0.24
218		8013	8	26		0.17 ± 0.02	< 0.2
165		8014	5	22		0.31 ±0.03	< 0.13
166		8006	4	27		0.24 ± 0.03	< 0.08
169		9307	12	19		< 0.07	< 0.9
170		9302	17	28		0.06 ±0.03	
171		9304	11	23		0.05 ± 0.03	< 0.7
"		"	25	27		0.04 ± 0.03	
172		9306	10	22		0.04 ± 0.02	< 0.4
"		"	24	42		0.09 ± 0.02	
174		914	7	66		0.09 ± 0.02	< 0.1
175		910	8	23		0.08 ± 0.02	< 0.3
176		906	5	23		0.07 ± 0.02	< 0.1
177		901	8	71		0.07 ± 0.02	< 0.1
178		1014	5	24		0.06 ± 0.02	< 0.08

Table 4. Neutron Activation Results.

179		1009	6	28		0.04 ± 0.02	< 0.11
180		1010	7	23		< 0.03	< 0.09
181		1003	9	36		< 0.03	< 0.13
183		1111	5	21		< 0.05	< 0.13
184		1105	6	17		< 0.06	< 0.2
185		1102	8	48		0.03 ± 0.01	< 0.1
186		1113	9	23		0.04 ± 0.02	< 0.2
187		9402	6	26		0.11 ± 0.02	< 0.1
205		•	8	43		0.04 ± 0.02	< 0.2
188		9404	8	44		0.02 ± 0.01	< 0.1
189		9406	10	23		0.09 ± 0.03	< 0.4
190		9409	11	21		0.06 ± 0.02	< 0.2
191		1202	5	21		0.06 ± 0.03	< 0.13
192		1208	6	24		0.2 ± 0.03	< 0.13
206		•	9	29		0.05 ± 0.02	< 0.3
193		1212	8	43		0.02 ± 0.015	< 0.12
194		1215	9	24		0.06 ± 0.02	< 0.2
196		1301	9	79		1.17 ± 0.02	< 0.14
240		•	6	69		0.14 ± 0.01	< 0.07
197		1302	6	42		0.03 ± 0.01	< 0.08
198		1303	5	12		< 0.07	< 0.2
199		1306	6	23		< 0.05	
201		1310	8	42		0.06 ± 0.02	< 0.2
202		7602	9	24		0.04 ± 0.03	< 0.4
203		7603	5	20		0.06 ± 0.04	< 0.2
204		7605	6	21		< 0.07	< 0.24
219		1401	5	12		0.17 ± 0.06	< 0.3
•		•	11	26		0.04 ± 0.03	< 0.8
220		1405	6	42		0.05 ± 0.02	< 0.2
221		1411	8	28		0.05 ± 0.02	< 0.2
222		1417	9	25		0.06 ± 0.03	< 0.4
231		1503	5	24		< 0.06	< 0.2
232		1509	7	40		0.05 ± 0.02	< 0.15
233		1514	8	26		< 0.04	< 0.2
234		1518	9	26		< 0.05	< 0.4

batch and sheet number (col. 2), the duration between irradiation and counting (col. 3), the duration of the count (col. 4), the Th concentration as a two sigma limit or with a one sigma error (col. 5) and the U concentration as a two sigma limit (col. 6). In col. 2 the first two digits are the last two digits of the batch number and the last two digits are the sheet number. In four cases (core) the optical surfaces were milled away before vaporization.

The 226 keV Np peak was not seen in any of the spectra and so the U concentrations in the samples are reported as a two sigma upper limit. The limit varied from 0.1 pg/g for samples counted within a few days of irradiation to 1 pg/g for samples counted several weeks after irradiation. The specification is 7 pg/g.

If there was any suggestion of a 310 keV Pa peak then a Th concentration was recorded with a one sigma error. If a peak was not discernible then a two sigma limit was reported. Except for batch 80, the Th concentration of all batches is less than 0.1 pg/g. The specification is 2 pg/g. Batch 80 appears to be a significant exception in that the first four samples were above 0.1 pg/g. Subsequently samples from four other sheets from batch 80 were also high confirming that this batch is exceptional. The Th concentration in the first samples from 7902, 9402, 1208, 1301 and 1401 were all above 0.1 pg/g but second samples from the same sheets were all below 0.1 pg/g, except for 1301 which was 0.14 pg/g. Either there was a local concentration of Th in these sheets or handling contamination resulted in a reading higher than the average.

4.2 Mass Spectrometry Results.

A large quantify of acrylic has been vaporized and the residue analyzed for Th and U by mass spectrometry. The results are listed in Table 5 and shown in Fig. 3. In most cases the acrylic from two coupons (or sheets) was combined so as to get 6 kg samples for analysis. These mass spectrometry results are significantly higher than the neutron activation results suggesting handling contamination of the mass spectrometry samples at CRL [2)]. Even so, almost without exception, the results are less than the acrylic specifications of Th at 2 ppt and U at 7 ppt.

4.3 Alpha Spectroscopy Results.

Only two disequilibrium measurements were performed. Over 20 kg of acrylic from batch 47 and from batch 79 were vaporized. A portion of the residue was analyzed by mass spectrometry and a known amount of ^{229}Th was added to the remainder which was then separated into Th,

