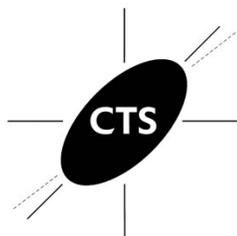


Plastics Interlaboratory Testing Program

Research Summary Report DSC Testing – 2nd Qtr 2014

The Differential Scanning Calorimetry (DSC) Analysis is an ongoing research test conducted by CTS beginning with the Second Quarter of 2013. All participants in this cycle received two materials for testing, Polybutadiene (PBT) and Acrylonitrile Butadiene Styrene (ABS). Each material contained two samples W19 and W20, for testing. Each of these samples was composed of 10 grams of pellets. Labs reported results for Crystallization Temperature (T_c), Melt Transition Temperature (T_m), Enthalpy absorbed (H_c), Enthalpy released (H_m), and Glass Transition Temperature (T_g)

Participants used ISO 11357-1 for DSC testing of plastic materials. None of the labs were flagged for inconsistent data, with most of the data falling very close to each other. Although the analysis did not contain a large number of data replicates, the results were very consistent. Some factors to consider in the next round of testing would be to include a heating procedure for the start temperatures, hold times and end temperatures. Also for the next round CTS will specify to determine the glass transition temperature using the **half-step-height** method.



Plastics Interlaboratory Testing Program

Research Summary Report #90, 2nd Qtr 2014

[About CTS and the Plastics Interlaboratory Program](#)

[Key for Web Summary Report](#)

[Results Summary for this Report](#)

Analysis Analysis Name

[760](#) [T_c](#) DSC Crystallization Temperature

[761](#) [T_m](#) DSC Melt Point

[762](#) [H_c](#) DSC heat released

[763](#) [H_m](#) DSC heat absorbed

[764](#) [T_g](#) DSC Glass Transition

About CTS and the Plastics Interlaboratory Program

Founded in 1971, Collaborative Testing Services, Inc. (CTS) is a privately-owned company that specializes in interlaboratory tests for a wide variety of industries, including rubber, plastics, fasteners and metals, containerboard, paper, color and wine, as well as proficiency tests for forensic laboratories. All of the tests are designed to assist organizations in achieving and maintaining quality control objectives. Labs from the U.S., as well as more than 80 countries currently participate in CTS programs.

Collaborative Testing Services initiated the Collaborative Reference Program for PLASTICS in 1992 at the request of industry, ASTM committee D-20 members, and accrediting bodies. Additional test methods are always under review and are incorporated into the program when possible.

The program allows laboratories to compare periodically the level and uniformity of their testing with that of other participating laboratories. It also provides a realistic assessment of the state of plastics testing proficiency.

For each test there is a summary of the statistics for the analysis and a graphical representation of the data. Also shown are notes concerning specific laboratory results, as well as significant findings related to instrument types or other testing variations. Refer to the KEY FOR SUMMARY REPORT for an explanation of terms and guidelines for interpreting the results.

For further information contact:

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Key for Web Summary Report (Page 1 of 2)

WebCode	Assigned laboratory identification number (temporary) used to ensure lab confidentiality while permitting a lab to locate its data in the Plastics Web Summary Report published on the CTS web site. The WebCode for each analysis can be found in the Performance Analysis Report mailed to each participant.
Lab Mean	The average of the test results obtained by the participant.
Grand Mean	The average of the LAB MEANS for all included participants. Laboratories flagged with an X or an M (see DATA FLAG column) are excluded from the GRAND MEAN.
Difference from Grand Mean	The difference of the LAB MEAN from the GRAND MEAN.
Between-Lab Standard Deviation	An indication of the precision of measurement between the laboratories. The greater the spread of the LAB MEANS about the GRAND MEAN, the larger the BETWEEN-LAB STANDARD DEVIATION (and vice versa).
Comparative Performance Value	An indication of how well a laboratory's results agree with the other participants. The CPV is a ratio indicating the number of standard deviations from the GRAND MEAN. The closer a laboratory's COMPARATIVE PERFORMANCE VALUE is to zero, the more consistent its results are with the other participants' data (and vice versa). The critical value for each CPV will vary depending on the number of labs participating in a test.
Inst Code	A code indicating the manufacturer of the instrument used to perform the test (see separate INSTRUMENT CODE LIST for each test section) if instruments are tracked.
Data Flag	DATA FLAGS are assigned based on the simultaneous analysis of both samples tested. Refer to the following chart for an explanation of each symbol:

