TMA

Thermomechanical Analyzer

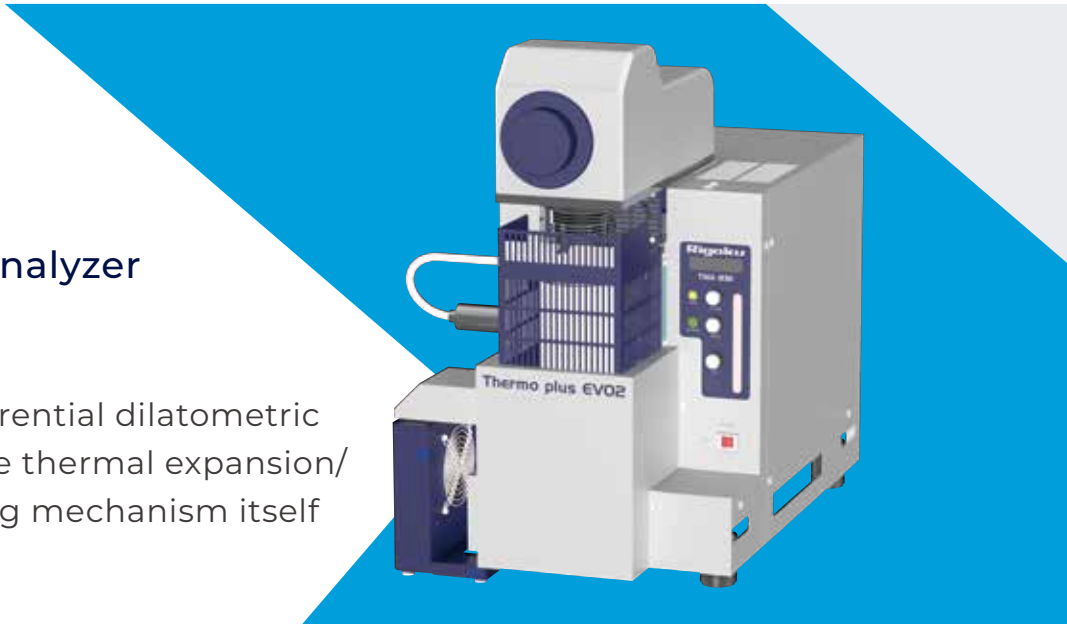
TDL

Thermo Dilatometer

Rigaku

POWERING NEW PERSPECTIVES

TMA Thermomechanical Analyzer
TDL Thermo Dilatometer



Thermomechanical Analyzer

TMA8311

Rigaku's TMA uses a differential dilatometric system, which cancels the thermal expansion/ shrinkage of the detecting mechanism itself

The differential dilatometric system achieves precise measurements with high reproducibility even in low expansion materials or thermal expansion/shrinkage of small samples

TMA offers four measurement modes, compression, tensile, penetration, and three-point bending, depending on the load conditions and the shape of the sample. In compression and tensile modes, thermal expansion and the coefficient of thermal expansion can be calculated from the displacement data.

Correction using a sample with known expansion coefficient

The measurement results of a sample with known expansion coefficients are compared to the literature values, allowing users to create and register a calculated calibration file obtained from the difference in expansion at each temperature. Using the registered calibration file to calibrate the expansion in the measurement results provides more accurate data. This function can also be used to manage the accuracy of data between multiple devices.

Versatile, expandable multipurpose measurement system

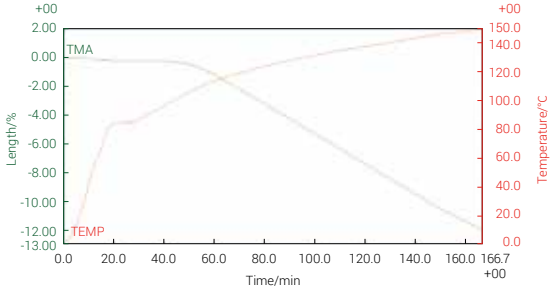
Simply changing the attachment enables a wide range of measurements, including compression, tensile, penetration, and three-point bending. In addition to constant load, load control can be set to constant-rate (changing compression or tensile load at a constant speed) or sinusoidal cyclic load (applying compressive/ tensile load at a fixed frequency)

Interchangeable cooling options

Different types of cooling units are available to meet your measurement purpose. Each cooling unit is easy to install and remove, so they can be readily exchanged according to the measurement needs.

