Dynamic Mechanical Analyzer DMA 242 C

NETZSCH

Method

Dynamic Mechanical Analysis (DMA)

With **D**ynamic **M**echanical **A**nalysis **(DMA)** it is possible to make a quantitative determination of the mechanical properties of a sample under an oscillating load and as a function of temperature, time and frequency (e. g. DIN 51005, DIN 53513, DIN 53440, DIN-IEC 1006, ASTM D 4092, ASTM D 4065).

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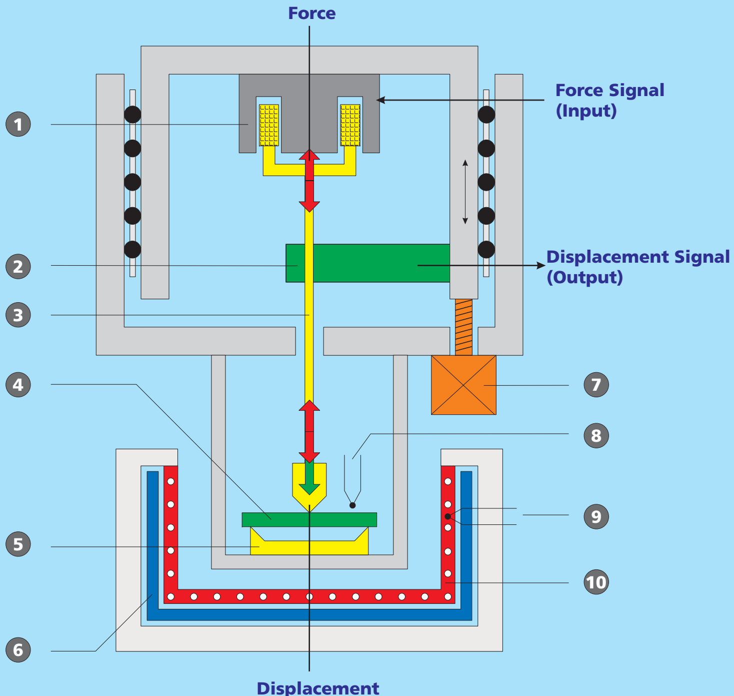
Technical Data

Temperature range:	-170°C ... 600°C	
Heating rates:	0.1 … 20 K/min	
Cooling time:	20°C … -150°C in 10 min (cooling agent: liquid nitrogen)	
Modulus range (E')	10^{-3} … 10^{6} MPa (dependent on deformation mode)	
Frequency range:	0.01 Hz … 100 Hz	
Measuring range tan δ:	0.00006 … 10	
Controlled stress:	max.	16N
	static (tension or pressure):	8 N
	dynamic:	± 8 N
Controlled strain:	± 0.1 ... 240 µm autoranging with highest resolution (nm range)	
Atmosphere:	inert and reactive purge gases (non toxic, non-flammable, non-explodable)	

TMA mode
FOURIER Analysis
Automatic Calibration Routines

Operating Principle



1. oscillator
2. displacement sensor (patented)
3. push rod
4. sample
5. sample holder
6. cooling jacket
7. stepper motor
8. sample thermocouple
9. control thermocouple
10. heating device

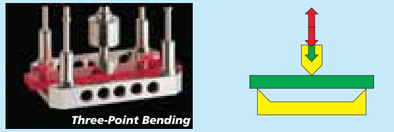
A sinusoidally oscillating force is applied to the sample (input signal)

The resulting sinusoidal deflection or deformation (output signal) contains information about the storage modulus E', the dynamic loss modulus E'' and the mechanical loss factor tanδ.

E*	=	complex elasticity modulus /Pa
G*	=	complex shear modulus /Pa
K*	=	complex compression modulus /Pa
h	=	sample height /mm
a*	=	complex dynamic displacement /mm
d	=	sample diameter /mm
F	=	dynamic load /N
l	=	bending length /mm
b	=	sample width /mm
A	=	cross section area /mm²
A_p	=	cross section area of the push rod/mm²

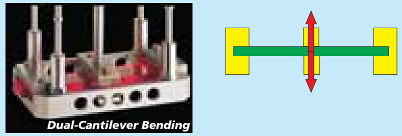
Modes of Deformation

(special sample holders upon request)



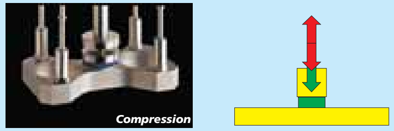
$$E^* = \frac{l^3}{4bh^3} \cdot \frac{F}{a^*}$$

materials with a high storage modulus: filled or reinforced thermoplastics, metalls, alloys (>10^1 … 10^5 MPa)



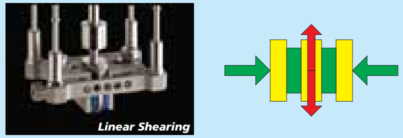
$$E^* = \frac{l^3}{16bh^3} \cdot \frac{F}{a^*}$$

materials of mid modulus range: rubber and thermoplastics, duromers (>10^{-1}… 10^5 MPa)



$$K^* = \frac{h}{A} \cdot \frac{F}{a^*}$$

samples with high damping: uncured rubber, soft elastomers, glues (10^{-1} … 10^3 MPa)



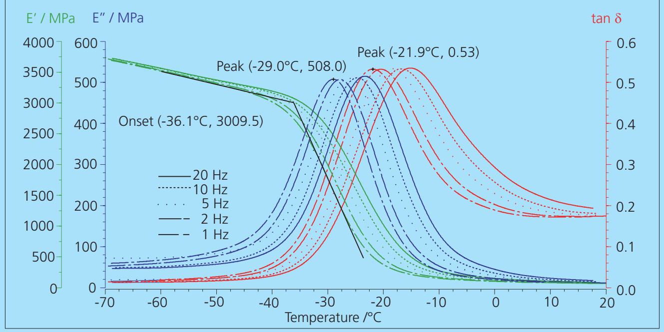
$$G^* = \frac{h}{2A} \cdot \frac{F}{a^*}$$

rubber, foams, biopolymers, pasty materials (10^0 … 10^4 MPa)

$$E^* = \frac{l}{A} \cdot \frac{F}{a^*}$$

films and fibers (10^0 … 10^4 MPa)

Application - Multifrequency Scan on an SBR Rubber Mixture



Sample:	SBR rubber mixture
Deformation mode:	dual cantilever bending
Heating rate:	2 K/min
Frequency:	multi

Influence of frequency on the glass transition
Increasing frequency provides:
higher characteristic temperatures
higher stiffness (E')

e-mail: at@ngb.netzsch.com · www.ngb.netzsch.com

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