

KaleidaGraph Plotting and Data Analysis Manual

Introduction

Once a sample has been tested, the test data must be made sense of. We use KaleidaGraph to plot and analyze our test data, since it is superior to Excel in its graphing capabilities. This manual will detail how to make proper graphs for Instron and DSC test data using KaleidaGraph.

Procedure

This document contains the following sections:

- A. Instron Compression Test Plotting
 - a. Creating Data Table (7 steps)
 - b. Creating Plot (21 steps)
 - c. Data Analysis (12 steps)
 - d. Formatting Plot (12 steps)
- B. DSC Test Plotting
 - a. Creating Data Table (10 steps)
 - b. Creating Thermogram (7 steps)
 - c. Creating Heat Curves (16 steps)
 - d. Formatting Plot (1 step)

Materials

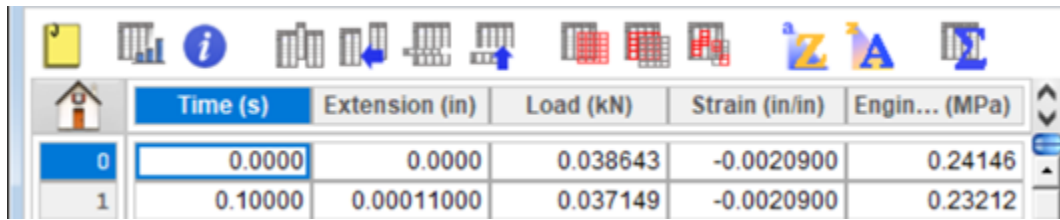
- KaleidaGraph (This can be downloaded on a student discount. The cost will be reimbursed by the Materials Department).
- All necessary data files, loaded onto the computer you are using to graph.

Formatting Data Table

4. Clicking into the new data table, enter the keyboard commands **Ctrl+A** and **Ctrl+K** in order to highlight all your data and open a data formatting menu. In the menu, change “Type” to “Float” and click “Apply”.

5. Change the table’s column titles to read:

Time (s) | Extension (in) | Load (kN) | Strain (mm/mm) | Engineering Stress (MPa)



	Time (s)	Extension (in)	Load (kN)	Strain (in/in)	Engin... (MPa)
0	0.0000	0.0000	0.038643	-0.0020900	0.24146
1	0.10000	0.00011000	0.037149	-0.0020900	0.23212

Correctly named column titles

6. Add four columns using the “Insert Column” symbol (pictured below), which is located on the toolbar at the top of the data window.



The “Insert Column” icon

7. Name these new columns in the following way:

Strain Adjust (in/in) | Engineering Strain (in/in) | True Strain (in/in) | True Stress (MPa)

Creating Plot:

Strain Adjust

1. Click the double-arrow symbol (pictured below) to reveal the variable labels for each column.

The screenshot shows a software window titled "906_B072518_S2_0.1ipm_1.001in 10:53:30 PM 10/26/2018". The interface includes a toolbar with various icons. Below the toolbar is a table with the following data:

	Extension (in)	Load (kN)	Strai...st (in/in)	Engin...n (in/in)	Strain (in/in)
	c1	c2	c3	c4	c5
0	0.0000	0.038643	0.0020879	-0.0035904	-0.0020900
1	0.00011000	0.037149	0.0020879	-0.0035904	-0.0020900

A circled icon in the top right corner of the table area indicates a function to expand or collapse the column labels.

Click the circled icon to expand or collapse the view of the column labels.

Note: By highlighting an individual column, the variable labels are shifted. To avoid confusion, make sure that no columns are highlighted during any of the data operations in this stage.

The screenshot shows the same software window, but now the "Strai...st (in/in)" column is highlighted in blue. The table data is as follows:

	Extension (in)	Load (kN)	Strai...st (in/in)	Engin...n (in/in)	Strain (in/in)
			c0	c1	c2
0	0.0000	0.038643	0.0020879	-0.0035904	-0.0020900
1	0.00011000	0.037149	0.0020879	-0.0035904	-0.0020900
2	0.00026000	0.040574	0.0021379	-0.0035404	-0.0021400
3	0.00044000	0.045643	0.0023177	-0.0033606	-0.0023200
4	0.00062000	0.037609	0.0026374	-0.0030409	-0.0026400
5	0.00080000	0.026337	0.0030170	-0.0026613	-0.0030200
6	0.00098000	0.032642	0.0031868	-0.0024915	-0.0031900
7	0.00116000	0.035476	0.0033467	-0.0023316	-0.0033500
8	0.00133000	0.038170	0.0034865	-0.0021918	-0.0034900
9					

The status bar at the bottom indicates "Row: 0 Column: 3".

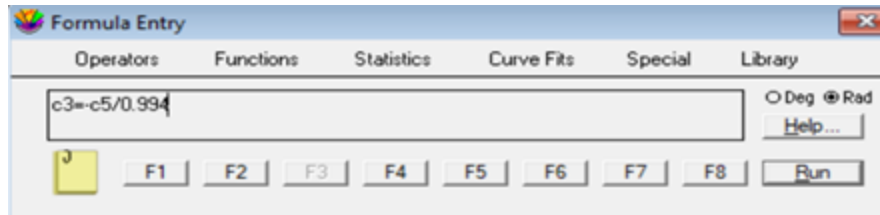
Highlighting a column shifts the formula labels.

2. Enter the keyboard command **Ctrl+F** to open the "Formula Entry" window.
3. Enter the following formula into the text box:

$$[Strain Adjust] = - [Strain] / \{length of test sample in inches\}$$

The length of the test sample should be available in the test's data file name.

Note: Column titles in brackets represent that column's corresponding variable (i.e. 'c8').