Dynamic TMA (Optional package)

With this unit, temperature control is performed with the sample's shrinkage rate as a parameter instead of a constant temperature heating rate. This method can be used for ceramic sintering simulations, allowing the creation of sintered pieces with controlled shrinkage rates. The figure on the right shows the result of dynamic TMA measurement of the alumina before sintering. It can be seen that the temperature is controlled so that the shrinkage rate remains constant (0.1%/min.)



Measurement example:
Dynamic TMA measurement of alumina before sintering

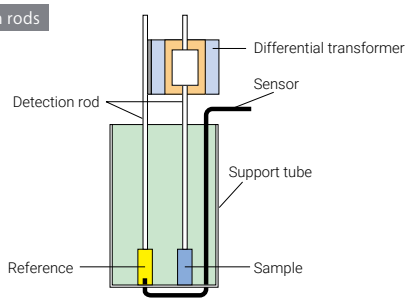
Highly expandable system for various measurement purposes

Rigaku's TMA system lets you to choose and switch between measurement attachments according to the type of sample. This allows you to accurately measure low-expansion samples (differential expansion: twin rods) or analyze polymer samples (non-differential or conventional expansion; single rod). For the non-differential type (single rod) attachment, two sensor (thermocouple) shapes are available: the straight type offers excellent reproducibility, while the bent-back type allows for adjustments according to the sample.

Note: Depending on the measurement conditions or temperature range, a specific type may be required.

Differential compression loading method

Twin rods



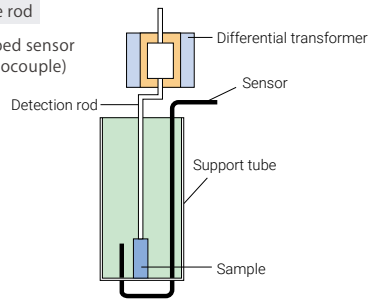
Rod- or plate-shaped sample

Suitable for thermal expansion measurement of rod- or plate-shaped materials in comparison to a reference. Continuously cancels the expansion of the support tube. Offers excellent reproducibility even for less expansive materials up to 10^{-7} (1/K) order.

Single rod compression loading method

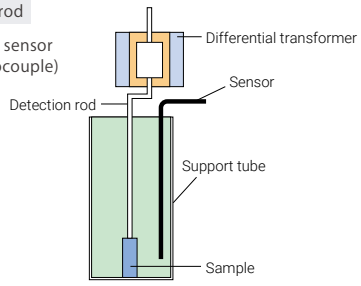
Single rod

U-shaped sensor (thermocouple)



Single rod

straight sensor (thermocouple)

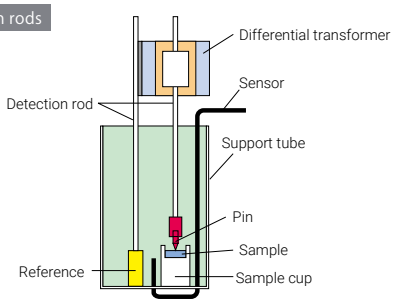


Rod- or plate-shaped sample, Polymer

Non-differential type (single rod), which involves setting only the sample, allows for the measurement of larger samples (up to Φ12 mm) compared to the differential expansion type.