<u>DATA FLAG</u>	<u>STATISTICALLY INCLUDED/EXCLUDED</u>	<u>ACTION REQUIRED</u>
*	INCLUDED	CAUTION - review testing procedure and monitor future results. Results fall outside 95% ellipse but within a 99% ellipse that is calculated but not drawn.
X	EXCLUDED	STOP - immediate review of data and/or testing procedure is required. Results fall outside the 99% ellipse. See specific notes following each table for more information on why the data is excluded.
M	EXCLUDED	PROCEED - lab was unable to report data for at least one sample.

Graph - For each laboratory, the LAB MEAN for the first sample (x-axis) is plotted against the LAB MEAN for the second sample (y-axis) with each point representing a laboratory. The horizontal and vertical cross-hairs are the GRAND MEANS for each sample. When 20 or more laboratories are in the statistics, an ellipse is also drawn so that 95% of the time a randomly selected laboratory will be included inside the ellipse. Plotted data flags are explained above.

Common Problems Highlighted in Footnotes

1. **Extreme data** - The laboratory's results for one or both samples are so inconsistent with those of the other participants that the lab mean(s) fall outside the plot. The participant is advised to immediately review his data and/or testing procedure.
2. **Systematic bias** - The laboratory's results are either consistently high or low for both samples when compared to the other participants (the plotted point falls near the top or bottom of the ellipse). This indicates that the participant is performing the test with a constant bias. Causes of systematic errors include improper calibration, the particular make/model of equipment or a modification to the testing procedure.
3. **Inconsistency in testing between samples/sample sets** - The laboratory's results indicate that there are differences in the way the two samples tested (the plotted point falls to the side of the ellipse). This type of error may be attributed to the analyst deviating from the procedure when testing one of the samples or a material interaction occurrence with the instrument or room conditions. The inconsistency is reflected in the CPVs for the two samples, such as a +1.5 CPV for sample A and a -2.2 CPV for sample B. CTS also will specify if the laboratory's data for one sample are high/low compared to the other participants. If this inconsistency is slight, the lab's plotted point will be an * that falls on the edge of the ellipse.
4. **Inconsistency in testing within a sample** - The laboratory's within-lab standard deviation for a specified sample is high when compared to the other participants, often causing the lab's plotted point to fall outside of the ellipse.

Labs flagged with an * are not typically included in the footnotes of a data table. These labs may locate their position in the control ellipse and use the definitions above to help identify the type of testing error. An * should serve as a caution flag, a "yellow light", to a lab. If this error is repeated in future rounds, a lab may need to stop and review its testing procedures. The initial data flag is not cause for alarm. Interlaboratory tests conducted at regular intervals permit a lab to recognize trends in testing.

Results Summary for Web Summary Report #90

Plastics Interlaboratory Testing Program

Analysis 760 - DSC Crystallization Temperature

Material: PBT	Sample W19	188.61	° Celsius	0.979% COV
Material: PBT	Sample W20	194.26	° Celsius	1.44% COV

Analysis 761 - DSC Melt Point

Material: PBT	Sample W19	223.71	° Celsius	0.613% COV
Material: PBT	Sample W20	221.64	° Celsius	0.490% COV

Analysis 762 - DSC heat released

Material: PBT	Sample W19	43.979	*Joules Per (7.25% COV
Material: PBT	Sample W20	31.828	*Joules Per (7.48% COV

Analysis 763 - DSC heat absorbed

Material: PBT	Sample W19	37.903	*Joules Per (17.7% COV
Material: PBT	Sample W20	32.735	*Joules Per (10.9% COV