Table 5. Mass Spectroscopy Res

Batch	Sheets	Weight kg	Th pg/g (MS)	U pg/g (MS)
47	7,	3.43	1	0.44
	8,	3.43	1.4	1.1
	9,	3.45	1.6	0.5
	4,	3.58	1.1	0.4
	12,	3.58	0.7	0.2
	6,2,11	21.07	0.4	0.15
48	2,3	6.22	0.7	0.6
	6,5	6.48	0.5	0.2
	9,14	6.73	0.5	
49	4,5	6.39	0.5	0.2
	7,8	6.58	0.9	0.3
	11,13	6.63	1.1	0.2
	1,2,3,9,12	23.8	0.8	0.5
79	4,10	7.14	0.7	0.2
	2,7	7.17	0.6	0.3
	9,15	7.15	0.7	0.2
	3,6,11,12,14	26.41	0.9	0.3
80	10,11	6.72	2.2	0.5
	8,14	6.76	1.2	0.3
	3,6	6.29	1.1	0.2
93	4,	5.83	1.1	0.5
	5,	5.8	2.1	0.7
	8,	6.35	1.4	0.4
10	2,3	6.77	0.7	1
	13,14	6.63	1	0.2
	6,9	6.7	0.9	0.2
11	2,3	6.68	0.6	0.15
	5,6	6.38	0.8	0.3
	11,13	6.7	0.9	0.3
94	9,	6.41	1.2	1.1
	2,	5.89	0.8	0.4
	6,	6.79	1.2	0.7
9	9,10	6.64	1.1	0.9
	1,2	6.65	1.1	0.5
	5,6	6.5	0.8	0.3
12	8,9	6.55	0.8	0.1
	12,13	6.52	0.7	0.8
	2,3	6.45	1.1	0.2
13	1,2	6.66	0.5	0.8
	3,4	5.88	0.7	0.7
	6,10	6.74	0.5	0.6
76	2,	6.75	0.5	0.2
	5,	6.23	0.7	0.2
14	1,3	6.64	0.8	0.2
	5,6	6.39	0.8	0.2
	11,17	6.81	0.7	0.15
15	3,4	6.46	0.7	0.2
	9,10	6.88	1.2	0.3
	18,19	6.87	1.4	0.2

U and Ra using ion exchange columns [6]. The radioisotopes were electroplated out of solution and the planchettes alpha counted for several weeks. There was no evidence for disequilibrium in the Th/U chains and the levels of ^{232}Th and ^{238}U were consistent with the mass spectrometry results.

4.4 Discussion of Th/U Results:

The mass spectrometry results are well below the specifications but they are also significantly larger than the neutron activation results. For reasons already reported [2] we should rely on the neutron activation results and assume that the saw cutting at CRL contaminates the cut surfaces. We conclude, with the exception of batch 80, that the Th and U in the sheet acrylic is at least an order of magnitude better than the specifications of 2 and 7 pg/g respectively.

Because they contain significantly higher levels of Th the sheets from batch 80 have been excluded from the vessel.

5) Optical Absorption Coefficients.

5.1 SNO Specifications.

The optical requirements and specifications of the acrylic were detailed in an earlier report [7]. In that report a weighting function was defined which folded in the Cerenkov spectrum, the transmission through the D_2O and H_2O and the PMT quantum efficiency. The light detected in SNO is the integral of the product of the acrylic transmission times the weighting function. The report also contained the acrylic optical absorption coefficients required. These coefficients were based on multiple measurements of samples provided by suppliers. Table 6 lists the weighting function, the absorption coefficient specification and the product of the acrylic transmission for 2.2" and 4.5" acrylic times the weighting function as a function of wavelength. Even though the weighting function is significant at 300 nm, 2.2" of acrylic attenuates 93% of the light. Whereas at 400 nm only 5% of the light is attenuated by the 2.2" acrylic. A figure of merit is defined as the ratio of light detected with the acrylic to light detected without acrylic i.e. the sum of column 4 (5) divided by the sum of column 2. The specifications require a figure of merit of 0.7 for 2.2" material (0.58 for 4.5" material).

Table 6. Optical Standards.

Wavelength nm	Weighting	Abs. Coeff. cm-1	trans x weigh 2.2" material	trans x weigh 4.5" material
300	1.08	0.49	0.07	0.00
320	1.3	0.18	0.48	0.17
340	1.39	0.07	0.95	0.63
360	1.34	0.04	1.08	0.85
380	1.28	0.02	1.15	1.02
400	1.17	0.01	1.11	1.04
420	1.03	0.01	0.97	0.92
440	0.9	0.005	0.88	0.85
total	9.49		6.68	5.48

The QC on the optical absorption coefficients showed that the Polycast production acrylic was not as good as earlier samples in that it failed to meet the specification at 300 nm. SNO decided to accept this material since most of the light at this wavelength was lost anyway but to insist that the specifications be meet at each of the other wavelengths. Some material did not satisfy the specification at 340 nm, in particular, and was rejected.

5.2 Optical Bulk Absorption Coefficients.

There is a lot of optical data on file at CRL but only examples of it will be shown in this report. Optical measurements have been made by Polycast and CRL on over 400 samples. Polycast reported the absorption coefficient of samples from each sheet at 300 to 440 nm in 20 nm steps and at 500 and 600 nm. CRL made measurements in 0.2 nm steps. The Polycast and CRL values for the absorption coefficient at 340 nm for all sheets are shown in Figs. 4, 5 & 6. An indication of the measurement uncertainty in the CRL values may be seen from the multiple measurements on samples from two sheets one in batch 80 and the other in batch 12. For most of the batches the spread in values within the batch is experimental uncertainty. The spread between batches, within batch 47, 48 and 93 and sheet 8 in batch 12 are real. Almost all of the 2.2" sheets in batches 47 & 48 and the 4.5" sheets in batch 93 fail the specification (0.07) at this wavelength (340 nm). These sheets will not be used in the vessel but will be used by RPT for the fabrication qualification process.

5.3 Figure of Merit Results.

A plot of the figure of merit of each sheet may be of more relevance to SNO than the absorption coefficients at various wavelengths and was used to select sheets for the vessel and as input to the Monte

Carlo programs determining detector response. Table 7 lists the calculated figure of merit for the 2.2" and 4.5" batches. Fig. 7 and 8 are plots of these values for the two thicknesses. In the case of the 4.5" material the figure of merit was calculated from the absorption coefficients as though the material was 2.2" thick. This allows a direct comparison of the quality of the bulk acrylic. Actually, as can be seen from Table 6, 30% of the signal is lost by absorption in 2.2" acrylic meeting the specifications and 42% in the 4.5" material.

Material for the qualification program should be selected using these data. Batches 47, 48 and 49 and sheet 8 in batch 12 are the poorest quality 2.2" material, followed by selected sheets in batches 80 and 79. Batch 93 is the poorest quality 4.5" material. Unfortunately the other two batches are not much better.

