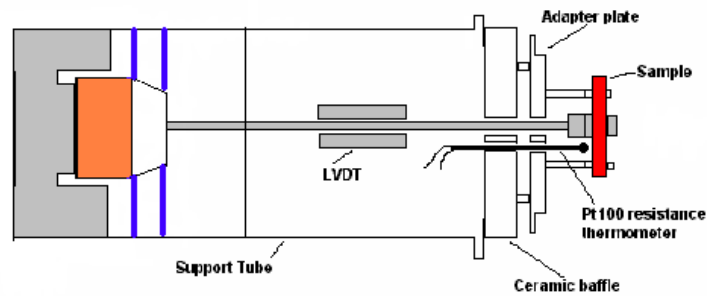
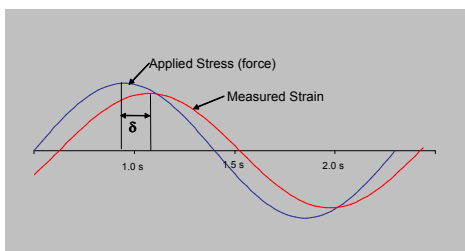


What is Dynamic Mechanical Analysis, DMA?

A Dynamic Mechanical Analyser, commonly referred to as just DMA, measures the stiffness and damping properties of a material. The stiffness depends on the mechanical properties of the material and its dimensions. It is frequently converted to a modulus to enable sample inter-comparisons. Damping is expressed in terms of $\tan\delta$ and is related to the amount of energy a material can store. DMA is the most sensitive technique for monitoring relaxation events, such as glass transitions, as the mechanical properties change dramatically when relaxation behaviour is observed.

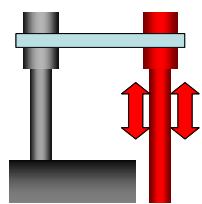


The instrument operation is relatively simple to understand. A force (stress) is applied to the sample through the motor. The stress is transmitted through the drive shaft onto the sample which is mounted in a clamping mechanism. As the sample deforms, the amount of displacement is measured by the LVDT positional sensor. The strain can be calculated from the displacement. The force (or stress) is applied sinusoidally with a defined frequency. A DMA is often referred to as a DMTA (Dynamic Mechanical Thermal Analyser) as during the measurement, the temperature of the sample is defined and can be changed.

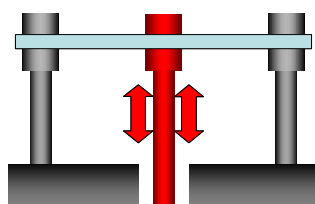


The magnitude of the applied stress and the resultant strain are used to calculate the stiffness of the material under stress. The phase lag between the two (or δ) is used to determine $\tan\delta$, the damping factor.

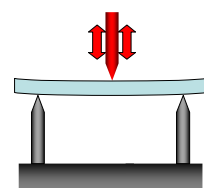
The sample can be mounted in the DMA in a number of ways depending on the characteristics of the sample. The 6 common geometries are shown below;



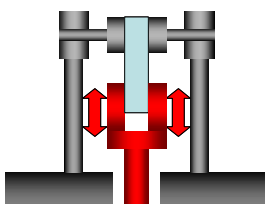
Single Cantilever Bending



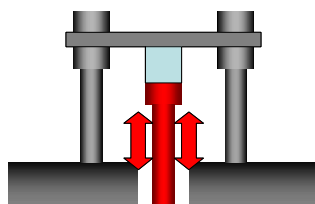
Dual Cantilever Bending



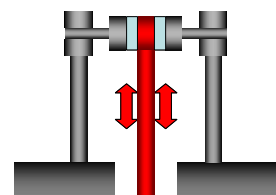
3 Point Bending



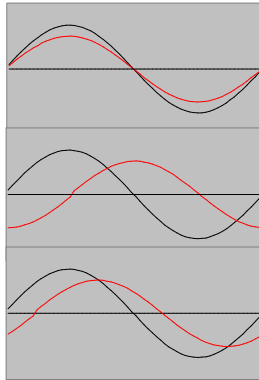
Tension



Compression



Shear



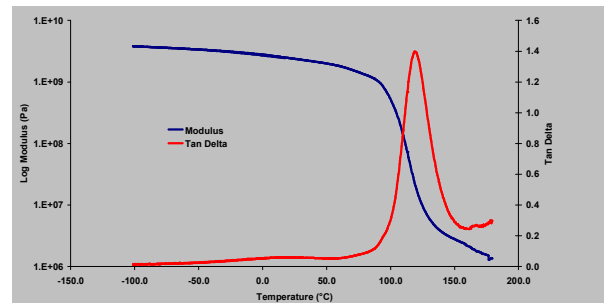
Where the strain is in phase with the stress, i.e. δ is 0° , the sample is classed as elastic. An example of an elastic material might be a rubber band or a metal spring.

Where the strain is 90° out of phase with the stress, i.e. δ is 90° , the sample is classed as viscous. Viscous materials such as Glycerine exhibit large damping properties.

Most materials are classified as viscoelastic i.e. δ is between 0° and 90° . Most polymers exhibit this behaviour and have an elastic and viscous component.

For elastic materials, the modulus is simply expressed as the ratio of stress to strain. $\tan \delta$ will be negligible. For viscous materials, stress and strain are related as a function of time as there is a phase difference between the two. $\tan \delta$ will be high as the damping effect will be large.

A typical response from a DMA shows both modulus and $\tan \delta$ for PMMA. As the material goes through its glass transition, the modulus reduces (the material becomes less stiff) and the $\tan \delta$ goes through a peak (the molecular reorganisation of the relaxation induces less elastic behaviour). The data give information on the position of the glass transition temperature, its frequency dependence, sample stiffness and other viscoelastic properties.



The TT DMA systems can perform analysis on many types of samples for example:

Bars	All bending geometries
Films	Tension
Fibres	Tension
Powders;	Using Powder Holders in bending geometry
Pellets	identiPol Fixture (requires identiPol for preparation)
Foams	Compression
Semi-solids	Shear or special geometry option
Liquids	Gauze platform, Sealed Tubes

It is also possible to control sample parameters:

Environment	Relative Humidity	Humidity Generator and Controller + Chamber
	Gas Phase	Optional purge gas
	Liquid Immersion	Triton Fluid Bath
Temperature		-190°C to 600°C
Frequency		Up to 1000 Hz
Sample Size		See Product Specification Sheet