Anton Paar

TORC 5000

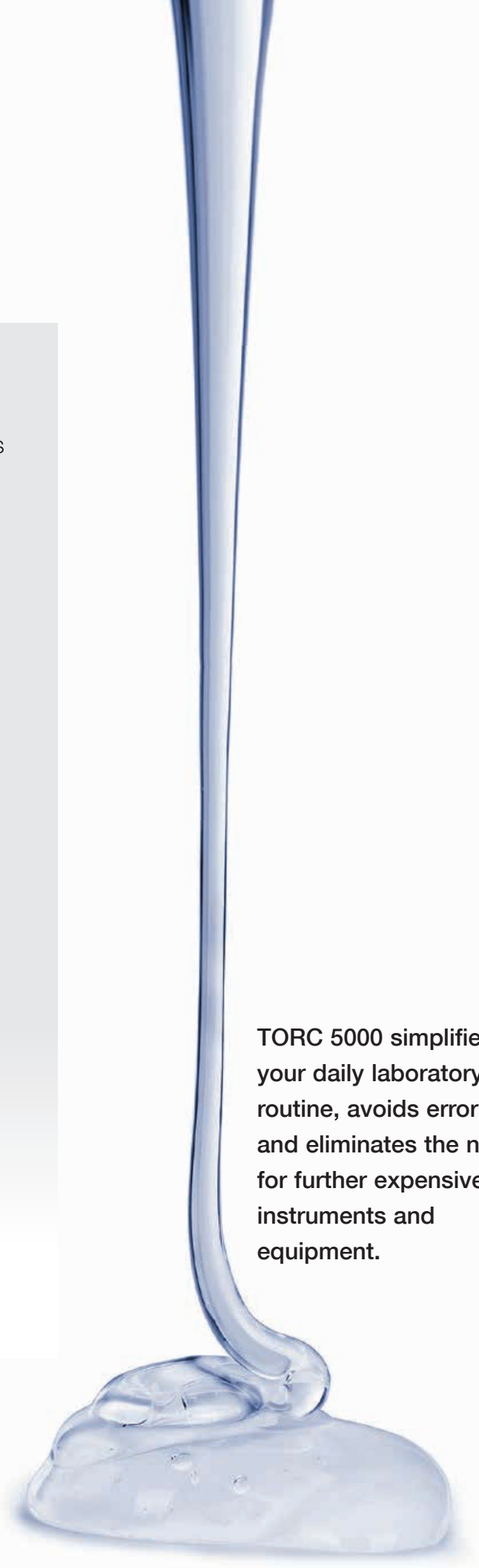
Thermo-optical Oscillating Refraction Characterization

The optics route to thermal analysis

Anton Paar launches **TORC 5000** (Thermo-optical Oscillating Refraction Characterization), which applies decades of know-how in optical instrumentation to thermal analysis in a unique and easy way.

This revolutionary technique utilizes periodic thermal excitation and analyzes the optical response to determine:

- Time-dependent processes e.g. curing, polymerization, aging
- Temperature-dependent processes e.g. glass and phase transitions
- The coefficient of thermal expansion by mathematical models
- Reaction kinetics e.g. chemical conversion



TORC 5000 simplifies your daily laboratory routine, avoids errors, and eliminates the need for further expensive instruments and equipment.

Is it time to do your thermal analysis optically?

TORC 5000 provides:

Thermal excitation – optical response

The temperature is modulated in the order of 0.1 K. This leads to a corresponding response in the measured refractive index of the sample caused by the temperature-induced density change.

Temperature dependence of refractive index

The change of refractive index with temperature (dn/dT) is calculated from the amplitude of the refractive index oscillation.

Thermal expansion coefficient

The amplitude of the refractive index oscillation is a measure of the coefficient of thermal expansion (CTE). CTE is calculated automatically using thermo-optical models (e.g. Beysens and Lorentz-Lorenz).

Reaction kinetics and aging

Density changes caused by the reaction influence the mean refractive index. This provides information about reaction conversion, volume shrinkage, and sample aging.

Structural changes in the sample

Phase changes, glass transitions, or other structural changes in the sample can cause a delay between the temperature modulation and the refractive index response. The phase-shift-based loss term is plotted and clearly indicates the time or temperature at which structural changes occur.

The received parameter values – refractive index, coefficient of thermal expansion, and the loss term – are summarized in one result plot and displayed on the PC screen.

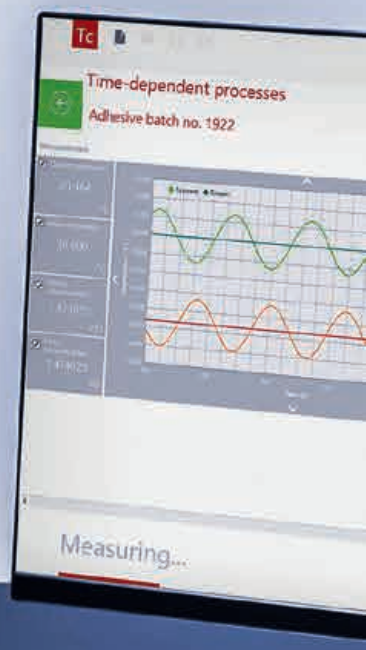
Highlights of TORC 5000

Everything on one screen

The PC-based software with an intuitive user interface is your guide from the start of your measurement to the results analysis. You can set up measurement series within seconds – and get thermal analysis at the push of a button.

Vast range of samples

TORC 5000 is suitable for many different samples. This includes: strongly adhesive substances or samples undergoing phase transitions. Flexible sample volume from a few µl up to 2 mL.



