LINSEIS

pushing boundaries

TGA L83

Thermo Gravimetric Analyzer

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Since 1957 LINSEIS Corporation has been delivering outstanding service, know-how and leading innovative products in the field of thermal analysis and thermo-physical properties.

Customer satisfaction, innovation, flexibility, and high quality are what LINSEIS represents. Thanks to these fundamentals, our company enjoys an exceptional reputation among the leading scientific and industrial organizations. LINSEIS has been offering highly innovative benchmark products for many years.

The LINSEIS business unit of thermal analysis is involved in the complete range of thermoanalytical equipment for R&D as well as quality control. We support applications in sectors such as polymers, chemical industry, inorganic building materials, and environmental analytics. In addition, thermophysical properties of solids, liquids, and melts can be analyzed.

Rooted in a strong family tradition, LINSEIS is proudly steered into its third generation, maintaining its core values and commitment to excellence, which have been passed down through the family leadership. This generational continuity strengthens our dedication to innovation and quality, embodying the essence of a true family-run business.

LINSEIS provides technological leadership. We develop and manufacture thermoanalytic and thermophysical testing equipment to the highest standards and precision. Due to our innovative drive and precision, we are a leading manufacturer of thermal analysis equipment.

The development of thermoanalytical testing machines requires significant research and a high degree of precision. LINSEIS Corp. invests in this research to the benefit of our customers.

CLAUS LINSEIS

CEO DIPL. PHYS.

Engineering & Innovation

To strive for the best due diligence and accountability is part of our DNA. Our history is affected by German engineering and strict quality control.

We want to deliver the latest and best technology for our customers. LINSEIS continues to innovate and enhance our existing thermal analyzers. Our goal is to constantly develop new technologies to enable continued discovery in Science.

Thermogravimetric **Analyzer**

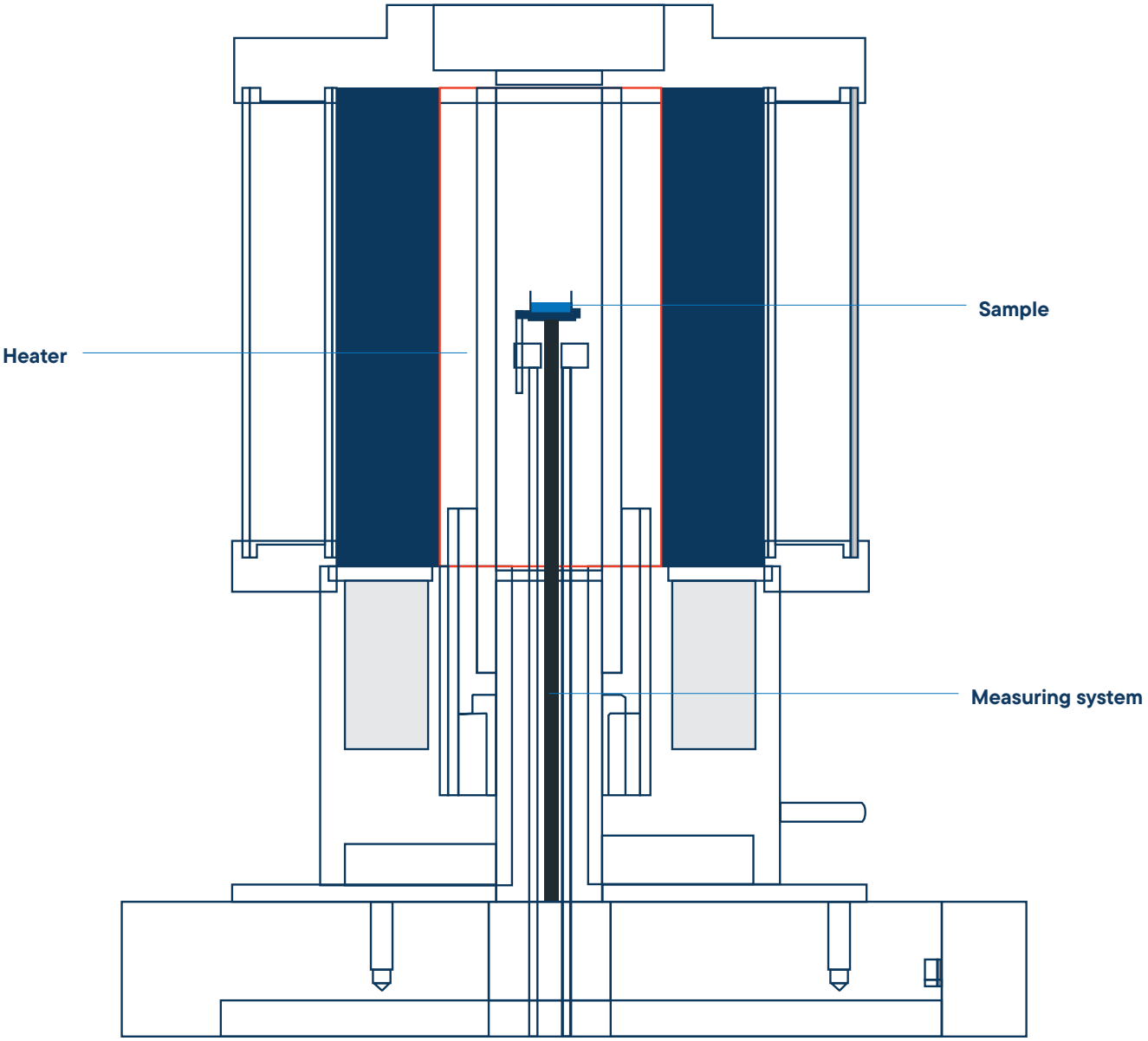
Thermogravimetry is a technique is a technique that monitores the sample mass against time or temperature in a specific atmosphere while the temperature is undergoing controlled changes. This technique mainly serves the determination of material compositions. It is a common used analysis method in the chemical and pharmaceutical industry. Thermogravimetric analysis (TGA) is typically performed on polymers, food, pharmaceuticals as well as many other materials.