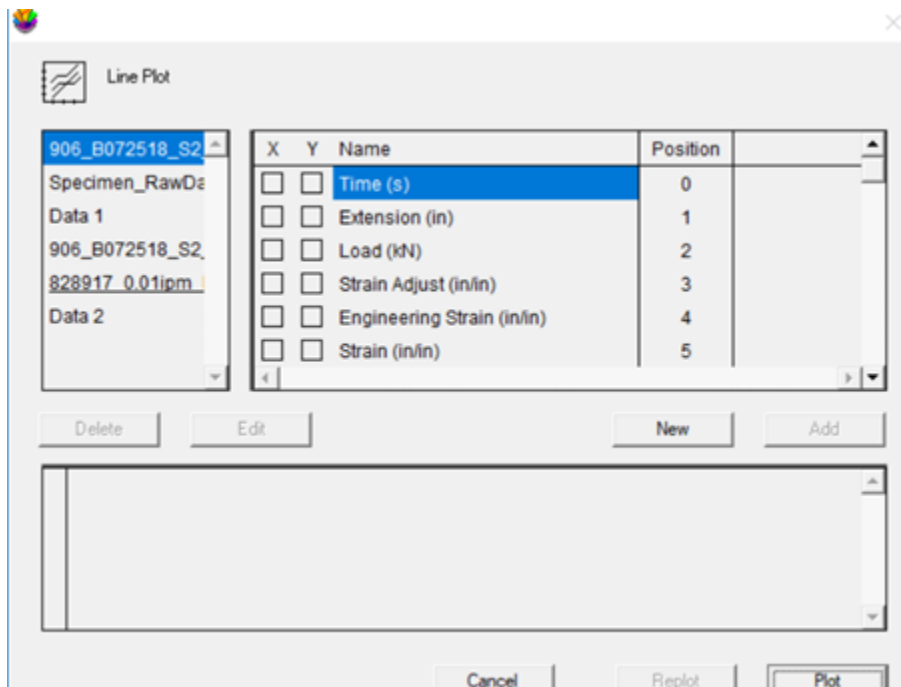


“Formula Entry” window with correctly typed formula

- Click “Run” to apply the operation.

Stress-Strain Toe Correction

- From the control ribbon at the top of the window, follow the directory: **Gallery » Linear » Line**.
- The following window should open:

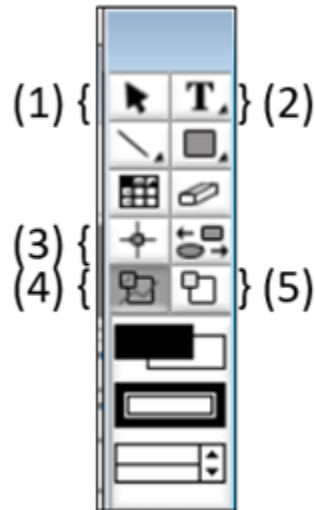


The “Line Plot” dialog box

- Check “Strain Adjust (in/in)” under “X”, and “Engineering Stress (MPa)” under “Y”.
- Click “Add”.

9. Click “Plot”.

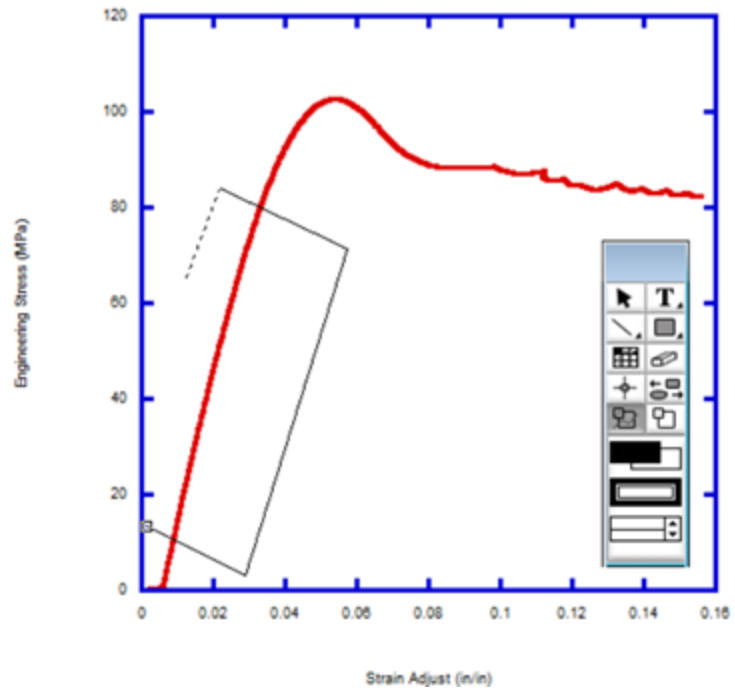
10. A stress/strain plot window, along with a separate plot toolbar (pictured below), should appear.



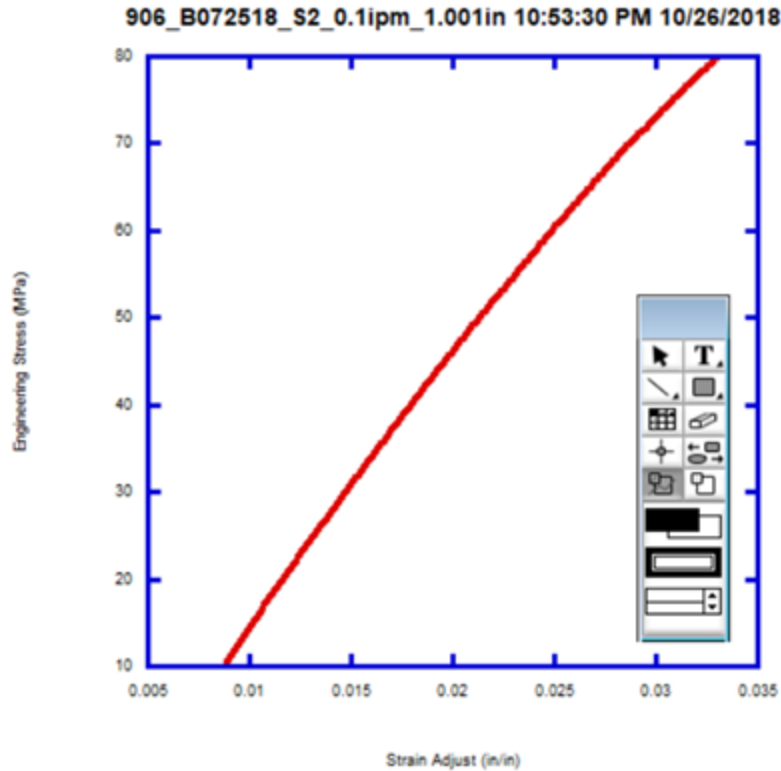
Plot Toolbar: your default tool should be (1). Always click back to it after utilizing other tools.

11. Using the masking function, (4), box in a linear portion of the curve. Click on the plot to ‘pin’ the corners of the box, and connect back to the starting point in order to ‘close’ the box and initiate the masking.

906_B072518_S2_0.1ipm_1.001in 10:53:30 PM 10/26/2018



Boxing in linear portion of curve using masking tool.



The isolated portion of the curve.

