ISO 6721-5 Dynamic Mechanical Properties (DMA) – Flexural Vibration

TEST METHOD SUMMARY

ISO 6721 Part 5 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, ISO 6721-5 determines the storage (elastic or E'), loss (viscous or E") and complex (E*) moduli, as well as tan delta (Tan 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: When characterizing polymer materials using DMA, it is particularly critical to have accurate test data. This is especially true when generating Master Curves, the most practical way to predict long-term product life using short-term test data. Leveraging the Williams-Landau-Ferry (WLF) model and its frequency-temperature test data shift procedures, this invaluable master curve methodology increases both the capabilities and the efficiency of the test lab. Accurate test data is so important here because small data errors can lead to large errors in material life estimation.

Solutions for ISO 6721-5 typically include these types of components;

LOAD FRAME OPTIONS*

Both the MTS Acumen® and the MTS Landmark® High-Force DMA test systems are ideal for conducting dynamic mechanical analysis (DMA) of polymers per ISO 6721-5. 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 testing requirements demand higher force capacities.

MTS Acumen®
Electrodynamic Test Systems

MTS Landmark®
Servohydraulic Test System

FIXTURE OPTIONS*

| 3 & 4-Point Bend Fixture	3-Point Bend Fixture	Dual Cantilever Beam Fixture
The 3 & 4-Point Bend Fixture (MTS Model 642.001 on the left) has a span range of 14 mm to 60 mm and a temperature range of -128°C to 149°C. The bend fixture on the right has a span range of 30 mm to 100 mm (and a temperature range of -150°C to 350°C.		The Dual Cantilever Beam Fixture accommodates loads up to 1000 N, specimen lengths ranging from 30 mm to 100 mm and temperatures of -150°C to 350°C. This versatile fixture can also be used in a 3-point bend and single cantilever configurations.

CHAMBER OPTIONS*

651.05F-01 Chamber

The MTS 651.05 Chamber has been tested in DMA applications. It maintains a consistent temperature gradient across the specimen. It has electrical heating elements and a motor-driven fan for diffused convection heat. Cooling is accomplished with liquid nitrogen.

A reference test method, ISO 6721-1, states temperature ramp rates of 1-2 °C/min or 2-5 °C step intervals held for 3-5 minutes are generally suitable. Since time to reach equilibrium greatly depends on the mass of the specimen, step intervals are often preferred. Consult our DMA application engineers for recommendations.

SOFTWARE OPTIONS*
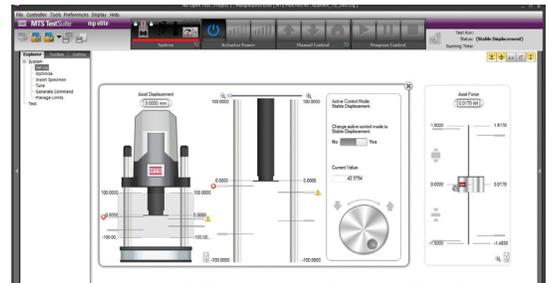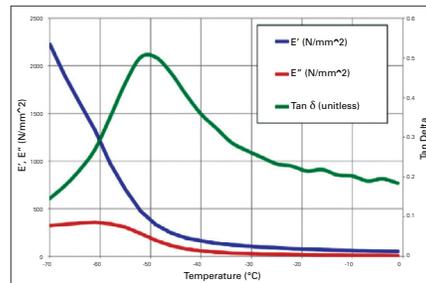
DMA / Dynamic Characterization Application Software	Multipurpose Testing System Software
To test per ISO 6721-5, application software MTS Model 793.31 DMA/Dynamic Characterization allows the user to conduct dynamic characterization (leveraging the Kelvin-Voigt model) with up to four channels of control. 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 ISO 6721-5 recommends test specimens of rectangular cross-section. The width and thickness along the specimen should not vary by more than 2% of the mean value. Specimen dimensions are often not critical although, for isotropic materials, further guidance is provided for clamped and simply supported specimens. Additional specimen guidance is also given for test conditions which yield storage moduli that is either > 50 GPa or < 100 MPa.