Unsurpassed performance
L - DSC – Combined weight change and differential scanning calorimeter
Unsurpassed sensitivity – sub microgram balance with thermostatic controlled measurement chamber
Benchmark resolution – for detection of fast weight changes
Reliable Automation – up to 90 positions autosampler
Ultra Fast Heater – 250 °C/min heating speed.

TGA L83

The LINSEIS TGA L83 is a robust and reliable TGA outperforming most competition high end models. The sub microgram balance offers highest sensitivity and resolution. The instrument is perfectly suited for academic teaching and day to day laboratory quality control applications

Furnace design



Advantages of LINSEIS TGA L83

- Precise temperature control
- Fast heating/cooling rates
- Atmosphere control
- High sensitivity
- Automation options
- Expanded analysis

Features of the TGA L83 Furnace

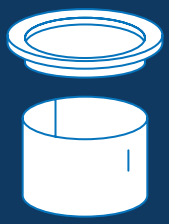
- Innovative top-loading system
- Enhanced heating and cooling performance
- Precise thermal management
- Adaptable sample handling
- Rapid cooling capability

Measurement Systems & Crucibles

The Linseis TGA L83 provides flexibility with a selection of user-exchangeable sensors, each compatible with various thermocouples to ensure optimal sensitivity for different temperature ranges and applications. Additionally, a variety of crucible types is available, allowing users to tailor the system to their specific analytical needs.

Crucibles

- Al_2O_3
- Platinum
- Aluminium
- others



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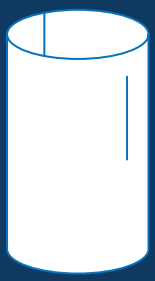
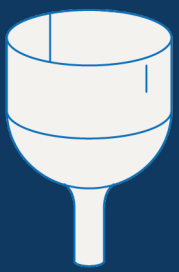


custom volume

TGA

TG-Sensor

TG sensor for top-loading crucibles

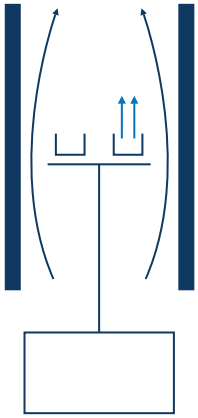


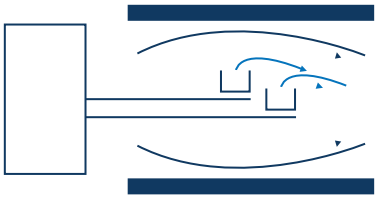
Compact STA-Sensor Typ S

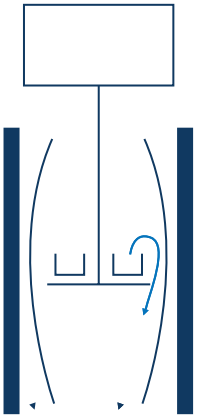
Benefits of the vertical top loading design