12. From the control ribbon, follow the directory: **Curve Fit » Linear**.
13. Check “Engineering Stress (MPa)” and click OK. A linear best-fit line should appear on the plot.
14. Right click on the plot, and check “Display Equation”. A linear ‘ $y = mx + b$ ’ equation will appear. Record the given ‘b’ value on paper, or copy it to the clipboard.
15. Before proceeding, it is essential that the data masking is undone by double-clicking (4) on the plot toolbar. **Note: The linear best-fit line will shift to accommodate the new data, and the ‘ $y = mx + b$ ’ equation will become unusable. This is why the initial ‘b’ value was recorded.**

16. Check that none of the cells in the data table are bordered in red (indicating masking). After this has been confirmed, the toe correction stress/strain plot may, under most circumstances, be discarded without saving. Consult with Dr. McCoy before doing so.

17. From the data table's formula window (opened using **Ctrl+F**), enter and run the following operations, in order:

$$[Engineering\ Strain] = [Strain\ Adjust] - \{ 'b' \}$$

$$[True\ Strain] = - \ln (1 - [Engineering\ Strain])$$

$$[True\ Stress] = [Engineering\ Stress] * (1 - [Engineering\ Strain])$$

18. From the control ribbon, follow the directory: **Gallery » Linear » Line**.

19. Check "Engineering Strain (in/in)" under "X" and "Engineering Stress (MPa)" under "Y". Click "Add".

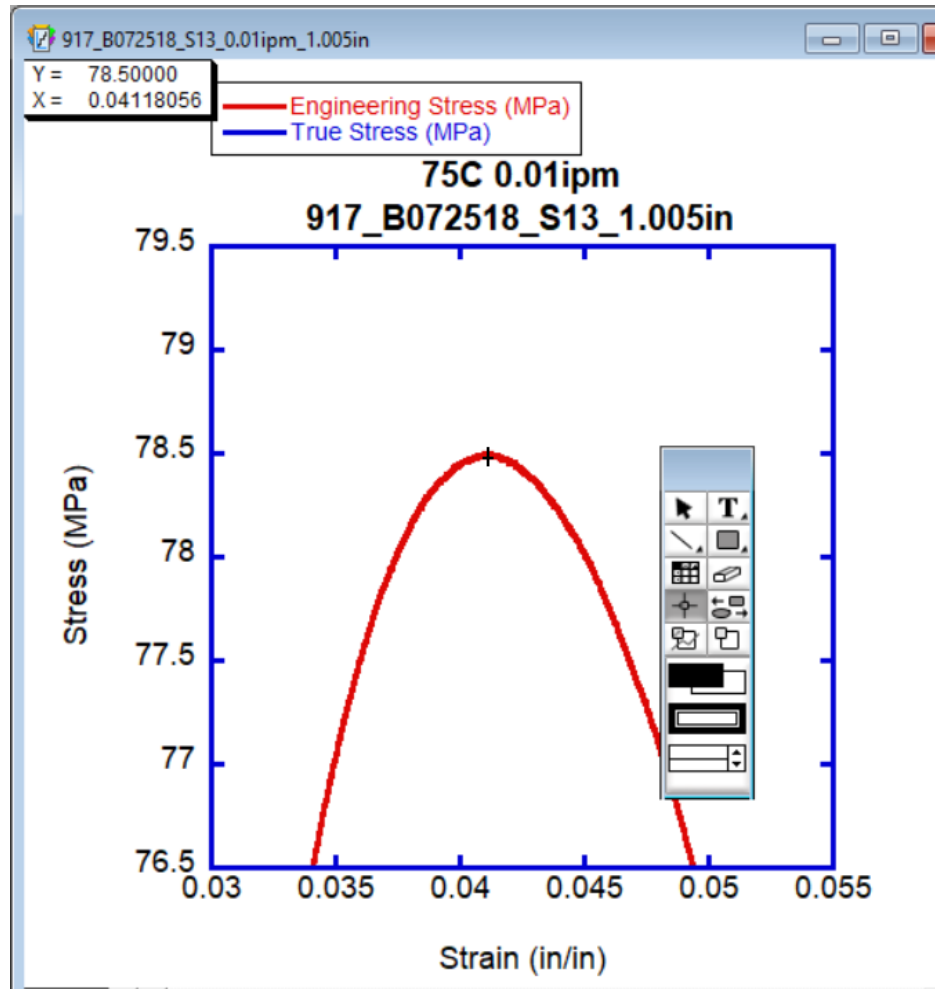
20. Check "True Strain (in/in)" under "X" and "True Stress (MPa)" under "Y". Click "Add".

21. Click "Plot". A plot with two stress/strain curves should appear.

Data Analysis:

Yield Stress

1. Use zoom, (5), on the plot toolbar to close in on the peak of the Engineering stress/strain curve.
2. Use the crosshair tool, (3), and click+hold on the peak. The strain/stress coordinates of where you have clicked will appear in the upper left corner of the plot window. Record the y-value to one decimal place, with units of MPa. Double-click on the zoom tool to zoom back out.

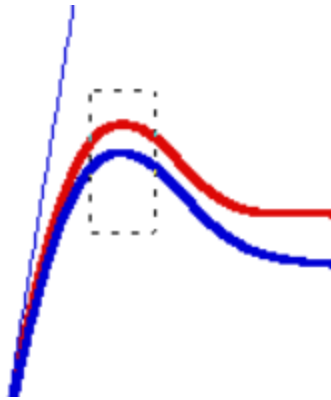


Centering and clicking on the peak using the crosshair function

3. Repeat steps 1-2 for the True stress/strain curve.

Crosshead Speed at Yield

4. Using the masking tool on the plot toolbar, (4), isolate the peaks of both curves at the same time.



Masking both peaks at once.