Differential penetration method

Twin rods



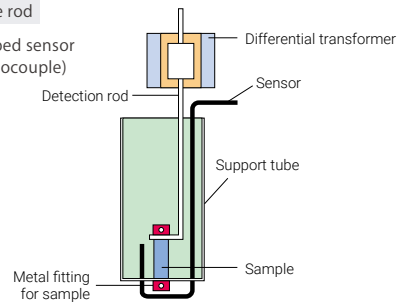
A few µm thick sample

This method uses Rigaku's unique differential system. A distinct feature of this system is that it can measure the glass transition or softening of materials a few micrometers thick with high precision. Measurement range is 1 µm full scale.

Tensile loading method

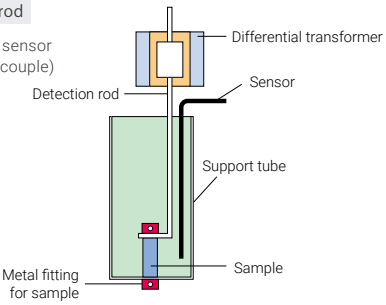
Single rod

U-shaped sensor (thermocouple)



Single rod

straight sensor (thermocouple)

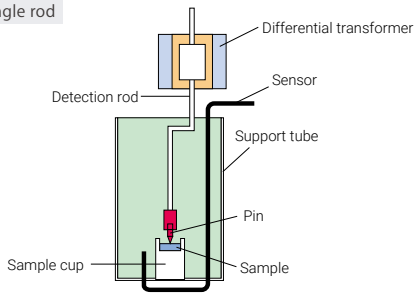


Fiber or film sample

In this method, both ends of a fiber or film sample are attached to a metal fitting and a tensile load is applied during measurement. The metal fitting is designed so that its weight does not affect the load, enabling high-precision measurements.

Penetration method

Single rod



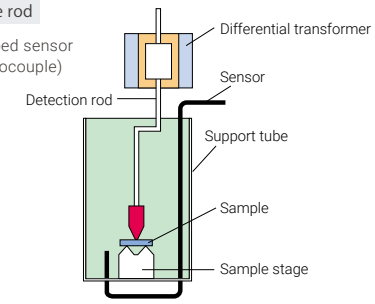
Sheet or film sample

A pin is pressed against a sheet or film sample. The sample is heated while a constant load is applied. Subsequently, the temperature and the load at which the pin penetrates the sample are measured. Linear heating or isothermal heating can be selected according to the purpose of the measurement.

3-point bending method

Single rod

U-shaped sensor (thermocouple)



Single rod

straight sensor (thermocouple)

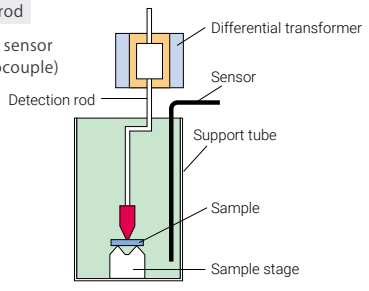


Plate sample

Measures the bending of plate-like materials. Obtains information on deformation temperature and deformation amount.

Various cooling units

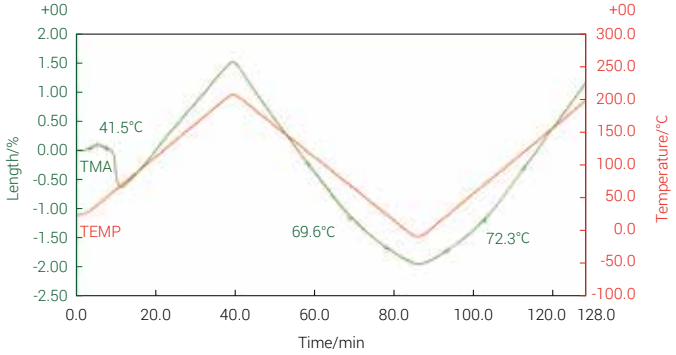
Different types of cooling units are available to meet your measurement purpose. Each cooling unit is easy to install and remove, so they can be readily exchanged according to the measurement needs.