The vertical “sample on top” design of the LINSEIS thermo-balance provides highest possible accuracy due to a stable position of the sample and easy sample handling.

TGA L83







Vertical system (sample on top) LINSEIS configuration

Advantages:
- Easy sample handling
- Easy exchange of sample holder
- Stable position of the sample in the furnace

(critical for good DTA/DSC and Cp results)

Disadvantage:
- Complicated construction

Horizontal system

Advantages:
- Small buoyancy effects

Disadvantages:
- Very difficult sensor exchange
- Difficult sample handling
- Very high purge gas rate required
- Problems due to sensor expansion during heating/cooling

Vertical system (sample on bottom)

Advantage:
- Stable position within furnace

Disadvantages:
- Difficult sensor exchange
- “Dangerous” gas flow within balance housing (sample gets blown out)
- Sensor position depends on sample weight

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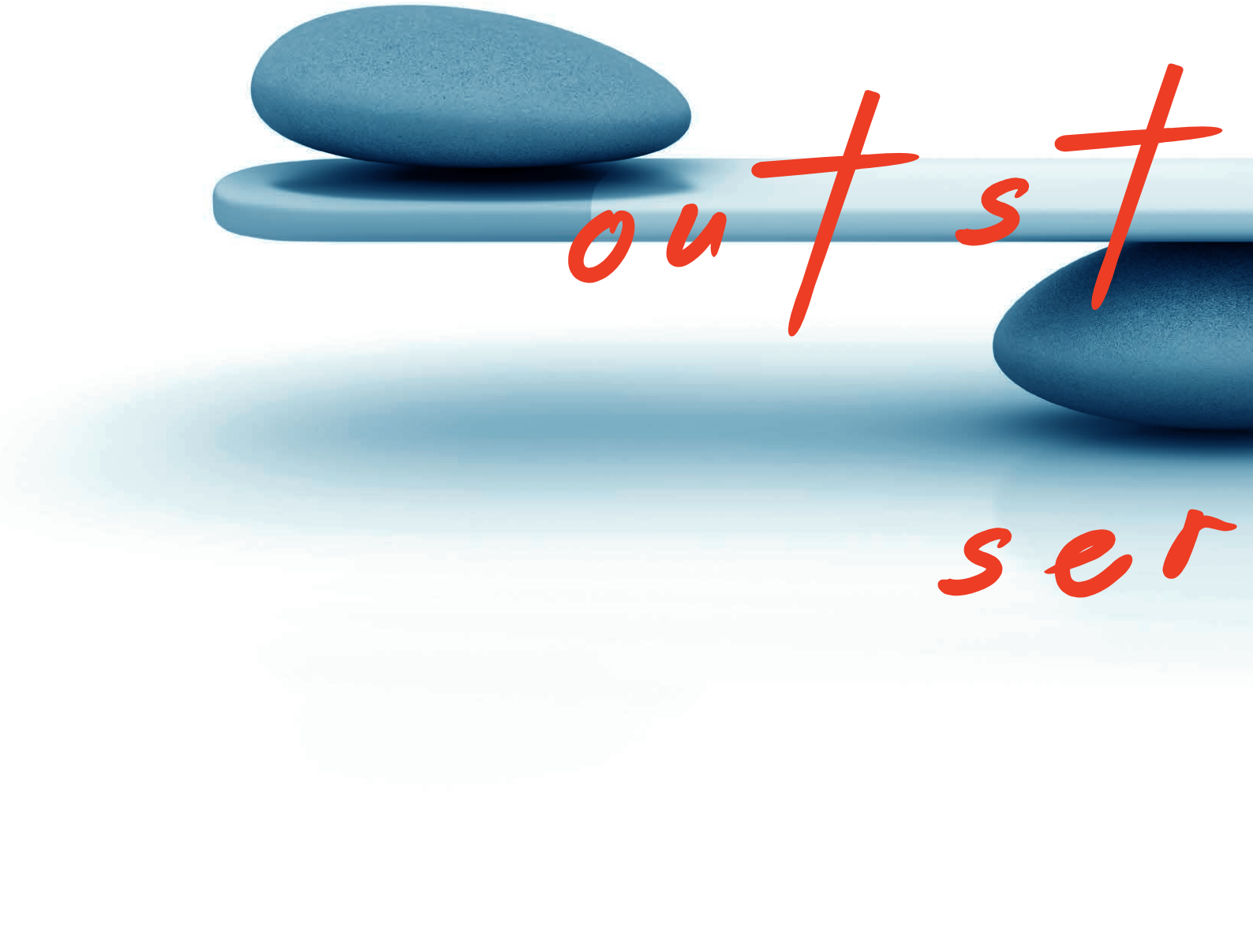