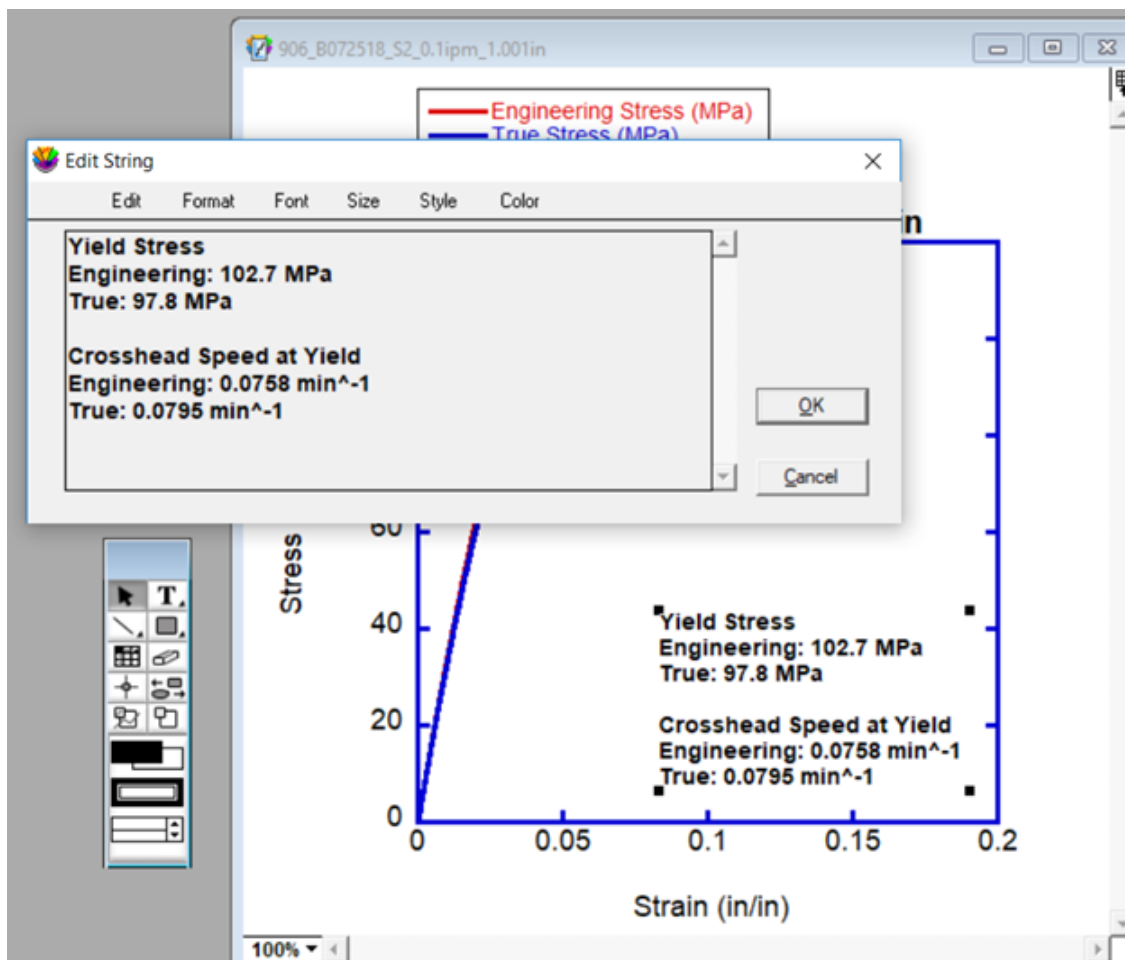
5. Go to the data table. If some data is bordered in red, the masking successfully carried over. If not, click on the grid icon on the upper right corner of the plot window to refresh the table-plot link.



Plots in KaleidaGraph have a tendency to remove themselves from the jurisdiction of their parent data tables. Clicking this icon will make a new but identical data table appear- one with a link to the plot.

6. From the control ribbon, follow the directory: **Gallery » Linear » Line**.
7. Check “Time (s)” under “X”. Under “Y”, check “Engineering Strain (in/in)”, as well as “True Strain (in/in)”. Click “Add” and then “Plot”.
8. Right click on the new strain/time plot. Check “Display Equation”. Two ‘ $y = mx + b$ ’ equations should appear, one for Engineering and one for True.

9. Multiply each 'm' value by 60. This is the Crosshead Speed at Yield for each curve. Record these values to three significant figures, with units of min^{-1} .
10. At this point the strain/time plot may be, under most circumstances, discarded without saving. Consult with Dr. McCoy before doing so.
11. Using the text box tool on the plot toolbar, (2), click on the stress/strain plot. Create an entry like the one pictured below, inputting the recorded values for yield stress and crosshead speed.

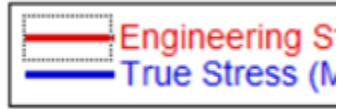


A correctly written text box with data analysis values.

12. Set the font size to 14 and the style to 'Bold'. Place the text in such a way that the stress/strain curves are obstructed as little as possible.

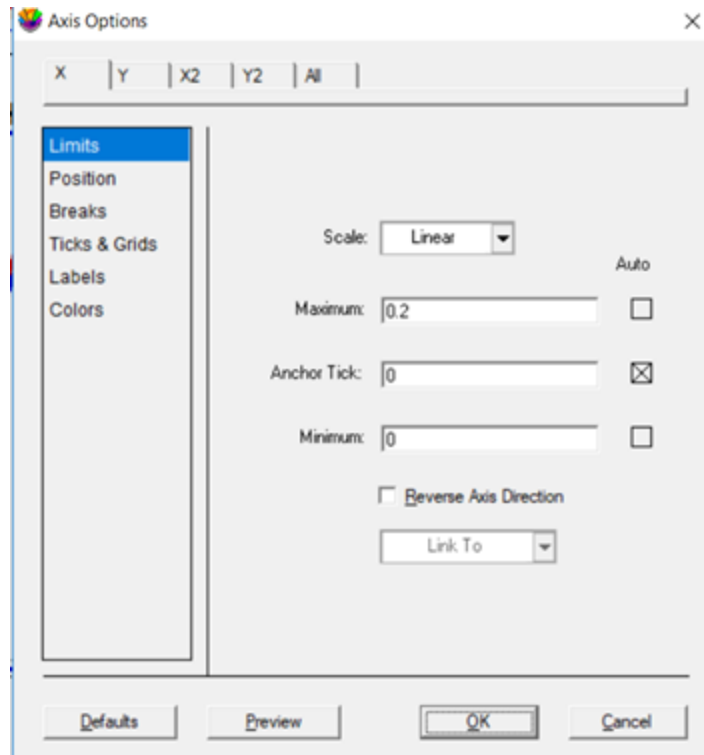
Formatting Plot:

1. Double-click on one of the lines in the plot legend. This will open the ‘Variable Settings’ window.



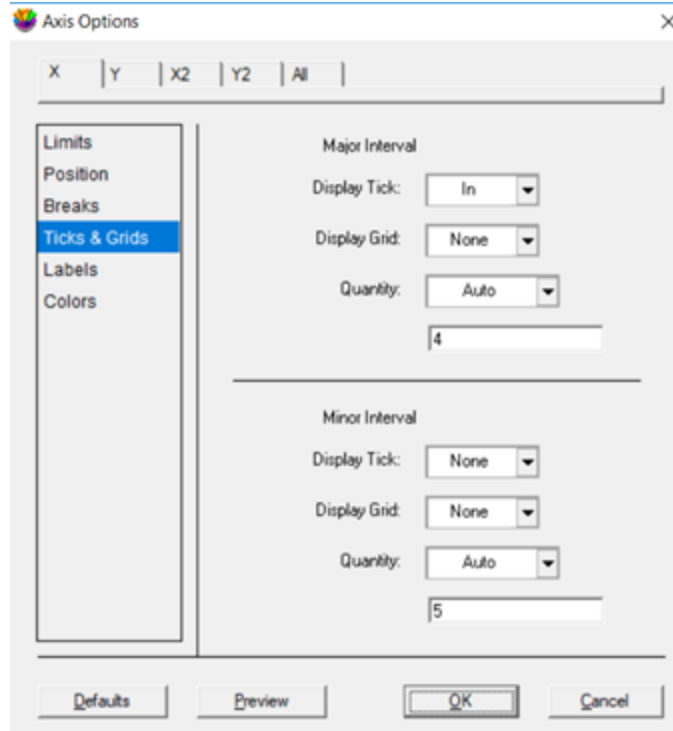
If your graph does not have a legend, right-click on the plot and check “Display Legend”.

