



What are Tg and CTE? How and why do we measure them?

Glass Transition Temperature

Glass Transition Temperature (Tg) is the point at which a material changes from its “glass-like” state into a more flexible, rubbery, elastic compound.

Historically, Differential Scanning Calorimetry (DSC) was used. DSC, however, does not measure a discrete point but a “thermal event” over a temperature range. DSC peaks can also shift with cure conditions and are easy to misinterpret – many times leading to higher values being reported. Therefore, we no longer use DSC to measure glass transition temperatures.

Dymax uses Dynamic Mechanical Analysis (DMA) to measure glass transition temperature. Using this method, the sample is subjected to an oscillatory stress, and the material response is measured. The Tan Delta peak is used to report the values on the Dymax Product Data Sheets.

Because Dymax light curable materials are thermoset rather than thermoplastic, physical properties will change above the Tg, but there will rarely be a steep drop off in material performance due to this. As always, you should subject your final assembly to the anticipated temperature range to validate performance.

Coefficient of Thermal Expansion

Thermal Mechanical Analysis (TMA) directly measures motion as a sample is heated and is therefore used to measure Coefficient of Thermal Expansion (CTE).

This is an important intrinsic property of adhesives and coatings that affects relative movement between parts. This can be critical in optical and electronic applications but is becoming more important for small medical devices as well.

The CTE of a cured adhesive will change above and below that polymer's Tg. The slope of the curves below and above the Tg are known as α_1 and α_2 .

Combining α_1 , α_2 and Tg gives the total movement that an adhesive will have over a selected temperature range. The lower that value, the lower will be the potential for relative movement between bonded parts.

Snapshot Summary:

T_g

- Glass Transition
- Measured via DMA
- Temp where material goes from rigid/glass-like to rubbery/elastic

CTE

- Coefficient of Thermal Expansion
- Measured via TMA
- Measures motion before and after T_g

References: A. Bachmann, "Advances in Light Curing Adhesives", SPIE, August 2001