ASTM D7028 Glass Transition Temperature (DMA Tg) of Polymer Matrix Composites by Dynamic Mechanical Analysis (DMA)

TEST METHOD SUMMARY

ASTM D7028 has become a widely used test standard in many companies due to lightweighting initiatives, especially in the automotive and aerospace industries, that have greatly increased the use of composites. This test standard determines the glass transition temperature (Tg) of polymer matrix composites containing continuous, oriented, high-modulus fibers. Rectangular specimen responses are measured while being heated at 5 C/min (9 F/min) under flexural oscillation at 1 Hz in the DMA mode. This resulting DMA Tg is an excellent indicator of the composite's upper limit application temperature, and is also useful for quality control of composite materials.

NOTE: Data accuracy is particularly critical with composites as failures can occur even when loads are within design parameters. Such failures are often attributable to the time-dependent phenomena known as creep. Accurate glass transition temperatures are best achieved using representative specimen sizes and a High-Force DMA test system which has no mechanical resonances, has the ability to measure across extreme dynamic range amplitudes, and has superior control of dynamic amplitude.

Solutions for ASTM D7028 typically include these types of components;

MTS Acumen®
Electrodynamic Test Systems

LOAD FRAME OPTIONS*

Both the MTS Acumen® and the MTS Landmark® test systems are ideal for determining the glass transition temperature (Tg) of polymer matrix composites per ASTM D7028. They offer a variety of force capacities and deliver up to 100 Hz (covering three decades) of precise, frequency controlled test protocols to accommodate a wide variety of DMA Tg, DMA and other fatigue testing needs. The compact MTS Acumen systems' electrodynamic actuation consumes less energy than other technologies, and provides a clean, quiet, and cost-effective system operation. The MTS Landmark 100 Hz Elastomer Test System is a tabletop system that features MTS servohydraulic actuation technology, and is the preferred test system when testing requirements demand higher force capacities.

MTS Landmark®
100 Hz Elastomer Test System

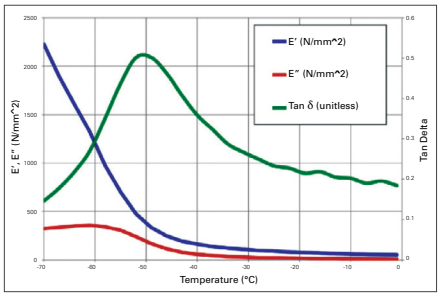
FIXTURE OPTIONS*

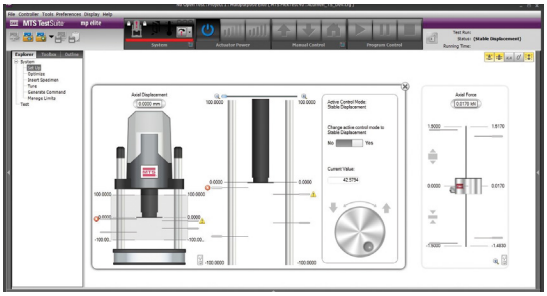
	
Dual Cantilever Beam Fixture	**3-Point Bend Fixture**
This MTS Dual Cantilever Beam Fixture is designed to meet the test requirements of ASTM D7028 and much more. It accommodates loads up to 1000 N, specimen lengths ranging from 30 mm to 100 mm (1.2" to 3.9"), and temperatures of -150°C to 350°C (-238°F to 662°F). The versatile designed fixture can also be used in a 3-point bend and single cantilever configurations.	The MTS 3-Point Bend Fixture has a span range of 30 mm to 100 mm (1.2" to 3.9") and a temperature range of -150°C to 350°C (-238°F to 662°F).

CHAMBER OPTIONS*

651.05F-01 Chamber	
	To ensure accurate and consistent results, the MTS 651.05F-01 Environmental Chamber has been tested in DMA applications. It is designed to maintain a constant temperature with very little temperature gradient across the specimen. Heating is achieved with electrical heating elements and a motor-driven fan for diffused convection heat. Cooling is accomplished with liquid nitrogen. It also has a built-in temperature controller, all-welded construction, and fiberglass insulation.

SOFTWARE OPTIONS*





DMA / Dynamic Characterization Application Software	Multipurpose System Software
To test per ASTM D7028, application software MTS Model 793.31 DMA/Dynamic Characterization allows the user to conduct dynamic characterization (leveraging the Kelvin-Voigt model) with up to four channels of control. The DMA application software measures Stiffness (K), Phase Angle, Damping (C), Modulus (E or G), Tan Delta, Glass Transition (Tg), and more. Additional software options include the TTS (time-temperature superposition) Master Curves module, which is commonly used to predict viscoelastic behavior at frequencies outside the range of what is typically achievable with physical testing. And the MTS Model 793.33 for static deflection testing and MTS Elastomer Express (for QA/QC testing).	MTS TestSuite Multipurpose Software delivers the test definition, execution, analysis and reporting capabilities required for dynamic testing. The intuitive user interface is optimized for MTS Acumen systems. The software lets you graphically build and run tensile, compression, bend, fatigue and fracture, multiaxial, block loading and custom profile tests with efficiency. With its easy-to-use interface, you can easily test to specific industry standards or pursue your own interpretation of a standard with customizable "plug-and-play" test methods. The software also captures all setup data and test results, allowing you to quickly repeat tests, analyze data with the stand-alone Analysis Software, and design and create reports with the convenient Excel Add-In.

*NOTE: This technical note is intended to show some of the popular and more common solutions used for this particular application. Most often, additional options are available and necessary to accomplish more comprehensive test objectives.

APPENDIX - TEST SPECIMEN DETAIL

The specimen, a flat rectangular strip of laminate, can vary in size but a span-to-thickness ratio greater than ten is recommended. One of the major fiber directions in the specimen shall be oriented parallel to the length axis of the specimen.

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