2. Set “Show Markers” to “None”, “Line Style” to solid, and “Line Thickness” to 3.0. Click OK.
3. Repeat steps 1-2 for the other line.
4. Double-click on the x-axis line to open the “Axis Options” window. Under “Limits”, set “Minimum” to 0. If needed, do the same under the “Y” tab, located at the top of the window.



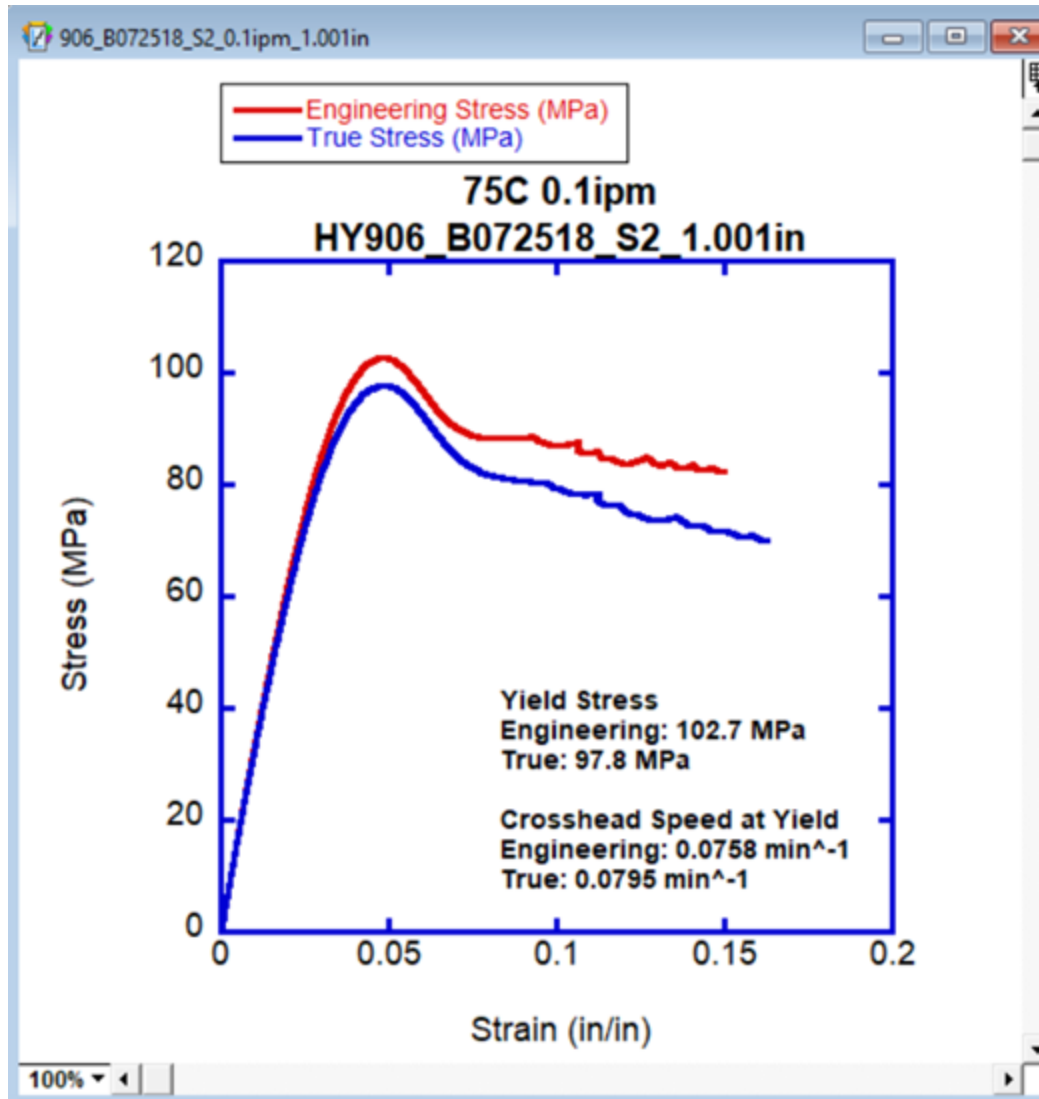
“Limits” section in the “Axis Options” window.

5. Go to the “Ticks & Grids” section on both “X” and “Y”, and make sure that the parameters are set to those pictured below.



“Ticks and Grids” section in the “Axis Options” window.

6. Under the “All” tab of the “Axis Options” window, go to “Thickness” and set both Tick and Axis Thickness to 3.0.
7. Double-click the x and y axis numbers and set “Size” to 18.
8. Double-click the axes labels and set “Size” to 18. Change the wording on these from “Engineering Stress (MPa)” and “Engineering Strain (in/in)” to just “Stress (MPa)” and “Strain (in/in)”
9. Double-click on the plot title, and change it to match the name of the test data file. Add more information if necessary. Set the font size to 20.
10. Double-click on the legend (but not on the legend lines) and set “Size” to 14.
11. Finally, name the plot file identically to the test data file using the keyboard command **Ctrl+R**.



A complete, correctly formatted Instron compression plot

12. Save the plot as a '.QPC' file, placing it with its corresponding test data files in a comprehensive archive. You do not have to save the data table; this can be extracted from the plot window at any time using the grid icon above the scroll bar.