Analysis 764 - DSC Glass Transition

Material: ABS	Sample W19	108.72	° Celsius	2.48% COV
Material: ABS	Sample W20	109.08	° Celsius	2.51% COV

**Plastics Interlaboratory Testing Program
Analysis 760
DSC Crystallization Temperature**

WebCode	Data Flag	Sample			Sample			Instr Code
		Lab Mean	Diff from Grand Mean	CPV	Lab Mean	Diff from Grand Mean	CPV	
BAC0PN		192.32	3.71	2.01	197.04	2.78	0.99	PE
BAIA52		189.40	0.79	0.43	196.80	2.54	0.91	TA
BAILBO		188.53	-0.08	-0.04	195.47	1.21	0.43	TA
BAO5UJ		188.63	0.02	0.01	194.03	-0.23	-0.08	TA
BCENOO		188.83	0.22	0.12	195.53	1.27	0.45	TA
BDFU2Z		185.71	-2.90	-1.57	188.16	-6.10	-2.18	TA
BIOOLY		188.67	0.05	0.03	194.14	-0.12	-0.04	TA
BNE0IA		186.53	-2.08	-1.13	195.50	1.24	0.44	TA
BZLDQ9		188.89	0.27	0.15	191.65	-2.61	-0.93	TA

Summary Statistics			
Grand Means	188.61 ° Celsius	194.26 ° Celsius	
Stnd Dev Btwn Labs	1.85 ° Celsius	2.80 ° Celsius	
Statistics based on 9 of 9 reporting participants			

Sample: W19 PBT & Sample : W20 PBT

Instrument Code List as Reported by the Labs

(PE) - Perkins Elmer Instruments

(TA) - TA Instruments

**Plastics Interlaboratory Testing Program
Analysis 761
DSC Melt Point**

WebCode	Data Flag	Sample			Sample			Instr Code
		Lab Mean	Diff from Grand Mean	CPV	Lab Mean	Diff from Grand Mean	CPV	
CBAU5D		222.33	-1.37	-1.00	220.37	-1.28	-1.17	TA
CBD5LN		221.63	-2.07	-1.51	221.40	-0.24	-0.22	TA
CBMEIU		224.27	0.56	0.41	221.50	-0.14	-0.13	TA
CG04O4		224.56	0.85	0.62	221.67	0.02	0.02	TA
CILAGN		223.27	-0.44	-0.32	220.50	-1.14	-1.05	TA
CLJ497		226.29	2.59	1.89	223.36	1.71	1.58	TA
CLKF9S		224.44	0.73	0.53	221.66	0.02	0.02	TA
CPVT0A		224.47	0.76	0.55	223.50	1.86	1.71	TA
CS00A3		222.45	-1.26	-0.92	220.57	-1.07	-0.99	PE
CSBODO		223.37	-0.34	-0.25	221.90	0.26	0.24	TA

Summary Statistics	
Grand Means	
223.71 ° Celsius	221.64 ° Celsius
Std Dev Btwn Labs	
1.37 ° Celsius	1.09 ° Celsius
Statistics based on 10 of 10 reporting participants	

