Determining Minimum Usable Sample Thickness in TMA

TA418

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 has a maximum sensitivity of 15 nm, a displacement resolution of 0.5 nm, and a baseline drift of 1 µm (typically, 0.5 µm between 0 to 500 °C). Therefore, the recommended measured sample dimensional change over this range for a determinations is >5 µm (roughly 10x the baseline drift). Knowing this, the minimum sample thickness required for testing can be determined from:

$$\alpha = \frac{\Delta L}{\Delta T} * \frac{1}{L_o} \rightarrow L_o = \frac{\Delta L}{\Delta T} * \frac{1}{\alpha} \qquad (1)$$

where:

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

For example, a material with an expected *α* of 50 µm/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 a 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.

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