DSC Test Plotting

Creating Data Table:

Opening Data File

1. Open the KaleidaGraph program.
2. Go to the control ribbon at the top of the window. Follow the directory: **File » Open**, and find the location of your test data. There will be many files to choose from: choose the one with the suffix “_all”.
3. The “Test File Input Format” menu will open.
 - a. Set “Delimiter” to “Tab”, typing a single comma into the specification box.
 - b. Set “Number” to “1”
 - c. Set “Lines Skipped” to 0
 - d. Check “Read Titles”
 - e. Click OK

Formatting Data Table

4. Add two columns using the “Insert Column” symbol, located of the toolbar at the top of the data window.



The “Insert Column” icon

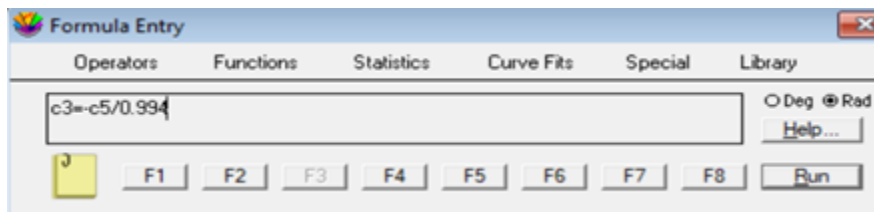
5. Name these columns “Heat Capacity (J.g*C)” and “Heat flow (W/g)”.
6. Click the double-arrow symbol (pictured below), located above the scroll bar of the data table window, to reveal the variable labels for each column.



Click on this icon to expand or collapse the view of the column labels.

Note: by highlighting an individual column, the variable labels are shifted. To avoid confusion, make sure that no columns are highlighted during any of the data operations.

7. Enter the keyboard command **Ctrl+F** to open the “Formula Entry” window.



“Formula Entry” window with correctly typed formula

8. Enter the following formula into the text box:

$$[\text{Heat Flow (W/g)}] = [\text{Heat Flow (mW)}] / \{\text{mass of test sample}\}$$

The mass of the test sample should be available in the test’s data file name.

Note : Column titles in brackets represent that column’s corresponding variable (i.e. ‘c8’).

9. Click “Run” to apply the operation.

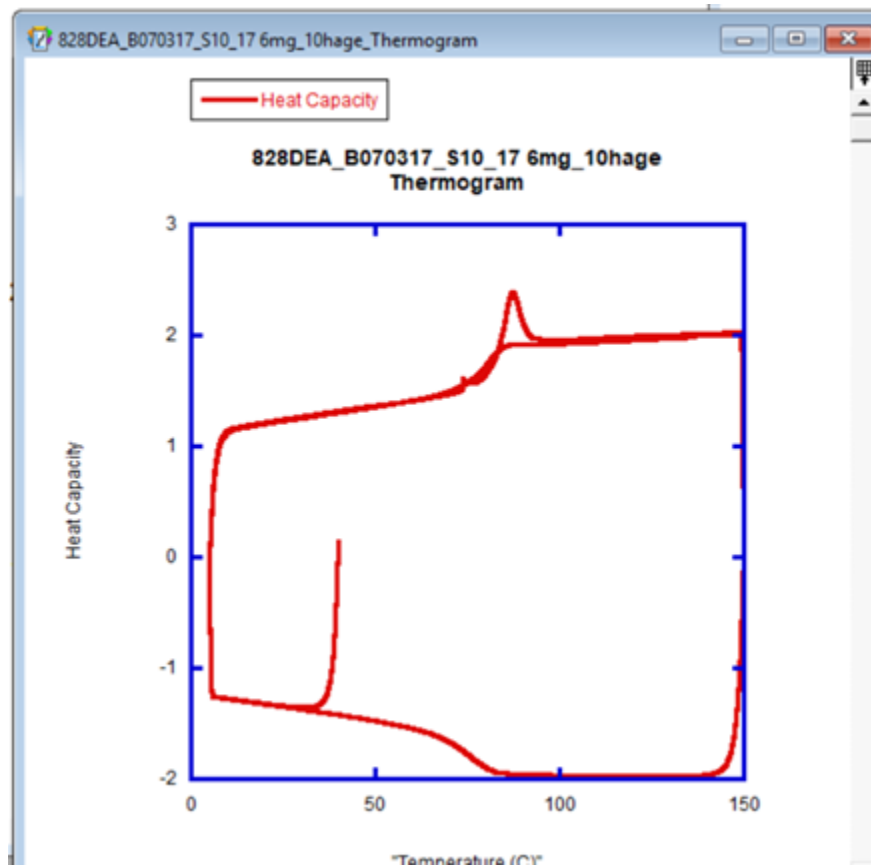
10. Enter the following formula into the Formula Entry box:

$$[\text{Heat Capacity (J.g*C)}] = [\text{Heat Flow (W/g)}] / 10 * 60$$

Click “Run”

Creating Thermogram

1. From the control ribbon at the top of the window, follow the directory **Gallery » Linear » Line**.
2. Check “Temperature (C)” under “X”, and “Heat Capacity (J.g*C)” under “Y”.
3. Click “Add”
4. Click “Plot”
5. A plot similar to the one pictured below should appear:



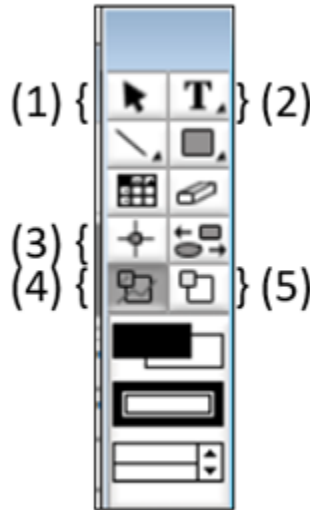
A typical thermogram

6. Name the plot file using the keyboard command **Ctrl+R**. Use the test data file name, adding a suffix of “_thermogram”.