Sample: W19 PBT & Sample : W20 PBT

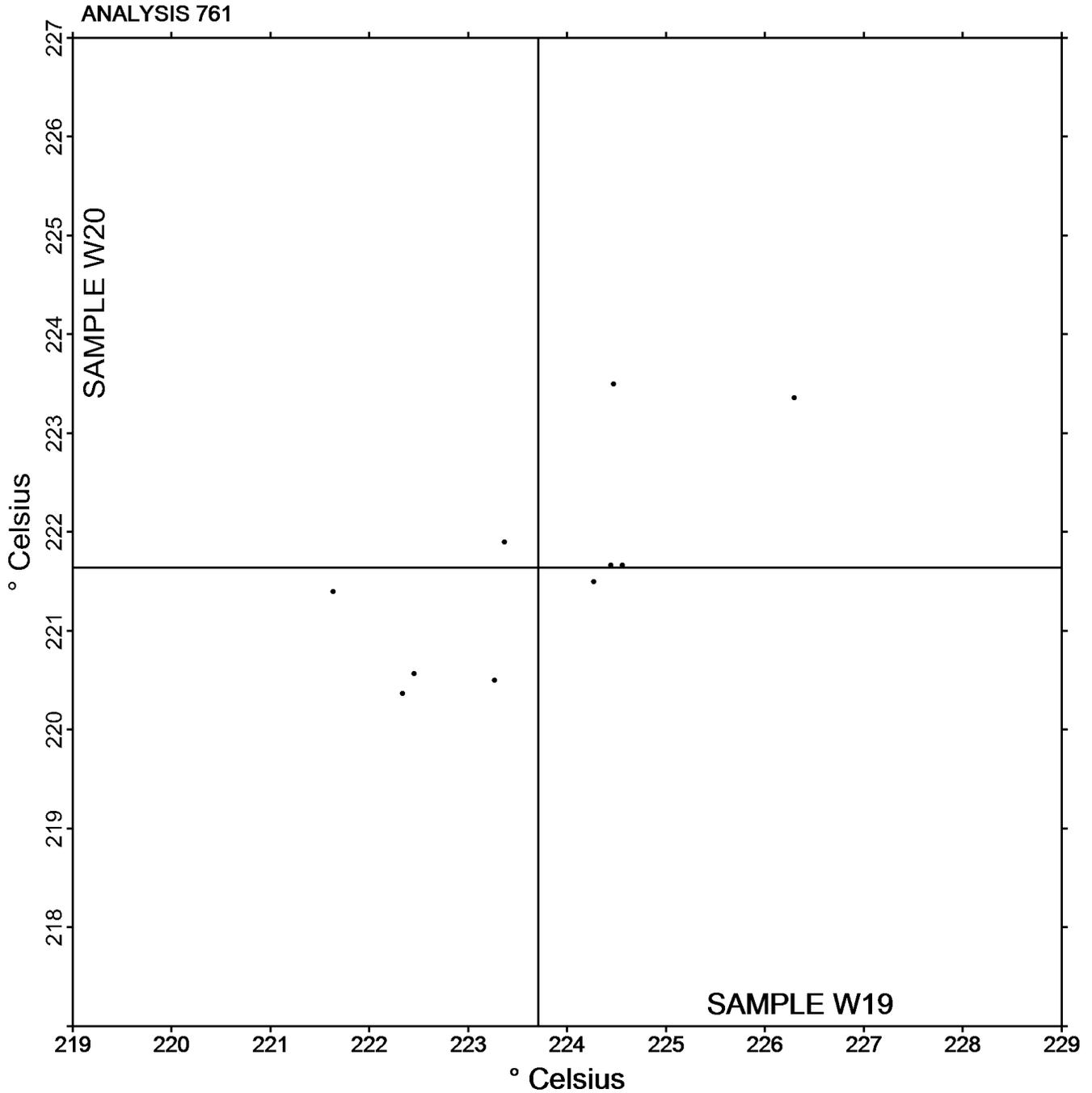
Instrument Code List as Reported by the Labs

(PE) - Perkins Elmer Instruments

(TA) - TA Instruments

Plastics Interlaboratory Testing Program
Analysis 761
DSC Melt Point

Grand Mean Sample : W19 223.71 ° Celsius Grand Mean Sample : W20 221.64 ° Celsius



If fewer than 20 laboratories are included in an analysis, a control ellipse will not be drawn on the two-sample plot

**Plastics Interlaboratory Testing Program
Analysis 762
DSC heat released**

WebCode	Data Flag	Sample			Sample			Instr Code
		Lab Mean	Diff from Grand Mean	CPV	Lab Mean	Diff from Grand Mean	CPV	
D2KLON		42.23	-1.75	-0.55	29.73	-2.10	-0.88	TA
DANOAA		39.11	-4.87	-1.53	30.92	-0.91	-0.38	TA
DEIET1		43.63	-0.35	-0.11	32.29	0.46	0.19	TA
DFSDC7		41.95	-2.03	-0.64	29.29	-2.54	-1.07	TA
DIBXLN		45.47	1.49	0.47	32.03	0.21	0.09	TA
DOEO4O		42.97	-1.01	-0.32	29.84	-1.99	-0.83	TA
DTILNR		48.83	4.85	1.52	35.60	3.77	1.58	TA
DUT8LN		47.64	3.66	1.15	34.92	3.10	1.30	TA