	Refrigerated cooling	LN_2 auto-filling cooling
Cooling unit	 Supports continuous heating/cooling measurement without using liquid nitrogen. The optional Power ON/OFF unit reduces the waiting time before and after measurement. This cooling unit employs non-fluorinated refrigerants, exempt from fluorocarbon emission regulations, eliminating the need for cumbersome management and inspection.	 Liquid nitrogen is used as a cooling medium. The unit controls the supply of low-temperature nitrogen gas according to the temperature program. Suitable for continuous heating and cooling measurements over a wide temperature range.
Measurement temperature range	70 to 600°C	−150 to 600℃
Heating rate	20℃/min	20℃/min
External dimensions/ weight	W295×D500×H570 mm 60 kg	(Controller) W150×D250×H270 mm / 4 kg (Dewar) φ480×H940 mm / 25 kg
Comments	Can be connected to the Power ON/OFF unit	Dewar capacity: 30 L

Example of measurement with cooling unit

During the first heating, shrinkage caused by manufacturing conditions is observed at 40°C. As a result of having predetermined a thermal hysteresis via the first heating and cooling processes, the change in thermal expansion due to a glass transition can clearly be observed at 72°C.

Refrigerated cooling TMA8311



Measurement example: Measurement of epoxy resin with refrigerated cooling unit

Humidity Controlled TMA

TMA8311/HUM

Thermal analyzer enabling easy TMA measurements under high- humidity atmosphere conditions

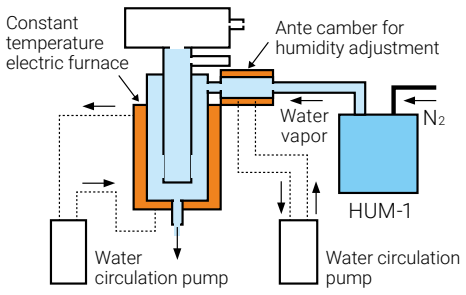
The TMA/HUM-1 is a system that combines a thermomechanical analyzer with a humidity generator, enabling TMA measurements in a controlled high-humidity atmosphere.

The HUM-1 employs a polymer-type relative humidity sensor and a high-precision temperature sensor, providing fast-response vapor control and long-term stability.

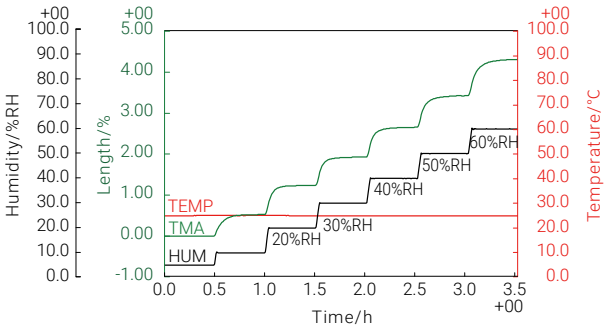
- Enables sample heating above 100°C under water vapor conditions of up to 90% RH (relative humidity) at 80°C. Supports compression, tension, and penetration modes.
- In addition to TMA displacement, load, and temperature, the system can display the concentration of water vapor.
- Water vapor concentration can be programmed and controlled in synchronization with the temperature profile using measurement and analysis software.
- The TMA/HUM-1 system is a powerful tool for evaluating moisture absorption behavior of materials, humidity dependence of polymer materials, and binder removal/sintering behavior of ceramics.

TMA/HUM-1 Humidity Controlled TMA

TMA/HUM-1 system configuration diagram*



* Measurements with a humidity generator require a bath circulator and, in some cases, may require two bath circulators, depending on the measurement.



Measurement example:
Expansion of copier paper due to changes in humidity

Change in degree of expansion when room temperature is held and the humidity is changed gradually.

Thermal Dilatometer

TDL8411

A differential expansion system is adopted to cancel out thermal expansion and shrinkage caused by the detection mechanism. This enables highly accurate and reproducible measurements even for low-expansion materials and thin samples.