Thirteen samples from sheet 11 of batch 80 were measured and the figure of merit calculated. The spread in the absorption coefficients at 340 nm is shown in Fig. 4. The figure of merit from batch 80 coupons is shown in Fig. 9. The standard deviation of the 13 measurements on sheet 11 is 0.04 and this is consistent with the expected uncertainty in the optical measurements. We conclude that no significant differences between the sheets of batch 80 exists, the spread in Fig. 9 is consistent with experimental uncertainties.

A detailed examination of the figure of merit of the various batches as plotted in Figs. 7 & 8 shows that almost all of the spread within batches is experimental. Sheet 8 in batch 12 and sheet 7 in batch 93 are clearly worse than the averages of those batches and the spread in the rejected batch 48 is larger than the experimental uncertainty. Otherwise less than a dozen sheets are more than 2 standard deviations from the batch average. However the differences between batches as emphasized by the averages plotted in Figs. 7 & 8 are real.

5.4 Discussion of Optical Results.

With the exception of some sheets in the first two batches of 2.2" material (47 & 48) and the first batch of 4.5" material (93) the acrylic satisfies the optical specification. However because of our tests on Polycast material prior to the purchase order and because of Polycast's assurances in writing we expected to get material 4% better than the specifications. In fact Polycast expected the material to have a figure of merit of 0.73 but guaranteed 0.7. Some of their material did significantly surpass their expected quality but many sheets were below that grade and for that reason we have stuck to the letter of the specifications and rejected all sheets which did not meet the specifications at 340 nm even though integrated over the frequency spectrum the figure of merit was not worse than 0.7.

The 4.5" material is uniformly poor but there are only 10 panels of that material and they are so thick anyway that much of the signal is absorbed.

The large variability of the 2.2" material may be a problem for the data fitters. This has yet to be determined. Consideration has to be given to the distribution of sheets throughout the vessel. The current plan is that the good and poor sheets will be randomly distributed and not be concentrated at specific locations. RPT are machining the sheets.

Acknowledgments:

We thank Dr. Emmanuel Bonvin for his continuing interest in acrylic quality and in the CRL work. All of the figure of merit values were calculated by him. All of the CRL optical measurements were made on a spectrophotometer ably operated by Candy Everall. The neutron activation samples were prepared for irradiation by Roxanne Collins and Trish Robinson and the milling was done by Carey Grahl. The mass spectrometry was performed by Nancy Elliot and Monique Campbell. The alpha planchettes were prepared and counted by Shelia Kramer Tremblay. Without exception these people worked competently and diligently for the SNO project.

We particular thank John Lee, Patty Sheahan and other members of Polycast for their interest in our project and their co-operation in attempting to provide SNO with the best possible acrylic consistent with their corporate constraints. Polycast shut down for four days to vacuum their facilities just before our production runs. They purchased a particle detector and repeatedly measured dust levels. They significantly expanded their normal QC procedures to obtain for us the best possible monomer. They incurred significant expense in altering their procedures so as to provide us with better acrylic.

References:

1) Optical Quality of Polycast 2.17" Acrylic, Batches 47, 48 & 49
E.D. Earle, R.J.E. Deal, E. Gaudette, C.J. Everall & E. Bonvin
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2) Th & U levels in Polycast Stage II Acrylic, Batches 47, 48 & 49
E.D. Earle, R.J.E. Deal, E. Gaudette, R. Collins, N. Elliot, S. Kramer-Tremblay & E. Bonvin
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3) Polycast Acrylic Sheets, a progress report.
E. D. Earle, R. J. Deal and E Gaudette
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4) Measurements of Th and U in Acrylic for the Sudbury Neutrino Observatory
E. D. Earle and E. Bonvin
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5) Thermal Ionization Mass Spectrometric Analysis for the SNO Project
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6) Ultra Trace Analysis of Acrylic for 232Th and 238U Daughters
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7) Evaluation of Optical Properties of Acrylic Samples from Different Suppliers
E. Bonvin and E. D. Earle
SNO-STR-92-068

Figures:

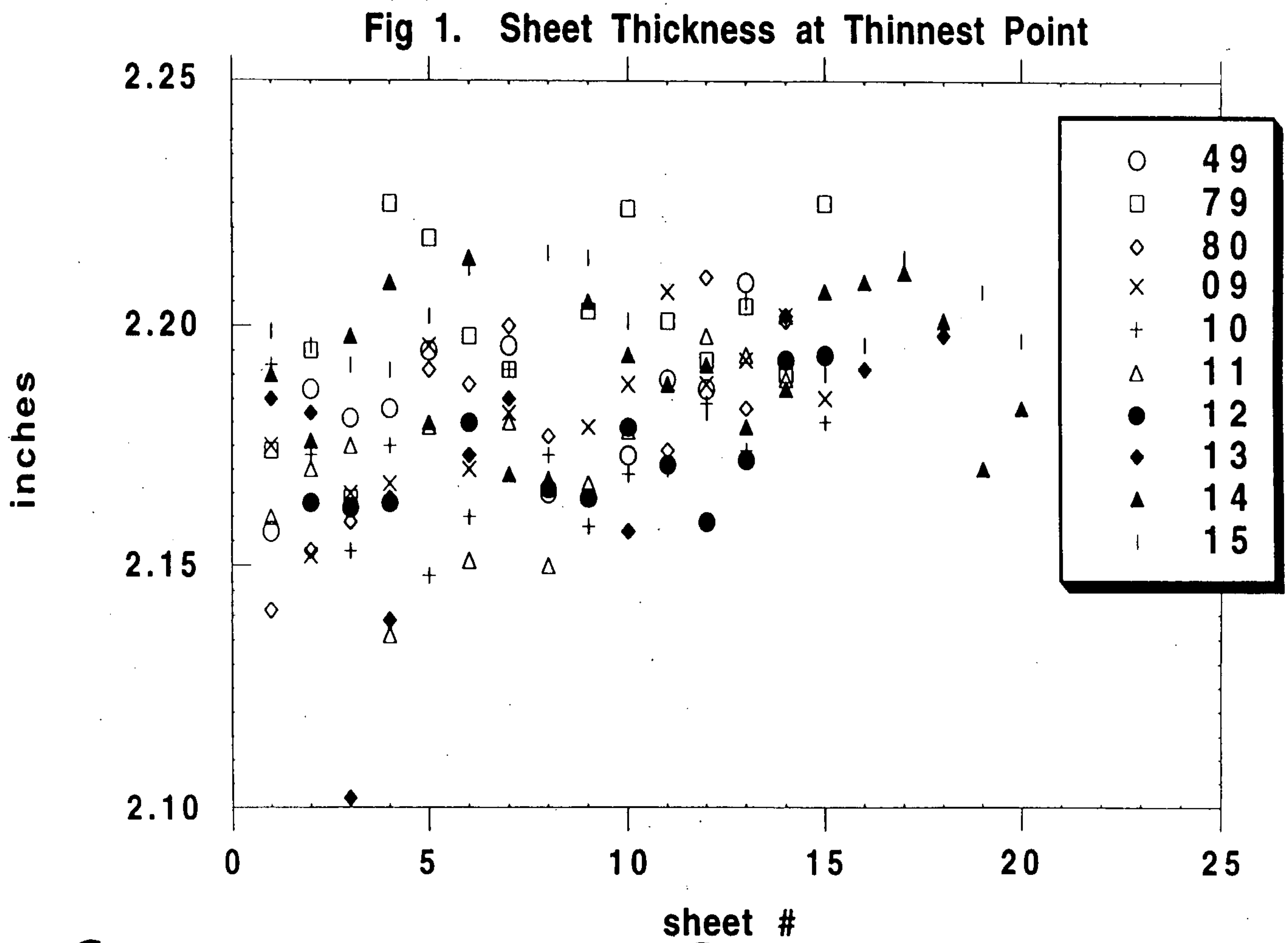
Fig 1. Sheet Thickness at Thinnest Point
2.25
2.20
2.15
2.10
inches
0
5
10
15
20
25
sheet #
49
79
80
09
10
11
12
13
14
15

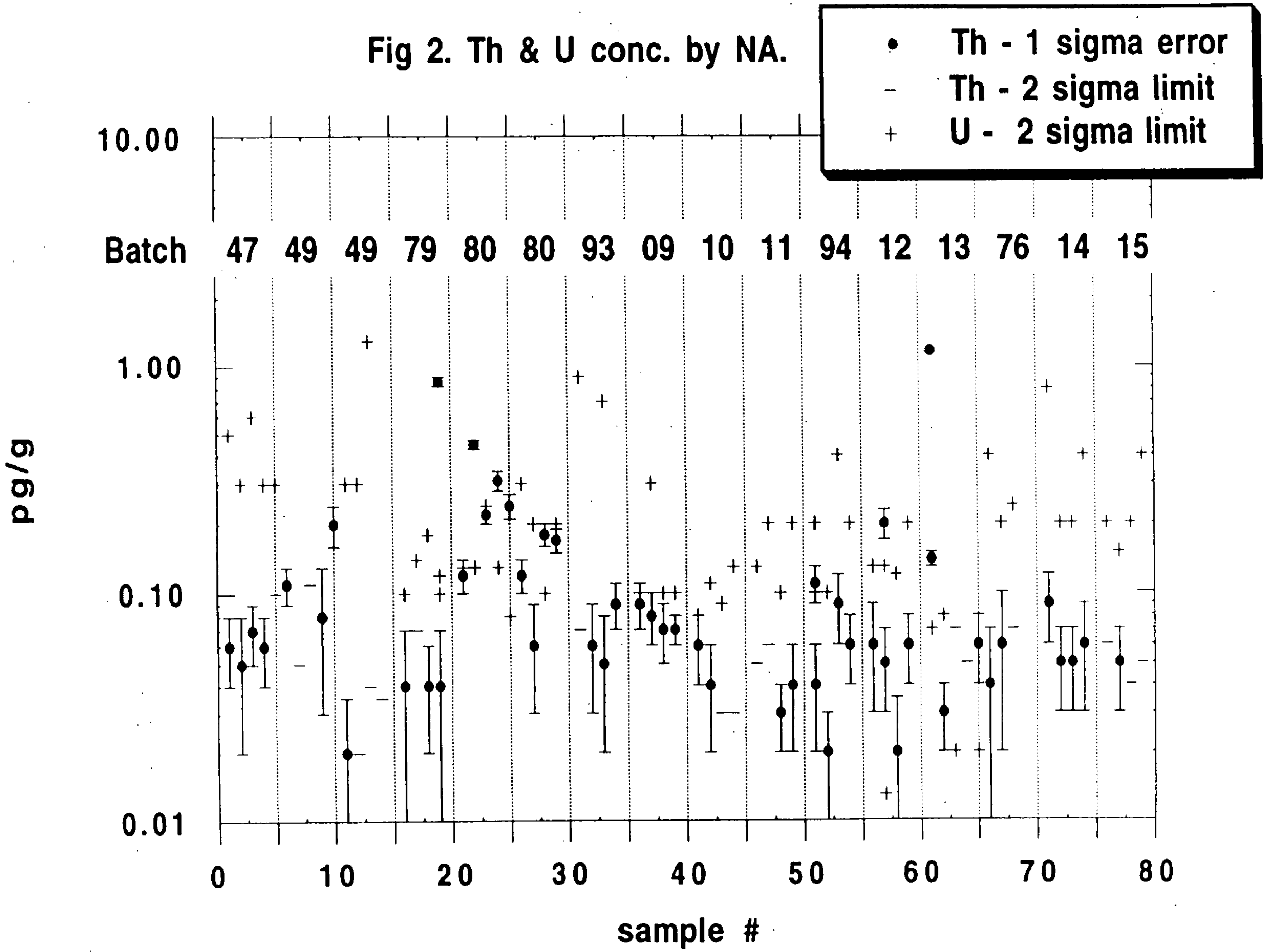

Fig 2. Th & U conc. by NA.
Th - 1 sigma error
Th - 2 sigma limit
U - 2 sigma limit
10.00
Batch 47 49 49 79 80 80 93 09 10 11 94 12 13 76 14 15
1.00
0.10
0.01
pg/g
0 10 20 30 40 50 60 70 80
sample #

