

SEMI G13-88

STANDARD TEST METHOD FOR EXPANSION CHARACTERISTICS OF MOLDING COMPOUNDS

1 Scope

1.1 This specification describes the procedure for measuring the Coefficient of Thermal Expansion (CTE) and Glass Transition Temperature (T_g) of thermosetting molding compounds.

2 Apparatus

2.1 *Mold* — Producing 0.1–0.2" cubes or equivalent with an aspect ratio of 0.8–1.

2.2 *Transfer Press*

2.3 *Micrometer* — (0.0001 accuracy)

2.4 *Thermomechanical Analyzer* — (TMA) (Dupont Model 943, Perkin-Elmer TMS-1, or equivalent)

2.5 *Recorder and Power Supply* — (Dupont Model 990, Perkin-Elmer UII, or equivalent)

2.6 *Oven* — ($200^\circ \pm 5^\circ\text{C}$ capability)

3 Materials

3.1 *Nitrogen (Gas)*

3.2 *Nitrogen (Liquid)*

4 Sampling

4.1 Mold samples according to product specifications.

4.2 Postcure the specimen in accordance with the material specification, and allow two (2) hours for cooling in a desiccator.

5 Procedure

5.1 Select a sample, making certain that all sides are flat and smooth. Measure the height of the sample with a micrometer to the nearest 0.0001 inch.

5.2 Place the sample into the TMA sample holder and bring the expansion probe down slowly until it just makes contact with the sample. Place sample on fixture per Instruction Manual. Add 3.0–5.0 grams to weight tray. Adjust the Linear Variable Differential Transformer (LVDT) to bring the recorder pen on scale. The LVDT is then zeroed with the zero switch. Readjust LVDT, if necessary, to bring pen on scale.

5.3 In a nitrogen atmosphere, heat the sample at a rate of $20^\circ\text{C}/\text{min.}$ to its post-cure temperature.

5.4 Without changing LVDT or probe position, use liquid nitrogen to cool the sample to a temperature at least 100°C below the deviation from α_1 .

5.5 Heat the sample at a rate of $5^\circ\text{C}/\text{min.}$ to at least 200°C .

5.6 Calculate $\alpha(\text{CTE})$, using the formula:

$$\text{CTE} = \left[\frac{(DL)(DY)}{(DT)(L)} \right]$$

where: $L_{(T+10^\circ)}$ = Length at Temperature 10° higher than temperature at which CTE is being measured. $L_{(T-10^\circ)}$ = Length at Temperature 10° lower than temperature at which CTE is being measured

ΔY = Y axis sensitivity in mils./in.

ΔT = change in temperature (20°C)

L = initial sample height (mils)

$K = \frac{\text{LIT CTE}}{\text{EXP. CTE}}$ for aluminum standard

5.7 Run two (2) samples for each lot and record the average.

5.8 An aluminum standard should be run to determine the calibration factor K for the Y (length) axis per 5.4 above, as necessary to insure the accuracy of the instrument's calibration.

5.9 Temperature readings should be calibrated periodically per manual instructions.

6 Report

6.1 Data is to include the orientation for which the sample is measured (e.g., perpendicular to flow).

6.2 CTE is reported as a function of temperature. CTE is to be reported every 10°C increments.

6.3 Report molding conditions and post-mold cure conditions.

6.4 Report specimen size.

NOTE: For many materials, the Glass Transition Temperature (T_g) may be determined by drawing tangents to the curve at the points of minimum and maximum slope. The point at which the tangents intersect is the T_g . The slopes of the lines are referred to as α_1 (below T_g) and α_2 (above T_g).

7 References

*ASTM D 696*¹ — Coefficient of Linear Thermo Expansion Plastic

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¹ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959