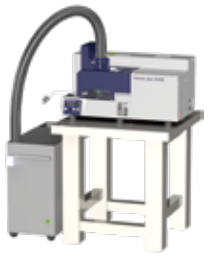
An automatic sample changer (ASC) can also be installed, contributing to energy saving and high throughput

Additional features include a built-in air-cooling fan to reduce post-measurement cooling time and automatic measurement of sample length.

- Differential expansion system cancels thermal expansion/shrinkage originating from the detection mechanism
- Built-in air-cooling fan shortens cooling time after measurement
- Automatic measurement of sample length
- Contributes to energy savings and high throughput (compact ASC can hold up to 25 samples)
- Correction software using measurement values of reference materials with known thermal expansion coefficients

Refrigerated cooling unit

Supports continuous heating/cooling measurement without using liquid nitrogen. The optional Power ON/OFF unit reduces the waiting time before and after measurement. This cooling unit employs non-fluorinated refrigerants, exempt from fluorocarbon emission regulations, eliminating the need for cumbersome management and inspection.

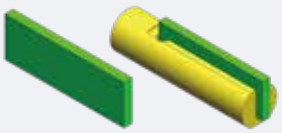
Cooling unit	
Measurement temperature range	−60 to 600℃
Maximum heating rate	20℃/min
External dimensions/weight	W295×D500×H570 mm 60 kg
Comments	Can be retrofitted to existing TDL systems (by replacing the electric furnace)

Thin Sample-Compatible TDL

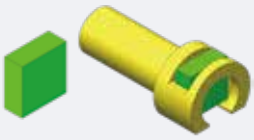
The TDL measurement unit is optimized for thin film and sheet materials, and supports ASC operation. Thin, small, or fragile samples can also be measured with ASC by using transport boats appropriate to the sample type. The shape and material of the transport boats can be customized according to the sample's geometry and measurement temperature range.

Example sample types

For observing longitudinal expansion of thin sheets that cannot stand on their own



For observing thickness-direction expansion of small fragments



Optional attachments

Flow meter

The flow meter controls the flow rate of the atmospheric gas (inert gas, air, etc.) supplied in the sample chamber.

Three models with 200, 500 and 1000 mL/min full scale are available.

Supported instruments: TMA, TDL

Gas selector

The gas selector links to the measurement program and switches the internal valves to control the gas flowing into the sample chamber.

Note: Flow meter is an optional unit. Please contact us for details on flow rate and gas type.

Supported instruments: TMA, TDL

2ch-FLOW COMPO Jr.

Gas switching and flow rate settings can be controlled in synchronization with the measurement program.

Gas types and full scale can be selected.

Supported instruments: TMA, TDL

Low-load unit for TMA

When installing a refrigerated cooling unit, attaching the Low-load unit suppresses vibrations from the refrigerator, allowing measurements with loads up to 2 g.

* Also effective when performing low-load measurements when not performing refrigerated cooling measurements

Supported instrument: TMA

Gas flow unit

The gas flow unit supplies inert gas to quickly lower the residual oxygen level in TMA and TDL. It also enables air flow supply from its internal pump.

Supported instruments: TMA, TDL

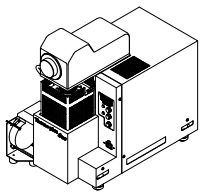
Tabletop vibration isolation table

Ideal for conducting TMA measurements in places with high levels of vibration.