Fig 3. Th & U conc. from MS

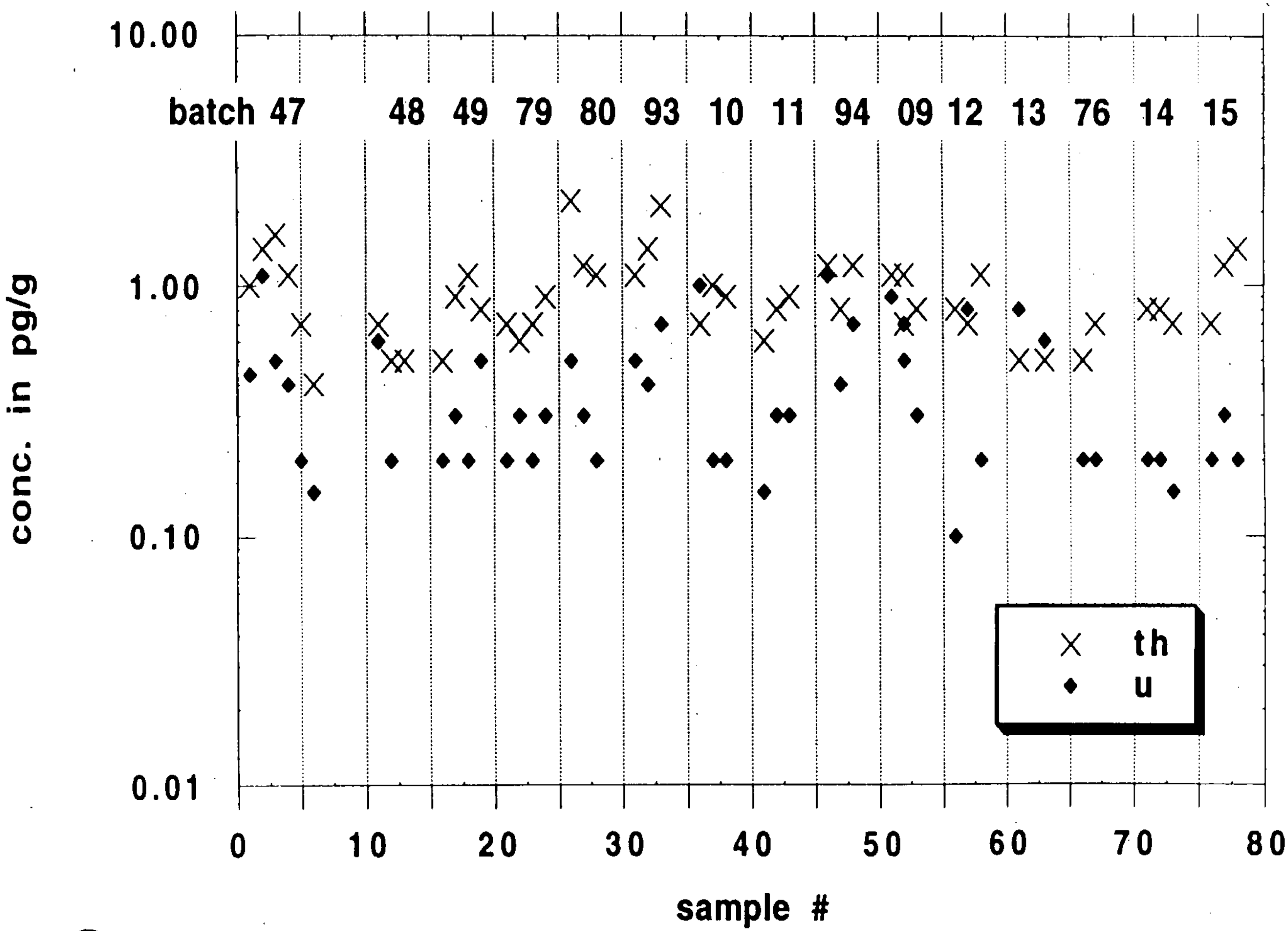

Fig 4. Absorption Coefficients for 6 batches @ 340 nm