Summary Statistics			
Grand Means	43.98	*Joules Per Gram	31.83 *Joules Per Gram
Stnd Dev Btwn Labs	3.19	*Joules Per Gram	2.38 *Joules Per Gram
Statistics based on 8 of 8 reporting participants			

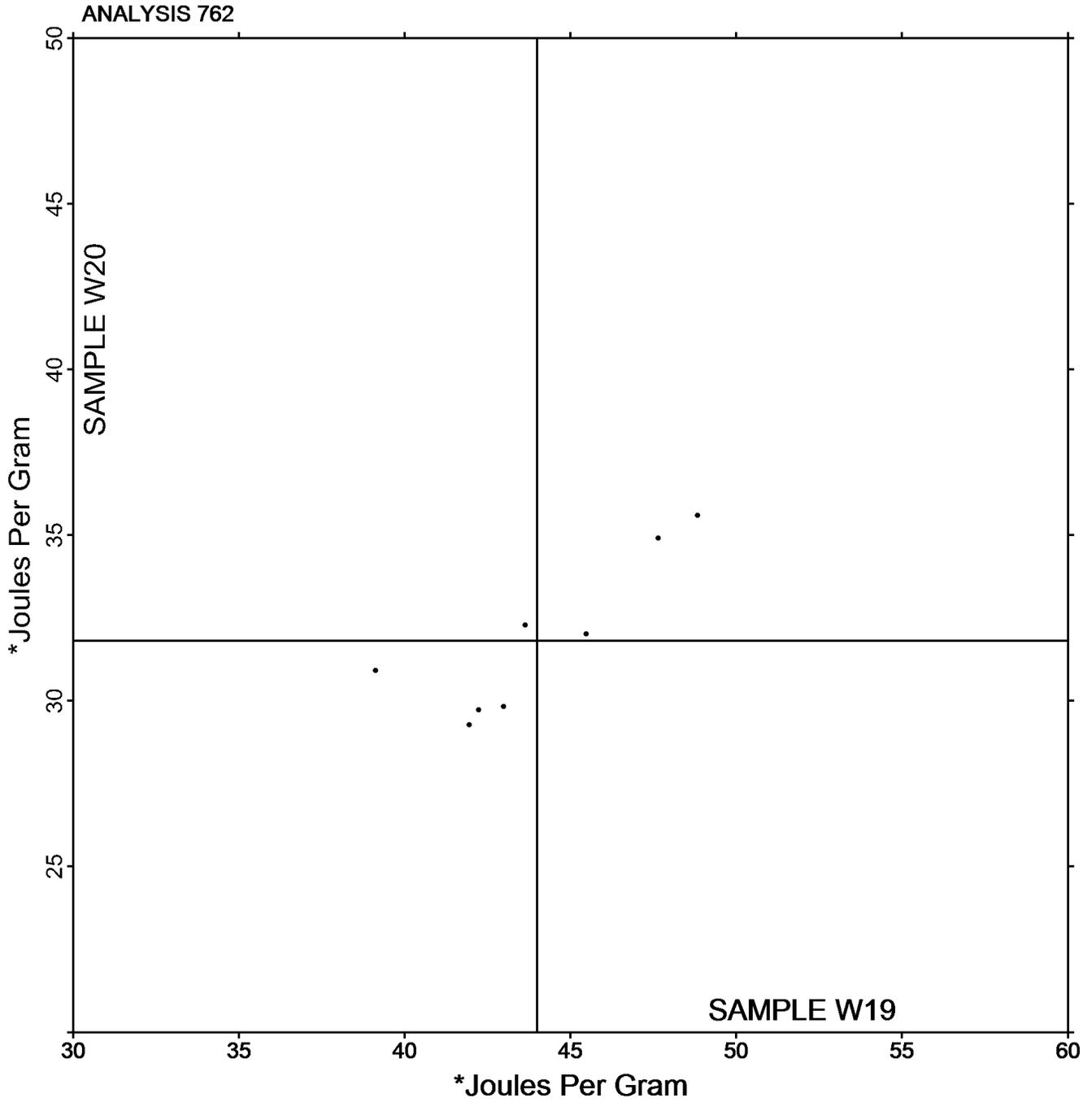
Sample: W19 PBT & Sample : W20 PBT

Instrument Code List as Reported by the Labs

(TA) - TA Instruments

Plastics Interlaboratory Testing Program
Analysis 762
DSC heat released

Grand Mean Sample : W19 43.98 *Joules Per Gram Grand Mean Sample : W20 31.83 *Joules Per Gram



If fewer than 20 laboratories are included in an analysis, a control ellipse will not be drawn on the two-sample plot

**Plastics Interlaboratory Testing Program
Analysis 763
DSC heat absorbed**

WebCode	Data Flag	Sample			Sample			Instr Code
		Lab Mean	Diff from Grand Mean	CPV	Lab Mean	Diff from Grand Mean	CPV	
ECAADT		47.73	9.83	1.47	34.93	2.20	0.61	TA
EFYEE8		34.13	-3.77	-0.56	30.33	-2.40	-0.67	TA
EIGNDI		31.11	-6.79	-1.01	33.70	0.96	0.27	TA
EMJKTU		32.54	-5.36	-0.80	27.80	-4.94	-1.38	TA
ENRDRE		35.73	-2.17	-0.32	29.83	-2.91	-0.81	TA
EPZJFM		35.59	-2.31	-0.35	32.35	-0.39	-0.11	TA
ERNAS1		37.59	-0.32	-0.05	33.54	0.81	0.23	TA
ESINAE		48.80	10.90	1.63	39.40	6.67	1.86	TA

Summary Statistics			
Grand Means	37.90	*Joules Per Gram	32.74 *Joules Per Gram
Std Dev Btwn Labs	6.70	*Joules Per Gram	3.58 *Joules Per Gram
Statistics based on 8 of 8 reporting participants			