7. Save the plot as a '.QPC' file, placing it with its corresponding test data files in a comprehensive archive.

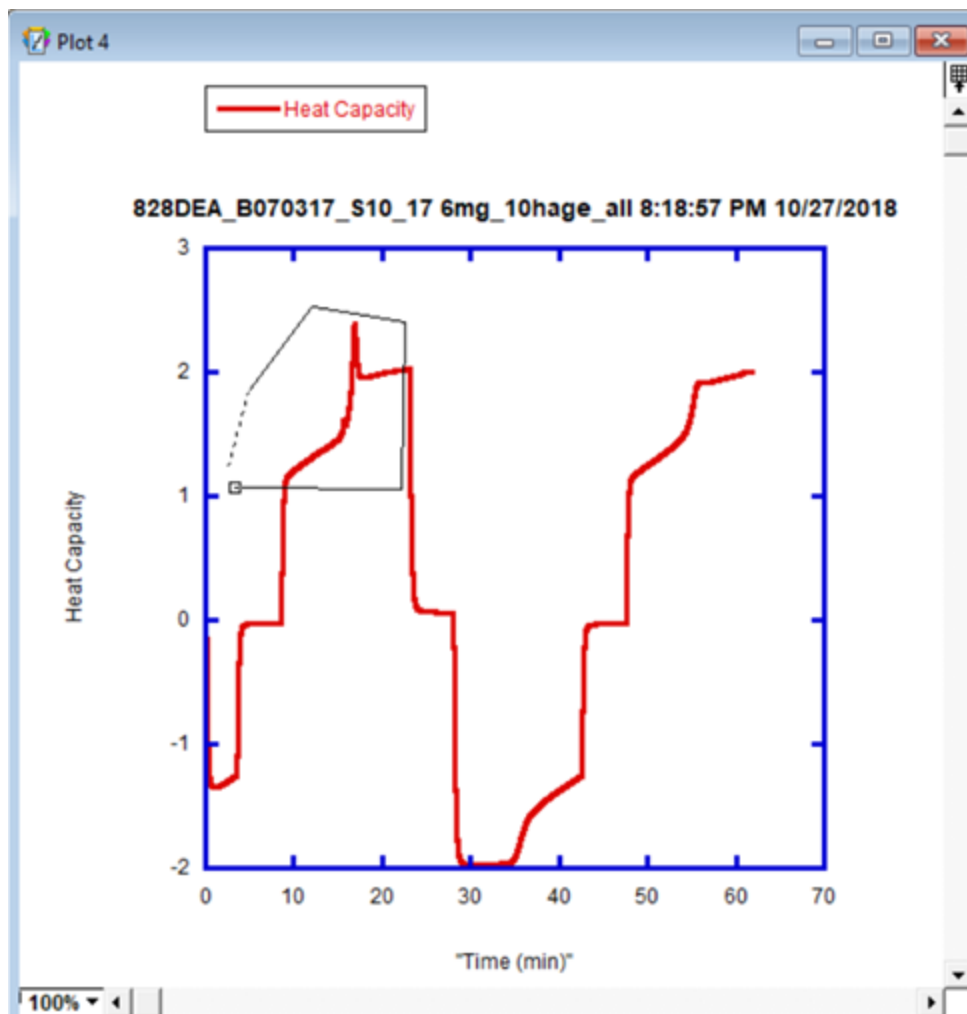
Creating Heat Curves

1. Click back into the data table. From the control ribbon, follow the directory **Gallery » Linear » Line**.
2. Check "Time (min)" under "X", and "Heat Capacity (J.g*C)" under "Y".
3. Click "Add".
4. Click "Plot".
5. A plot window and a plot toolbar (pictured below) should appear.



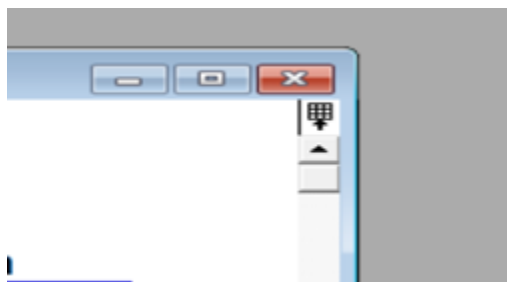
Plot Toolbar: your default tool should be (1). Always click back to it after utilizing other tools.

6. Using the masking function, (4), box in the nonlinear portion of the first peak (pictured below). Click on the plot to 'pin' the corners of the box, and connect back to the starting point in order to 'close' the box and initiate the masking.



Isolating all non-linear data from the first peak using the masking function.

7. Go to the data table. If some data is bordered in red, the masking successfully carried over. If not, click on the grid icon on the upper right corner of the plot window to refresh the table-plot link.



Click the grid icon to refresh the plot-table link.

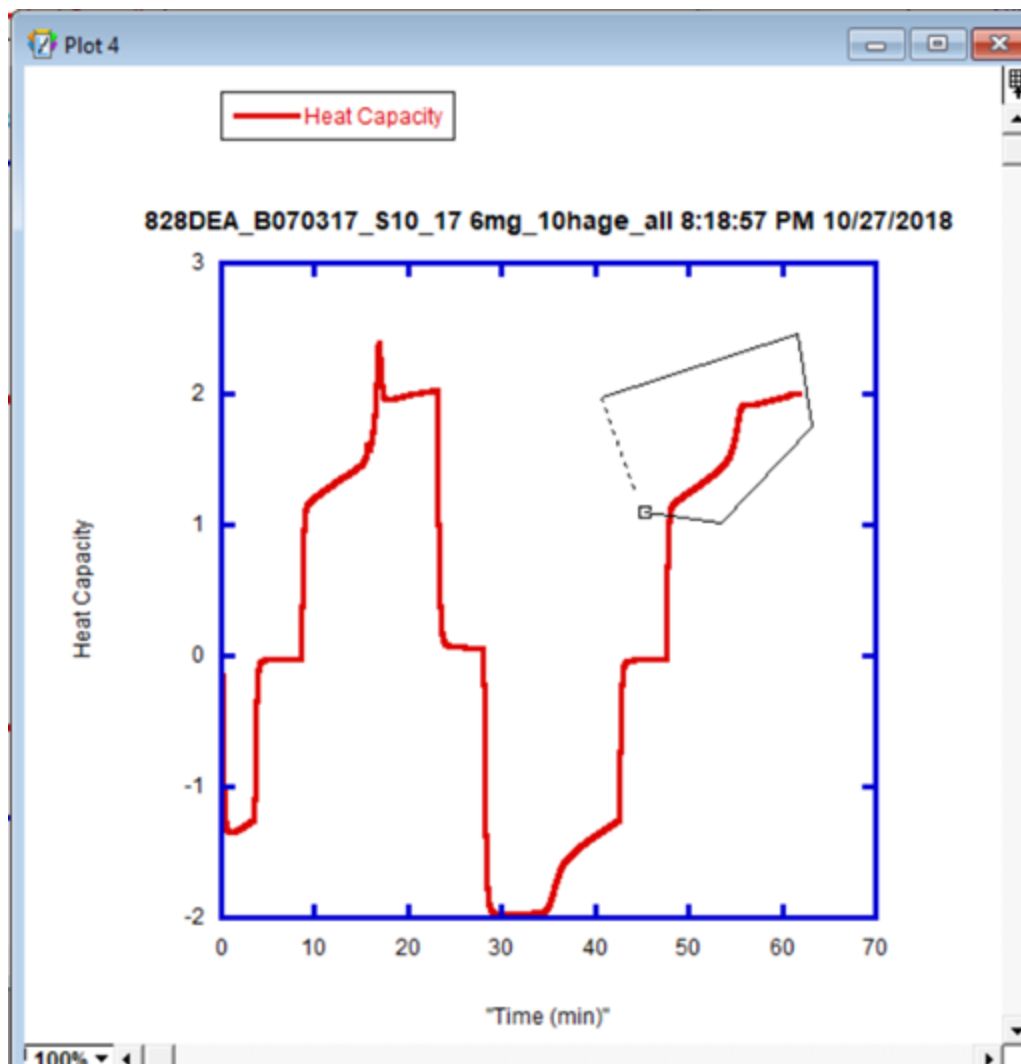
8. Highlight all unmasked data from the data table, and copy to a new data table window.
To open a new data table window, follow the directory **File » New**.