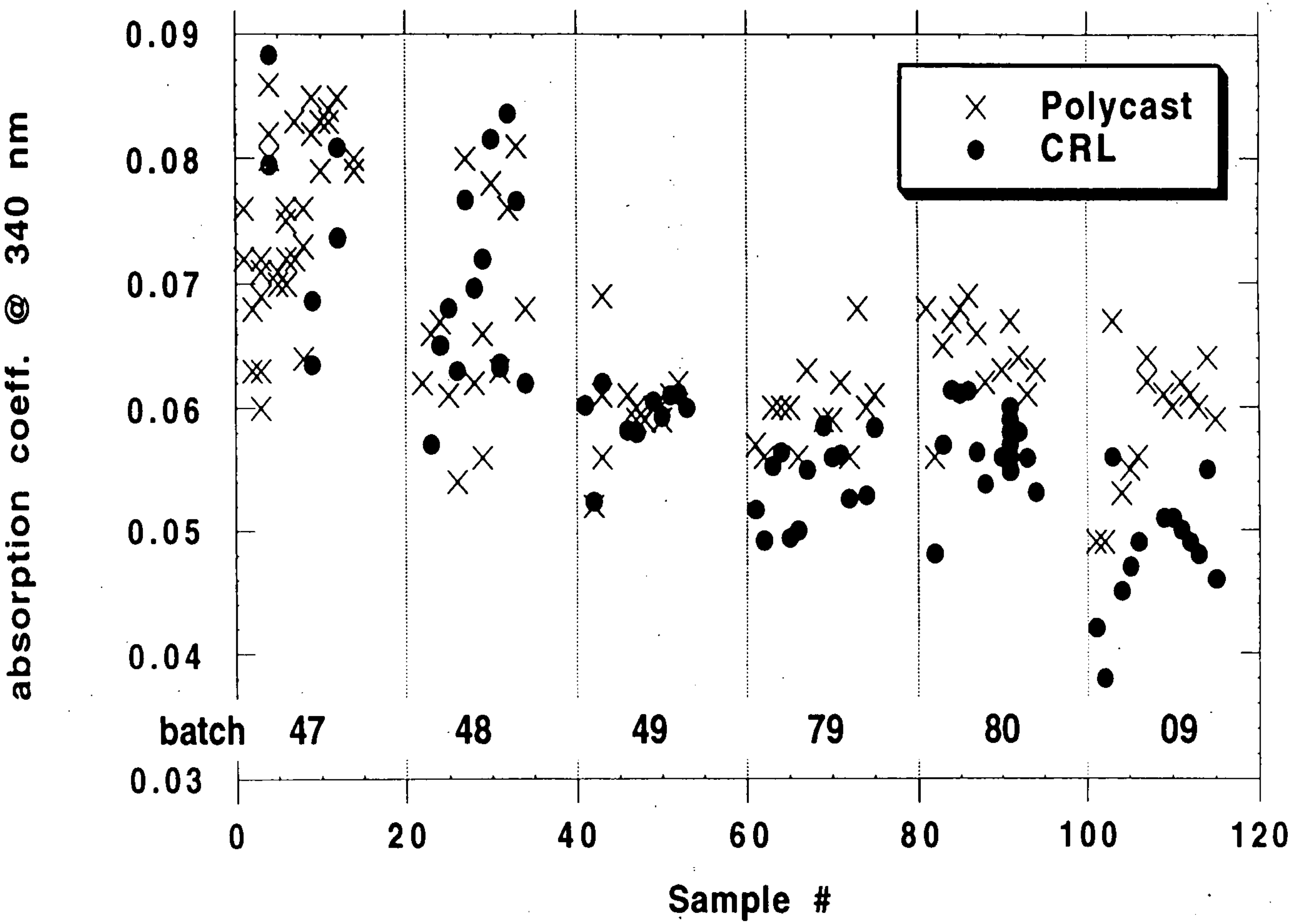

Fig 5. Absorption Coefficients for 6 batches @ 340 nm

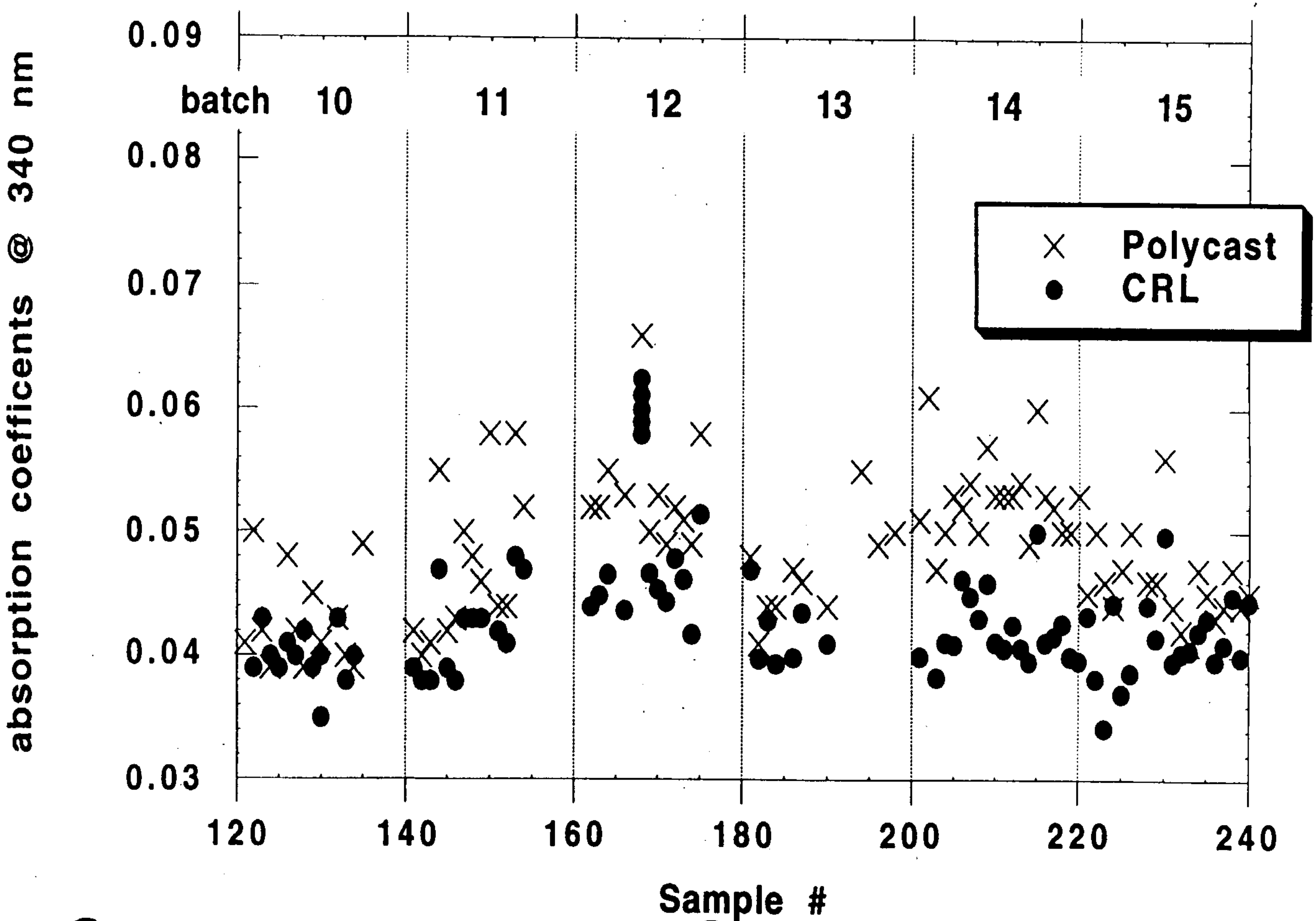

Fig. 6. Absorption Coefficients