ASTM D5023 Dynamic Mechanical Properties (DMA) of Plastics in Flexure (Three-Point Bending)

TEST METHOD SUMMARY

ASTM D5023 is one of the most commonly used test standards for conducting DMA of Plastics in Flexure. The test procedure characterizes the viscoelastic properties of thermoplastic resins, thermosetting resins and composite systems. Using rectangular specimens, ASTM D5023 determines the storage (elastic or E'), loss (viscous or E") and complex (E*) moduli, as well as tan delta (δ), as a function of frequency, temperature, or time. These properties provide insights into the thermomechanical performance, including glass transition temperature (Tg), damping behavior, and effectiveness of cure.

NOTE: Data accuracy and analysis is particularly critical with polymers, as failures can occur even when loads and stresses are constant over time. This is known as creep failure. Another common failure occurs when polymer life is shortened due to operation in higher temperatures than originally designed for. In accordance with the Williams-Landau-Ferry (WLF) model, the MTS DMA software can perform time-temperature superposition (TTS) algorithms, allowing materials researchers to generate master curves that are critical in predicting long-term life based on short-term test data. Three decades of reliable data is especially important here since data errors lead to large amounts of error in life estimation.

Solutions for ASTM D5023 typically include these types of components;

LOAD FRAME OPTIONS*

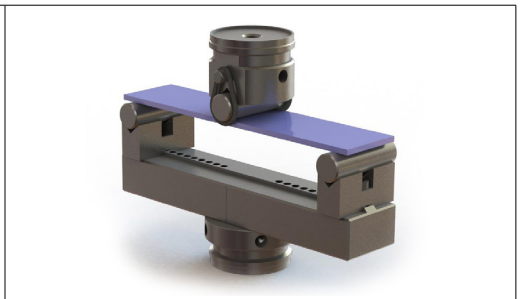
MTS Acumen®
Electrodynamic Test Systems

Both the MTS Acumen® and the MTS Landmark® test systems are ideal for conducting dynamic mechanical analysis (DMA) of polymers per ASTM D5023. 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 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 other requirements demand higher force capacities.

MTS Landmark®
100 Hz Elastomer Test System

BEND FIXTURE OPTIONS*

3 & 4-Point Bend Fixture



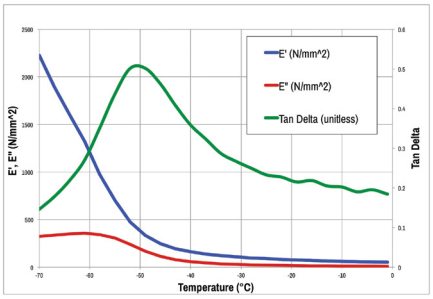
3-Point Bend Fixture

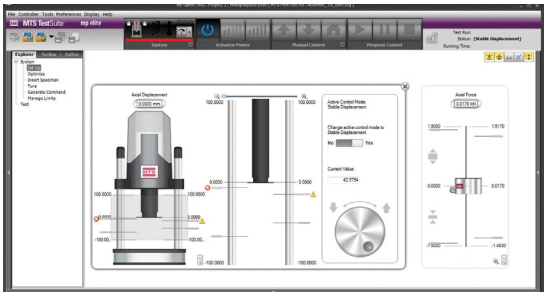
There are two MTS fixtures that can be used for ASTM D5023 three-point bending. The 3 & 4-Point Bend Fixture (MTS Model 642.001) has a span range of 14mm to 60mm (0.6" to 2.4") and a temperature range of -128°C to 149°C (-200°F to 300°F). The new MTS 3-Point Bend Fixture has a span range of 30mm to 100mm (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 Fiberglas™ insulation.

SOFTWARE OPTIONS*





DMA / Dynamic Characterization Application Software	TestSuite™ Software for MTS Acumen® Systems
To test per ASTM D5023, 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 your more comprehensive test objectives.

APPENDIX - TEST SPECIMEN DETAIL

The guidance provided in ASTM D5023 allows for test specimens to be cut from sheets, plates, or shapes molded to the desired finished dimensions. Normally the support span shall be 16 (tolerance +4 or –2) times the depth of the beam. Specimens should be long enough to allow overhanging on each end, at least 10% of the support span, but in no case less than 6.4mm (0.25") on each end. Exercise caution by making sure that the overhang is sufficient to prevent the specimen from slipping through the supports. A typical rectangular test beam is 64mm x 13mm x 3mm (2.5" x 0.5" x 0.125") tested flat-wise on a 50mm (2") support span, resulting in a span-to-depth ratio of 16.

MTS Systems Corporation
14000 Technology Drive
Eden Prairie, MN 55344-2290 USA
Telephone: 1-952-937-4000
Toll Free: 1-800-328-2255
Fax: 1-952-937-4515
E-mail: info@mts.com
www.mts.com

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