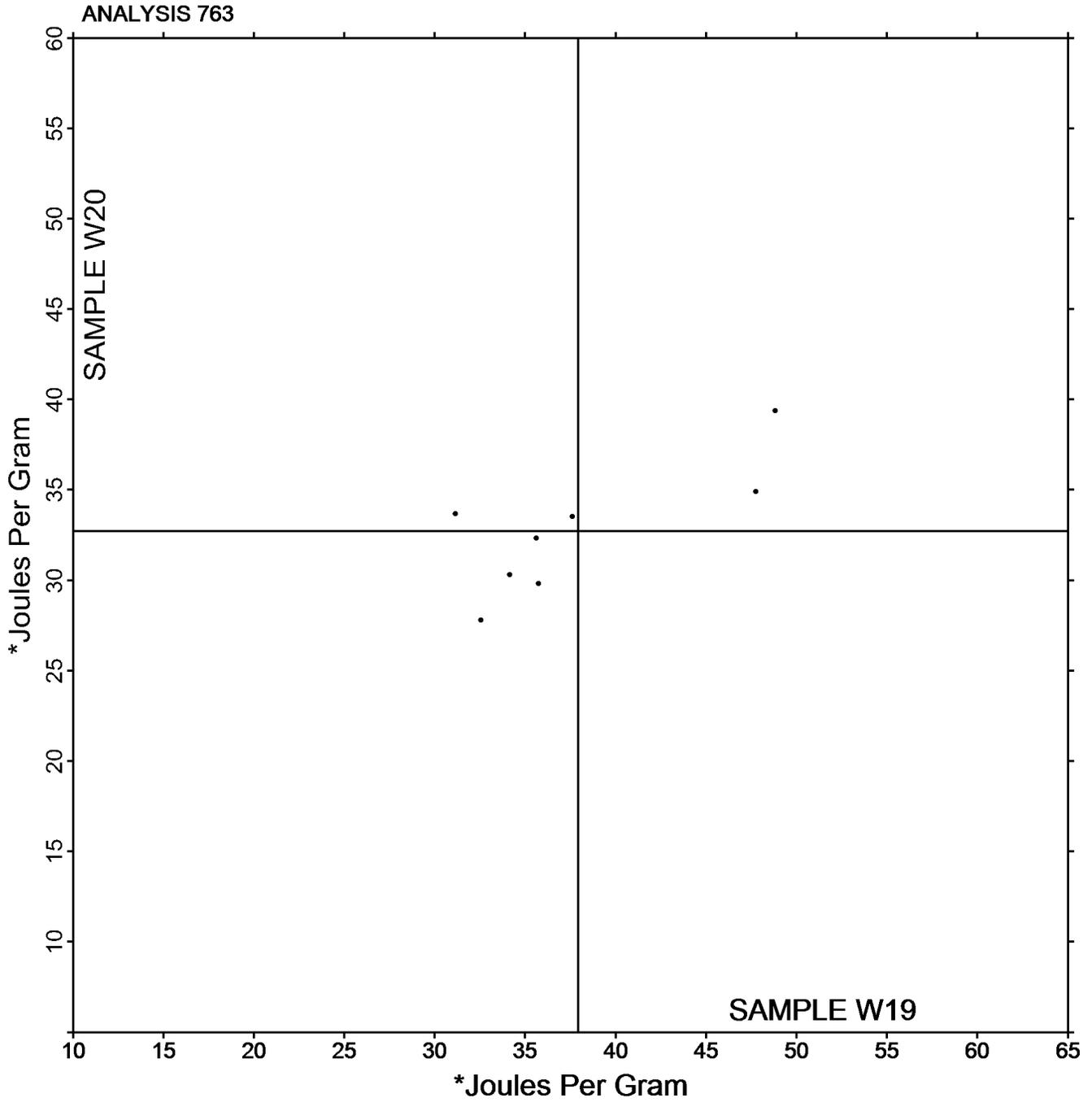
Sample: W19 PBT & Sample : W20 PBT

Instrument Code List as Reported by the Labs

(TA) - TA Instruments

Plastics Interlaboratory Testing Program
Analysis 763
DSC heat absorbed

Grand Mean Sample : W19 37.90 *Joules Per Gram Grand Mean Sample : W20 32.74 *Joules Per Gram



If fewer than 20 laboratories are included in an analysis, a control ellipse will not be drawn on the two-sample plot

**Plastics Interlaboratory Testing Program
Analysis 764
DSC Glass Transition**

WebCode	Data Flag	Sample			Sample			Instr Code
		Lab Mean	Diff from Grand Mean	CPV	Lab Mean	Diff from Grand Mean	CPV	
ABB4BN		111.03	2.32	0.86	111.10	2.02	0.74	TA
AIK5PM		102.57	-6.15	-2.28	103.33	-5.75	-2.10	TA
ALJ35M		108.37	-0.35	-0.13	109.03	-0.05	-0.02	TA
ASK1BM		109.60	0.88	0.33	109.60	0.52	0.19	TA
ASQS2P		109.07	0.35	0.13	109.03	-0.05	-0.02	TA
AST9CI		111.30	2.58	0.96	112.93	3.85	1.41	TA
ASYE0N		108.87	0.15	0.06	108.47	-0.61	-0.22	TA
ATR8FK		108.93	0.22	0.08	109.13	0.05	0.02	TA

Summary Statistics	
Grand Means	
108.72 ° Celsius	109.08 ° Celsius
Std Dev Btwn Labs	
2.70 ° Celsius	2.74 ° Celsius
Statistics based on 8 of 8 reporting participants	