for the 4" Batches

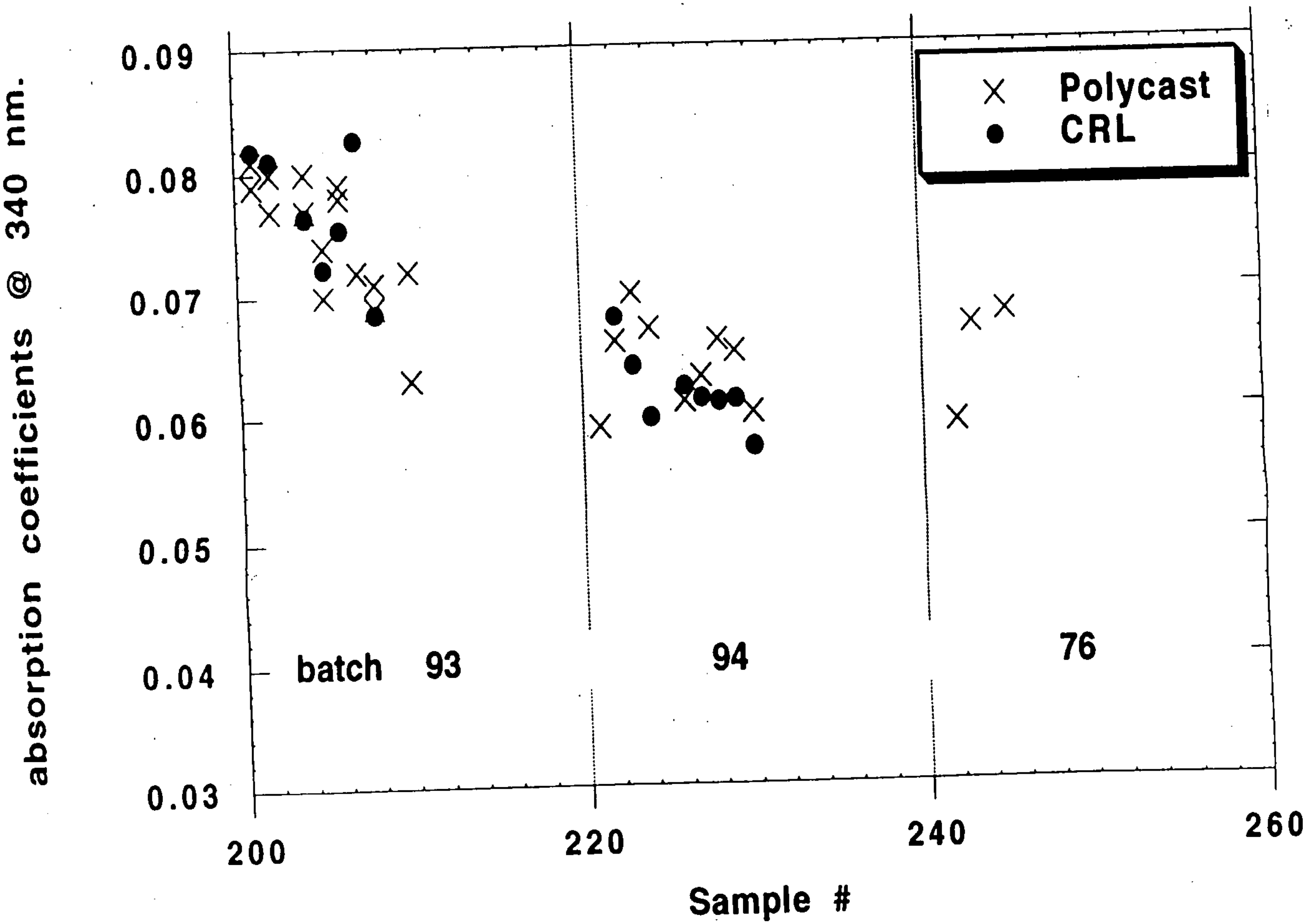

Fig 7. Figure of Merit for 2" Batches

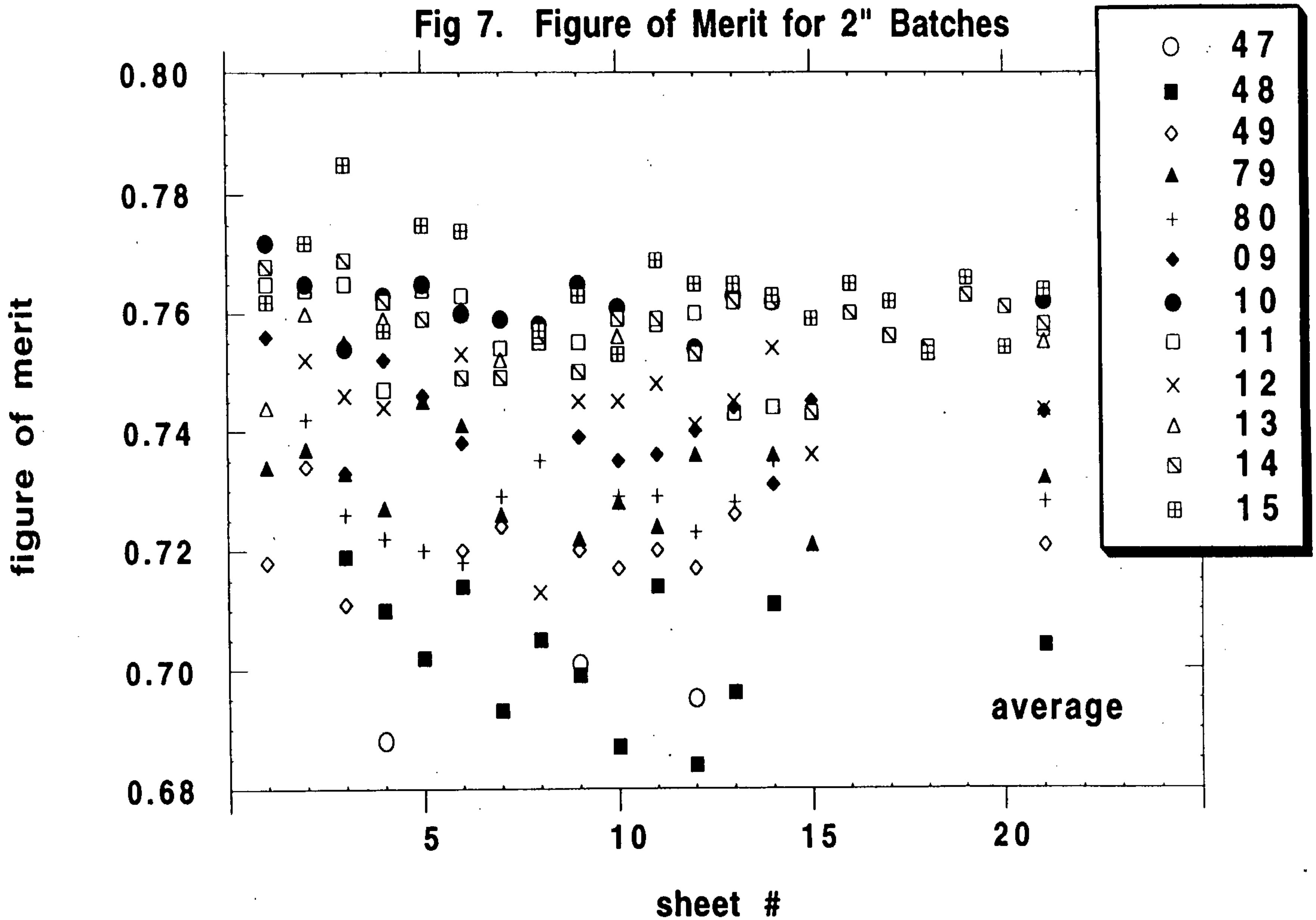

