TA Instruments

Thermal Analysis & Rheology

THERMAL APPLICATIONS NOTE

DETERMINING MINIMUM USABLE SAMPLE THICKNESS IN TMA

Thermomechanical analysis (TMA) is a technique widely used to determine transition temperatures and expansion/contraction properties of materials, including the coefficient of thermal expansion (α). When determining α, however, there are three factors which need to be considered to obtain reproducible quantitative results. These are TMA sensitivity and baseline drift, sample thickness, and the magnitude of α.

The TA Instruments TMA 2940 has a maximum sensitivity of 0.1 µm, a maximum resolution of 3nm, and a baseline drift (0 to 500°C) of about 0.5µm. Therefore, the recommended measured sample dimensional change over this range for α determinations is >5µm (roughly 10x the baseline drift). Knowing this, the minimum sample thickness required for testing can be determined from:

$$\alpha = \frac{\Delta L}{\Delta T} * \frac{1}{L_o} \quad \Rightarrow \quad L_o = \frac{\Delta L}{\Delta T} * \frac{1}{\alpha} \qquad [1]$$

where: ΔL = measured dimension change
L_o = original sample thickness
ΔT = temperature range of measurement

For example, a material with an expected α of 50µm/m°C would yield a recommended minimum sample thickness for testing of:

$$L_o = \left(\frac{5\mu m}{500^\circ C}\right) * \left(\frac{1}{50\mu m / m^\circ C}\right) = 200\mu m \qquad [2]$$

This minimum sample thickness will obviously change with α and temperature range. Clearly, it is better to use samples much thicker than this minimum if possible, as this will further improve signal-to-noise ratio.

Acknowledgment: This applications note was submitted by Jon Foreman of the Applications Laboratory (US).

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