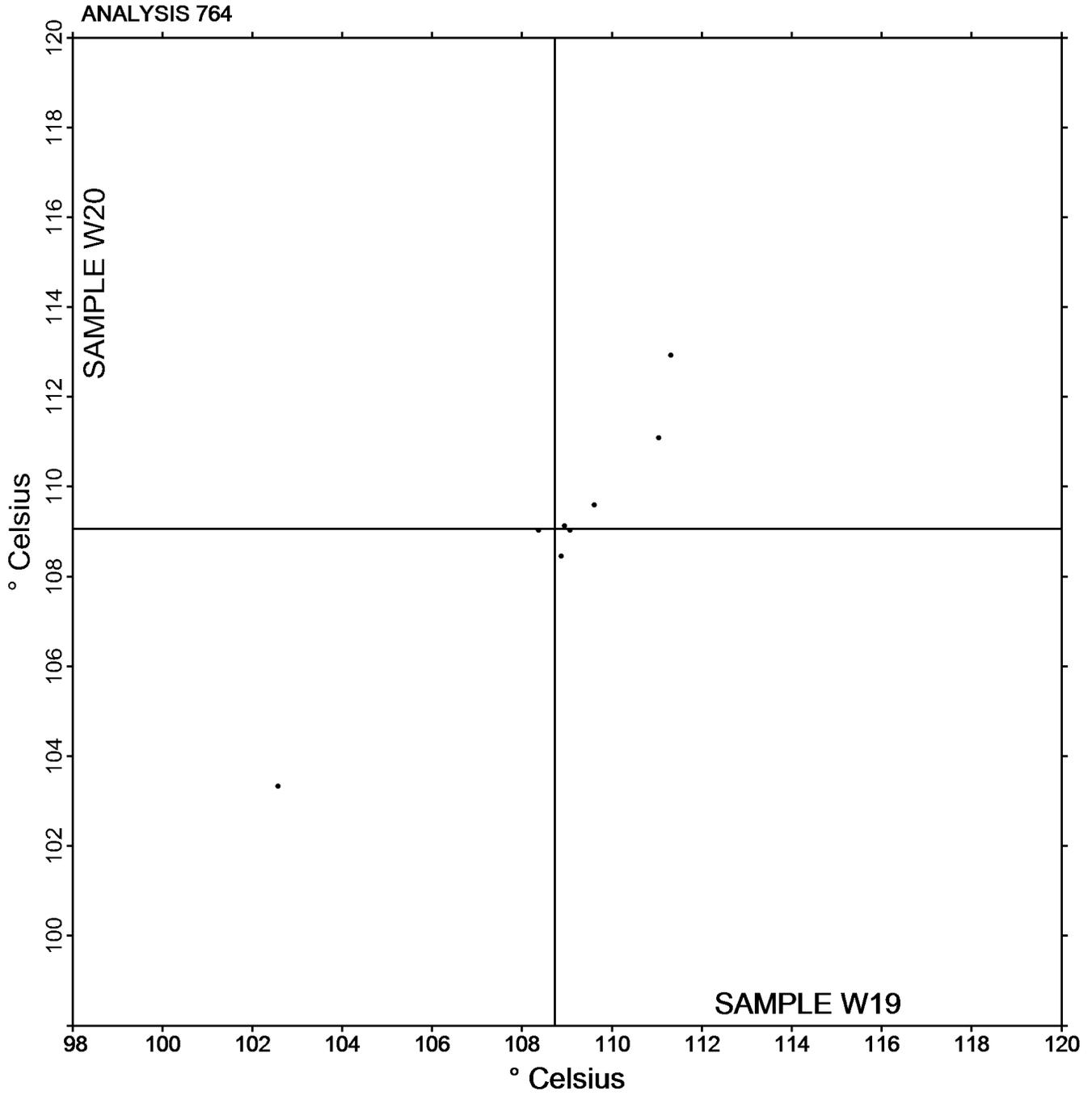
Sample: W19 ABS & Sample : W20 ABS

Instrument Code List as Reported by the Labs

(TA) - TA Instruments

Plastics Interlaboratory Testing Program
Analysis 764
DSC Glass Transition

Grand Mean Sample : W19 108.72 ° Celsius Grand Mean Sample : W20 109.08 ° Celsius



If fewer than 20 laboratories are included in an analysis, a control ellipse will not be drawn on the two-sample plot