Fig 8. Figure of Merit for the 4.5" Material normalized to 2.2"

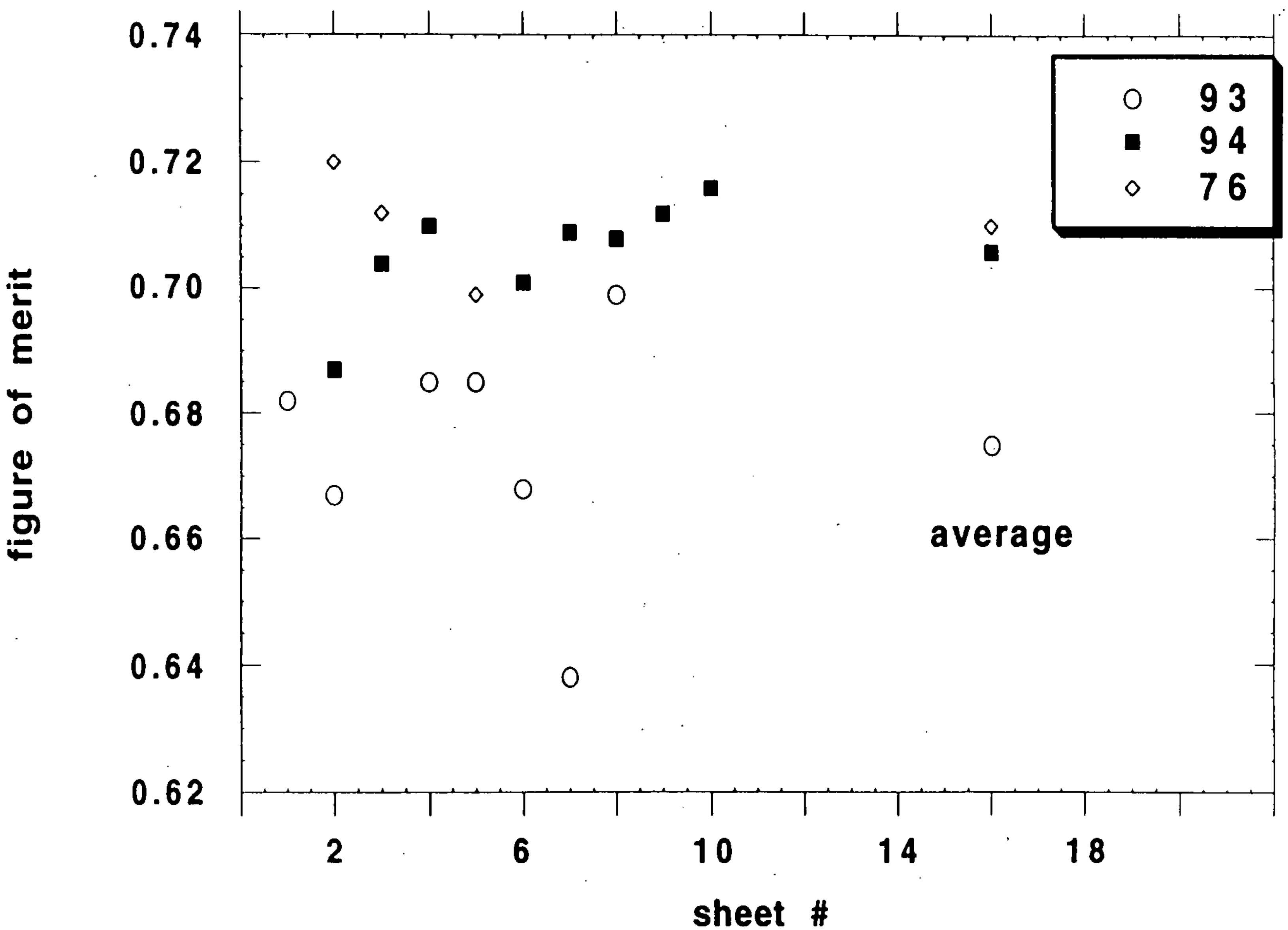

Fig. 9. Figure of Merit of Batch 80