TA Instruments

Thermal Analysis & Rheology

THERMAL APPLICATIONS NOTE

Experimental Considerations for Thermal Conductivity by Modulated DSC™

Modulated DSC provides a unique method for determining the thermal conductivity of polymers, glasses, and ceramics. See TA Instruments publication TA-086 for detailed theory and typical results. This Application Note summarizes important considerations for obtaining good thermal conductivity data from this MDSC approach.

- Thermal Conductivity measurements are derived from 1) apparent heat capacity measurement on a large test specimen and 2) heat capacity measurement on a thin test specimen.
- Follow all of the recommendations included in "Heat Capacity by Modulated DSC" (TN-16) for obtaining heat capacity results on thin test specimens.
- The key to obtaining good thermal conductivity data lies in minimizing the contact resistance between the test specimen and the DSC cell. Ensure that the DSC cell sample and reference platforms are smooth by polishing them briefly with a 6.3mm disk of 600 grit emery paper glued to the eraser end of a pencil.
- For the apparent heat capacity measurement, a known and controlled test specimen geometry is needed. Right circular cylinders cut from quarter inch rods are a convenient source of suitable specimens. Test specimens 3.4 to 3.8mm in length are convenient. Care should be taken to ensure that the cylinder ends are smooth, flat and parallel.
- The use of large diameter test specimens (i.e., 6.3mm) minimizes heat flow losses through the specimen sides.
- Since a 6.3mm diameter test specimen is larger than the diameter of the DSC sample platform, use 6.3mm disks of aluminum foil between the DSC cell disk and test specimen to ensure a uniform temperature distribution across one end.

  Note: Disks may be cut from lightweight household aluminum foil using a 6.33mm (0.25 inch) hole punch. Use a guard sheet of paper on either side of the foil in order to maintain the foil flat and crinkle free.

  Note: Do not use aluminum sample pans as they are too thick for this purpose.
- Coat both sides of the aluminum foil with a thin coating of silicon oil to ensure the minimum thermal resistance between the DSC cell and aluminum foil and between the foil and test specimen.
- Use a silicone oil coated aluminum foil as the reference during this measurement.

  Note: Results are optimized by making the aluminum foil disks and application of the silicone oil for the reference and sample as equivalent as possible.
- Once experimental temperature oscillations have begun, allow sufficient time for dynamic equilibrium to be achieved before recording experimental values. This typically requires 10 to 15 minutes.
- Use a long oscillation period. 80 seconds is recommended since it provides sufficient time for dynamic equilibrium.
- Obtain the thermal conductivity calibration constant D at the temperature of interest using a glassy material of low thermal conductivity. Commercial polystyrene is a suitable material whose thermal conductivity is well known. Tables which summarize reported literature values for polystyrene are shown below.

THERMAL CONDUCTIVITY
POLYSTYRENE

(C.Y. Ho, et.al. NBS Publication GCR-7783)

Temperature (K)	Temperature (°C)	Thermal Conductivity (W/°C m)
120	-153	0.1271
140	-133	0.1308
160	-113	0.1343
180	-93	0.1376
200	-73	0.1407
220	-53	0.1436
240	-33	0.1463
260	-13	0.1480
273	0	0.1506
280	7	0.1514
293	20	0.1529
300	27	0.1539
320	47	0.1562
340	67	0.1582
360	87	0.1605
370	97	0.1616

SPECIFIC HEAT CAPACITY
POLYSTYRENE

[V. Gaur and B. Wunderlich, J. Phys. Chem. Ref. Data, 11 (2) 313 (1982)]

Temperature (°C)	Temperature (K)	Specific Heat Capacity (J/g°C) Solid	Melt
-153.16	120	0.5221	
-143.16	130	0.5558	
-133.16	140	0.5898	
-123.16	150	0.6242	
-113.16	160	0.6591	
-103.16	170	0.6948	
-93.16	180	0.7310	
-83.16	190	0.7682	
-73.16	200	0.8062	
-63.16	210	0.8452	
-53.16	220	0.8755	
-43.16	230	0.9218	
-33.16	240	0.9617	
-23.16	250	1.0029	
-13.16	260	1.0451	
-3.16	270	1.0884	
6.84	280	1.1326	
16.84	290	1.1775	
26.84	300	1.1230	
36.84	310	1.2691	
46.84	320	1.3156	
50.00	323.16	1.3305	
56.84	330	1.3626	
66.84	340	1.4100	
76.84	350	1.4576	
86.84	360	1.5056	
96.84	370	1.5539	
106.84	380		1.8812
116.84	390		1.9067
126.84	400		1.9322
136.84	410		1.9576
146.84	420		1.9832
156.84	430		2.0086
166.84	440		2.0340
176.84	450		2.0596
176.84	460		2.0803
196.84	470		2.1105
206.84	480		2.1359

For more information or to place an order, contact:
TA Instruments, Inc., 109 Lukens Drive, New Castle, DE 19720, Telephone: (302) 427-4000, Fax: (302) 427-4001
TA Instruments S.A.R.L., Paris, France, Telephone: 33-01-30489460, Fax: 33-01-30489451
TA Instruments N.V./S.A., Gent, Belgium, Telephone: 32-9-220-79-89, Fax: 32-9-220-83-21
TA Instruments GmbH, Alzenau, Germany, Telephone: 49-6023-30044, Fax: 49-6023-30823
TA Instruments, Ltd., Leatherhead, England, Telephone: 44-1-372-360363, Fax: 44-1-372-360135
TA Instruments Japan K.K., Tokyo, Japan, Telephone: 813-5434-2771, Fax: 813-5434-2770

Internet: http://www.tainst.com

TA Instruments
Thermal Analysis & Rheology
A SUBSIDIARY OF WATERS CORPORATION