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New features

Electronic Upgrade

The new measuring electronics offer significant performance improvements, inspired by the architecture of the „Linseis Digital Balance“. The benefits of this new digital balance architecture include:

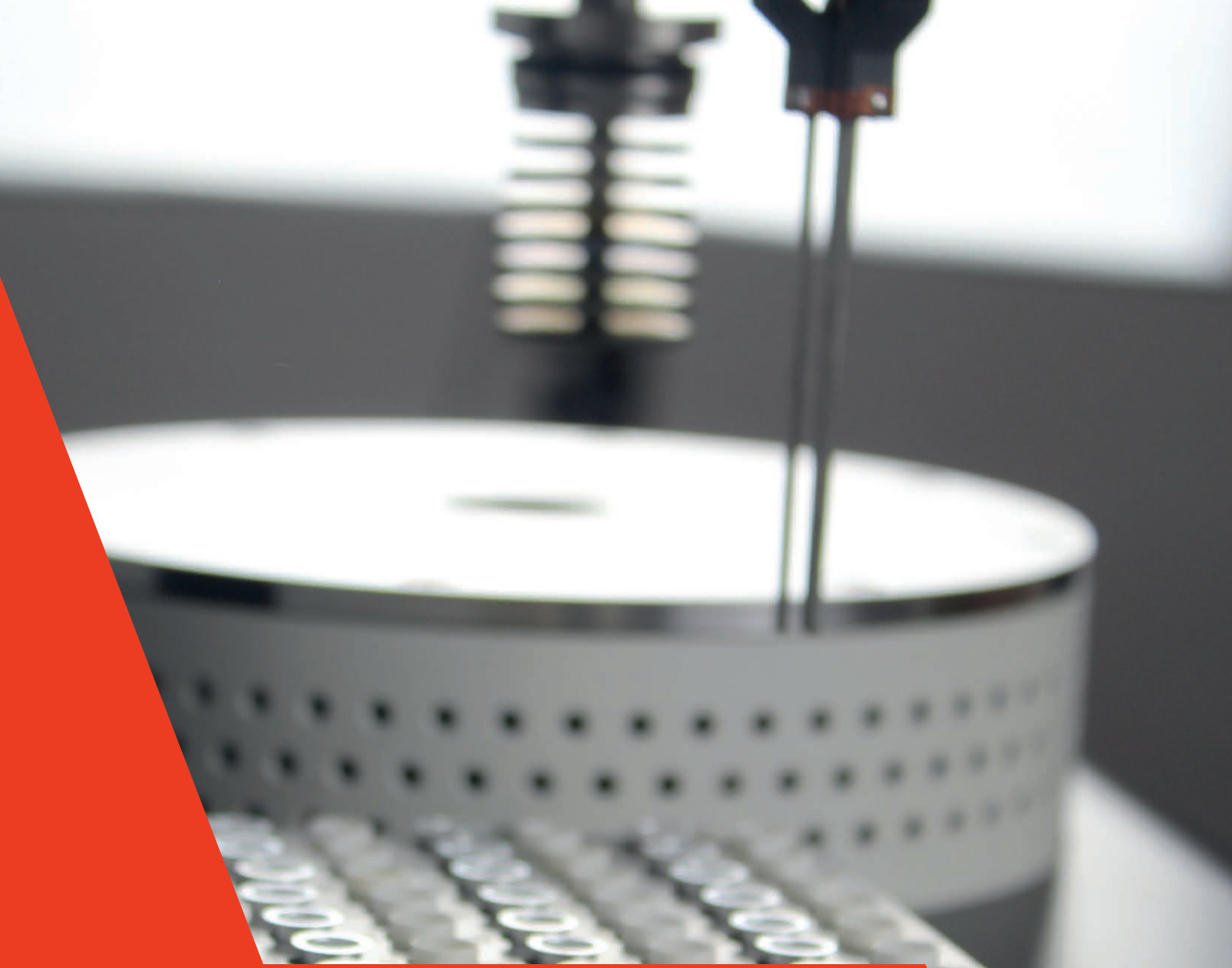
- **Minimization of drift:** Ensures consistently high precision over long periods of time.
- **Improved resolution:** Unique sub-microgram resolution.
- **Highest accuracy:** Improves the reliability of your measurement results.
- **Reproducibility:** Ensures consistent results with repeated measurements.