Simple sample handling

Thermo-optical analysis requires next to no sample preparation, which saves time and avoids errors.

Fast and accurate temperature control

Easy to use Peltier temperature control in a range from 4 °C to 125 °C with an accuracy of ±0.03 °C. Pre-heating or cooling of the sample well for fast measurement and minimal temperature perturbation of the sample.

Stable measurement over weeks

The quasi-isothermal measurement provides insight into time-dependent processes, e.g. curing or aging of different sample types over a long period of time. A stable baseline, precise measurement, and the robust design of the device make this possible.

Abundance of data

The measurement provides data for determining glass transition, melting point, curing time, curing rate, curing temperature, volume shrinkage, and volume expansion.

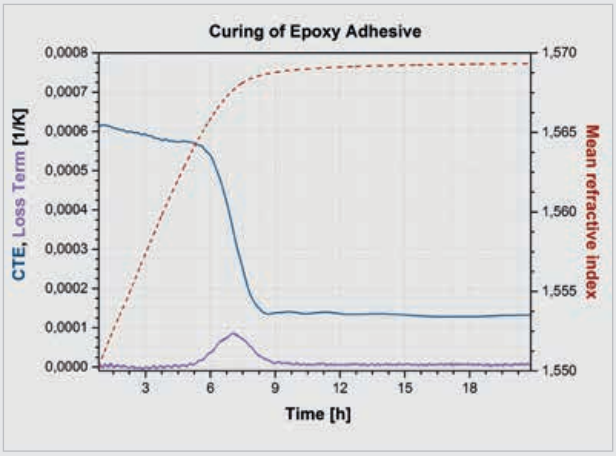
Ready to use immediately

No temperature calibration is needed for daily measurements. The instrument is pre-calibrated with PTB standards of refractive index. The periodical check of the refractive index is done within seconds with a water reference.

Compact and robust instrument

With its small footprint (smaller than a football) TORC 5000 fits onto every bench. The instrument is rugged and durable. It has a sapphire measurement surface with a hardness close to diamond and a fully anodized aluminum body.

Investigating time-dependent processes



The mean refractive index curve (red dashed line) indicates the progress of the chemical conversion (curing) and volume shrinkage.

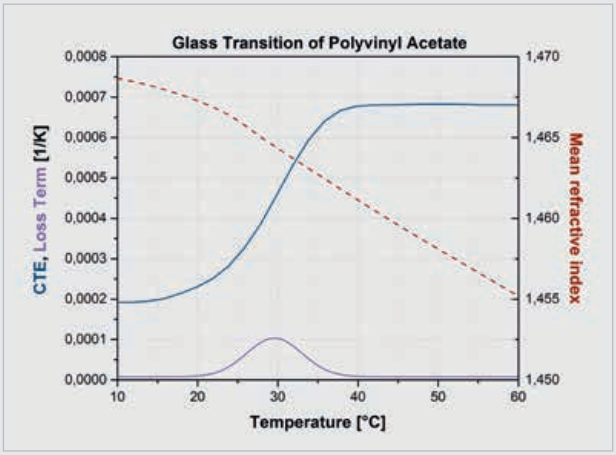
The calculated thermal expansion coefficient (blue line) is measured before, during, and after the curing with a step when the molecules are no longer mobile.

The phase shift (purple line) has a clear maximum at the curing time.

Material characterization
- Refractive index
- Temperature dependence of the refractive index (dn/dT)
- Coefficient of thermal expansion

Monitoring the curing process
- **Refractive index**
  - Chemical conversion
  - Volume shrinkage
- **Loss term**
  - Glass transition – indicator for curing time
- **Coefficient of thermal expansion**

Investigating temperature-dependent processes



The mean refractive index curve (red dashed line) indicates the progress of volume expansion during heating.

The calculated thermal expansion coefficient (blue line) is measured before, during, and after the glass transition.

The phase shift (purple line) has a clear maximum at the glass transition.

Temperature behavior
- **Refractive index**
  - Volume/density changes
  - Chemical changes e.g. aging
- **Loss term**
  - Glass transition – sample's usable temperature range
  - Melting point – operating/processing temperature – differentiating crystal modifications
- **Coefficient of thermal expansion**

Specifications

Refractive index (valid at standard conditions: T = 20 °C, λ = 589 nm, ambient temperature = 23 °C)

Range (nD)	1.3 to 1.72
Resolution (nD)	±0.000001
Accuracy (nD)	±0.00002
Accuracy (dn/dT)	±0.00001

Temperature

Range	4 °C to 125 °C
Heating rate/cooling rate	0.001 °C/min to 10 °C/min
Temperature accuracy	±0.03 °C
Temperature resolution	±0.001 °C
Min. temperature modulation amplitude	0.1°C
Min. temperature modulation period	10 seconds
Temperature control	Peltier

Material in contact with sample

Prism	Synthetic sapphire
Sample well	Stainless steel
Seal	FFKM

Components

Light source	LED light source, average lifetime >100000 h
Wavelength	589 nm (by wavelength-adjusted interface filter)
Power requirements	100 to 240 VAC ±10 %, 50/60 Hz, min. 10 W, max. 200 W, depending on sample temperature setting and ambient temperature

Dimensions

WxHxD [mm]	Measuring unit: 195 x 135 x 194 Communication unit: 215 x 95 x 190
Weight [kg]	Measuring unit: 6.1 Communication unit: 3.7

Further specifications

Protection class	Measuring unit: IP68, 2 hours at 1 meter depth

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