	Heat Capacity	"Heat Flow (mW)"	"Delta T (µV)"	"Delt...ro (µV)"
	C3	C4	C5	C6
2671	1.0174	-2.9844	-11.217	38.932
2672	1.0211	-2.9952	-11.261	38.982
2673	1.0248	-3.0062	-11.309	39.036
2674	1.0285	-3.0169	-11.356	39.090
2675	1.0313	-3.0252	-11.399	39.143
2676	1.0341	-3.0335	-11.441	39.195
2677	1.0372	-3.0423	-11.484	39.250
2678	1.0403	-3.0516	-11.525	39.308
2679	1.0418	-3.0561	-11.562	39.350
2680				

Row: 2677 Column: 3

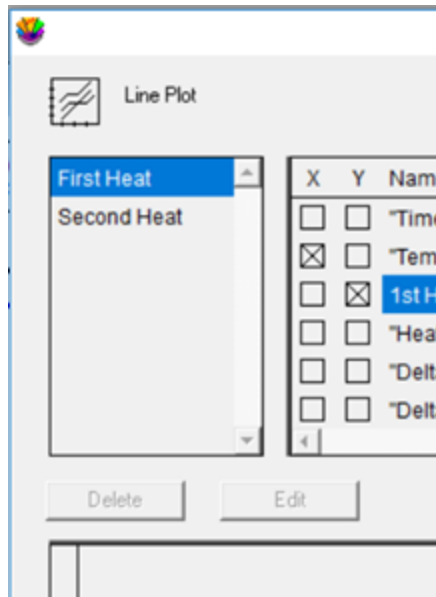
Highlight and copy the data from all columns, starting from where the masking ends and finishing where it begins again.

9. Name the new data table “First Heat” using the keyboard command **Ctrl+R**. Rename the “Heat Capacity” column “First Heat Capacity (J.g*C)”
10. Repeat steps 3-6 for the second peak of the heat capacity/time (pictured below), but instead naming the new data table “Second Heat” and the “Heat Capacity” column title “Second Heat Capacity (J.g*C)”



Isolating non-linear data from the second peak.

11. Click into the First Heat data table. From the control ribbon, follow the directory **Gallery** » **Linear** » **Line**.
12. From the "First Heat" tab, check "Temperature (C)" under "X", and "First Heat Capacity (J.g*C)" under "Y".



Information from both the “First Heat” and “Second Heat” data tables can be put into a single plot.

13. Click “Add”.

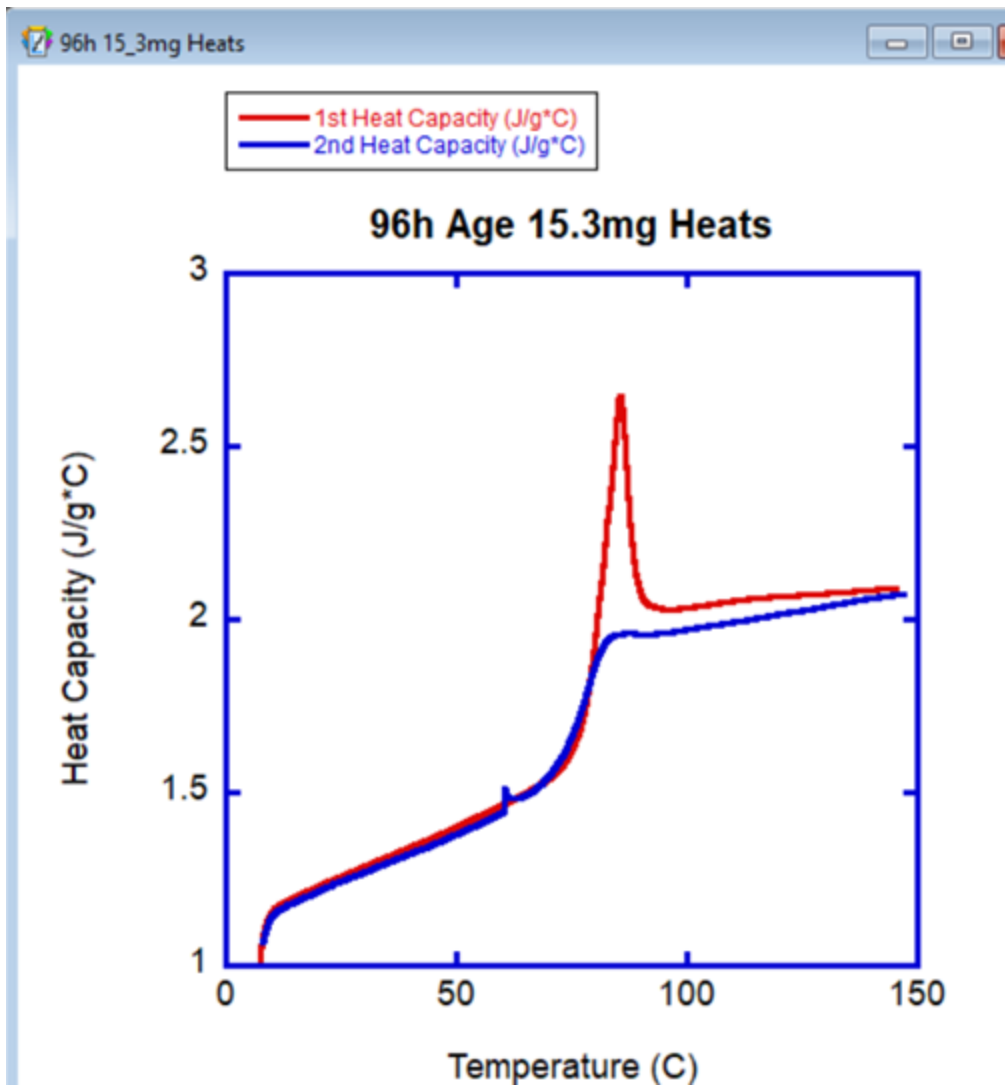
14. From the “Second Heat” tab, check “Temperature (C)” under “X”, and “Second Heat Capacity (J.g*C)” under “Y”.

15. Click “Add”.

16. Click “Plot”

Formatting Plot

1. See the “Formatting Plot” segment of the Instron Plotting Manual. Your complete plot should look like the one pictured below:



A complete, properly formatted DSC test plot.