Linseis Lab Link

With Linseis Lab Link, we offer an integrated solution to address uncertainties in measurement results. With direct access to our application experts via the software, you can get advice on the correct measurement procedure and evaluation of results. This direct communication ensures optimal results and maximizes the efficiency of your measurements for precise analysis and research as well as a smooth process flow.

Software Improvements

- **Lex Bus Plug & Play:** Our latest hardware interface Lex Bus revolutionizes the way data communicates within our systems. Lex Bus enables seamless and efficient integration of new hardware and software tools.
- **Improved furnace control:** Our new and further improved furnace control offers a faster heating and cooling as well as more precise temperature control, which leads to better measurement results through better temperature sequencing according to your wishes and requirements.
- **New software with user interface:** Our communication is now even more focused on the needs of our customers to ensure that you are always informed of the latest status and receive support whenever it is needed.
- **Process security:** We have optimized our software for process security to ensure that your data is protected at all times and processed in a fail-safe manner.
- **Error messages and bug fixes:** Our system automatically detects errors and bugs, which are immediately documented and fixed to minimize downtime.
- **Automatic updates and new features:** Our software receives regular automatic updates that not only improve security, but also continuously provide new features.
- **Permanent system monitoring:** Our software constantly monitors the system parameters to ensure optimum performance.
- **Preventive maintenance and problem detection:** Our preventive maintenance approach detects problems and wear and tear before they can cause damage and keeps your device in top shape.



Design Improvements

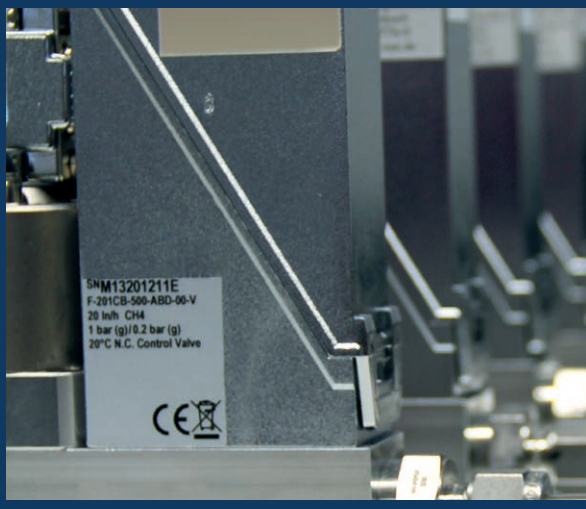
The new device design is characterized by an elegant aluminum casing that is both robust and aesthetically pleasing. The LED status bar provides a user-friendly visualization of important information. A touch panel enables intuitive operation and contributes to a modern user experience that combines comfort and functionality. The new device design focuses on ergonomic operation.