Supported instrument: TMA

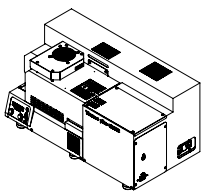
External dimensions

TMA8311
Mass : 30 kg



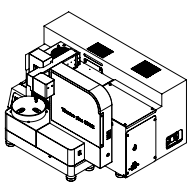
W380×D580×H580 mm

TDL8411
Mass : 28 kg



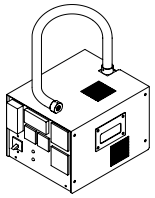
W702×D362×H356 mm

TDL8411+ASC
Mass : 44 kg



W702×D521×H496 mm

HUM-1
Mass : 15 kg



W290×D350×H260 mm

TMA Thermomechanical Analyzer
TDL Thermo Dilatometer

Specifications

TMA Thermomechanical Analyzer

Model	Thermo plus EVO2 Thermomechanical Analyzer TMA8311							
Measurement method	Compression loading				Tensile loading	Penetration		3-point bending
Type	Standard		High temperature		–	Differential penetration	Penetration	–
Detection system	Differential expansion	Non-differential expansion	Differential expansion	Non-differential expansion	Non-differential expansion	Differential expansion	Non-differential expansion	Non-differential expansion
Sample size	φ9 mm or less	φ12 mm or less	φ9 mm or less	φ12 mm or less	Thickness: 10 to 200 μm	φ5 mm or less		Length: 9 to 13 mm Width: 5 mm (max)
	Length: 10 to 20 mm				Length: 10, 15, 20 mm Width: 5 mm	Thickness: 4 mm (max)		Thickness: 2 mm (max)
Support tube, detection rod material	SiO_2		Al_2O_3		SiO_2	SiO_2		SiO_2
Maximum load	1000 mN							
Measurement temperature range*	Room temperature to 1100℃		Room temperature to 1500℃		Room temperature to 600℃			Room temperature to 1100℃
Maximum heating rate	100℃/min (Low temperature furnace: 20℃/min)							
TMA full scale	5000 μm							
Loading mode	1. Constant loading (up to 1000 mN in the shrinkage or tension direction, 1 mN step) 2. Constant-rate loading (up to 1000 mN in the shrinkage or tension direction at a rate of 1 to 500 mN/min.) 3. Sine-wave cyclic (oscillating from 1 to 1000 mN and a frequency of 0.01 to 1 Hz)							
Measurement atmosphere	Air, inert gas, vacuum, water vapor							

* Option (LN_2 auto-filling cooling unit: -150 to 600° C, Refrigerated cooling unit: -70 to 600° C)

TDL Thermal Dilatometer

Model	Thermo plus EVO2 Thermal Dilatometer TDL8411	
Measurement method	Compression loading	
Type	Standard	High temperature
Detection system	Differential expansion	
Sample size	φ5 mm, Length 10 to 20 mm	
Support tube, detection rod material	SiO_2	Al_2O_3
Maximum load	500 mN	
Measurement temperature range*	Room temperature to 1100℃	Room temperature to 1500℃
Maximum heating rate	40℃/min	
TDL full scale	5000 μm	
Measurement atmosphere	Air, inert gas	
ASC	Samples: 25 (length measurement sample: 1)	

* Option (Refrigerated cooling unit: -60 to 600° C)

HUM Humidity Generator

Model	HUM-1
Humidity generation method	Bubbling bath/ dry gas combination method
Humidity range	Room temperature to 80℃, dry to 90%RH
Gas type	Dry N_2
Humidity sensor	Polymer type relative humidity sensor
Temperature measurement element	Pt resistance temperature sensor
Duration for continuous humidity	100 hours at 60℃, 90%RH 40 hours at 80℃, 90%RH

Utility

TMA8311	Single phase 100-240 VAC, 50/60 Hz, 15 A, grounded 1-socket outlet
TDL8411	Single phase AC100-240 VAC, 50/60 Hz, 15 A, grounded 1-socket outlet
Refrigerated cooling unit	Single phase AC100 V, 50/60 Hz, 15 A, grounded 1-socket outlet
LN_2 auto-filling cooling unit	Single phase AC100 V, 50/60 Hz, 8 A, grounded 1-socket outlet
HUM-1	Single phase AC100 V, 50/60 Hz, 5 A, grounded 1-socket outlet
2ch-FLOW COMPO Jr.	Single phase AC100 V, 50/60 Hz, 1 A, grounded 1-socket outlet
Gas selector	Single phase AC100-240 V, 50/60 Hz, 0.5A, grounded 1-socket outlet

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