New Hardware Features

- **Tri-couple DTA measuring system:** DTA measuring system with three thermocouples for the smallest endo-/exothermic effects in inhomogeneous samples
- **Jacketed DTA measuring system:** For corrosive samples
- **Patented „forced flow“ method:** Enables forced flow through your TG or TG-DTA. Our system enables forced flow through the sample, where by up to 100 % reaction gas is fed directly to the sample. This novel method enables scalable measurements for the first time, allowing precise analysis under real conditions.

Unique features

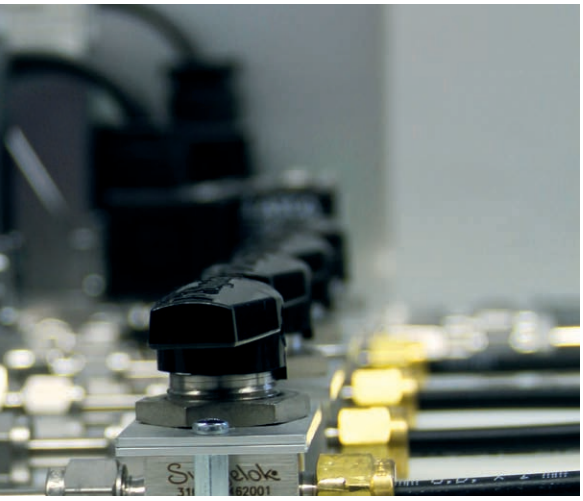
Measurement System
The TGA‘s measurement system features a high-precision platinum balance, ensuring accurate and reliable thermogravimetric analysis (TGA) data. Additionally, the innovative L-DSC sensor attachment allows the simultaneous detection of differential scanning calorimeter (DSC) signals, providing combined thermal analysis capabilities in a single system. This dual functionality enables comprehensive thermal characterization for various applications.



Options
The TGA system offers several advanced options to expand its functionality:

- **Evolved Gas Analysis (EGA):** The system can be coupled with gas analysis tools such as GC_MS (Gas Chromatography), MS (Mass Spectrometry), or FTIR (Fourier Infrared Spectroscopy) to analyze gases evolved during decomposition or chemical reactions.
- **Turbo-Molecular Pump:** Ideal for achieving ultra-high vacuum and maintaining clean gas atmospheres, this option enables precise measurements in controlled environments.
- **Vapor Generator:** An optional feature that facilitates controlled vapor introduction for advanced material studies.

Gas Dosing System
For enhanced gas management, the TGA L83 includes an optional automatic gas dosing system equipped with Mass Flow Controllers (MFCs). This system supports two independently controlled gas channels, allowing precise adjustment of gas flow rates directly through the software. This flexibility is essential for optimizing experimental conditions for various materials and processes.



Atmosphere

The TGA‘s robust design allows measurements under a wide range of environmental conditions, including:

- **Inert Atmosphere:** For stable thermal analysis without reactions.
- **Oxidative and Reducing Conditions:** Suitable for studying material behavior in reactive environments.
- **Vacuum Conditions:** Ideal for sensitive samples requiring minimal contamination.

Additionally, the system supports analysis under corrosive conditions when the appropriate precautions and compatible materials are used. Residual gas analysis can also be performed by integrating an optional heated capillary, ensuring comprehensive atmosphere monitoring.

Atmosphere

The TGA simplifies calibration with its automatic software and hardware integration. This function calculates and applies calibration factors automatically, ensuring consistent and accurate results. The calibration factor is displayed for user confirmation, streamlining the preparation process and enhancing reliability.

Equipment for gas control and safety (H_2, CO, CO_2, etc...)

All Linseis instruments can be prepared for the use in hydrogen atmosphere with just minor adjustments. The most important thing is a safety system that can ensure that there is no leakage and no explosive atmosphere generated outside of the instrument. Therefore, the Linseis safety system uses hydrogen sensors that are coupled to an automatic gas control panel. If there is a leakage or unwanted hydrogen release, the instrument is automatically flooded with inert gas and the hydrogen valves are closed. This ensures a minimum risk level during operation. Besides that, the system contains an optional burn off unit where the gas outlet is connected to, to ensure that also the used gas of the measurement chamber is not just released into the environment. The system can also be operated with several combinations of inert gases and even water vapor besides hydrogen.

In summary, the Linseis safety system comes with the following benefits:

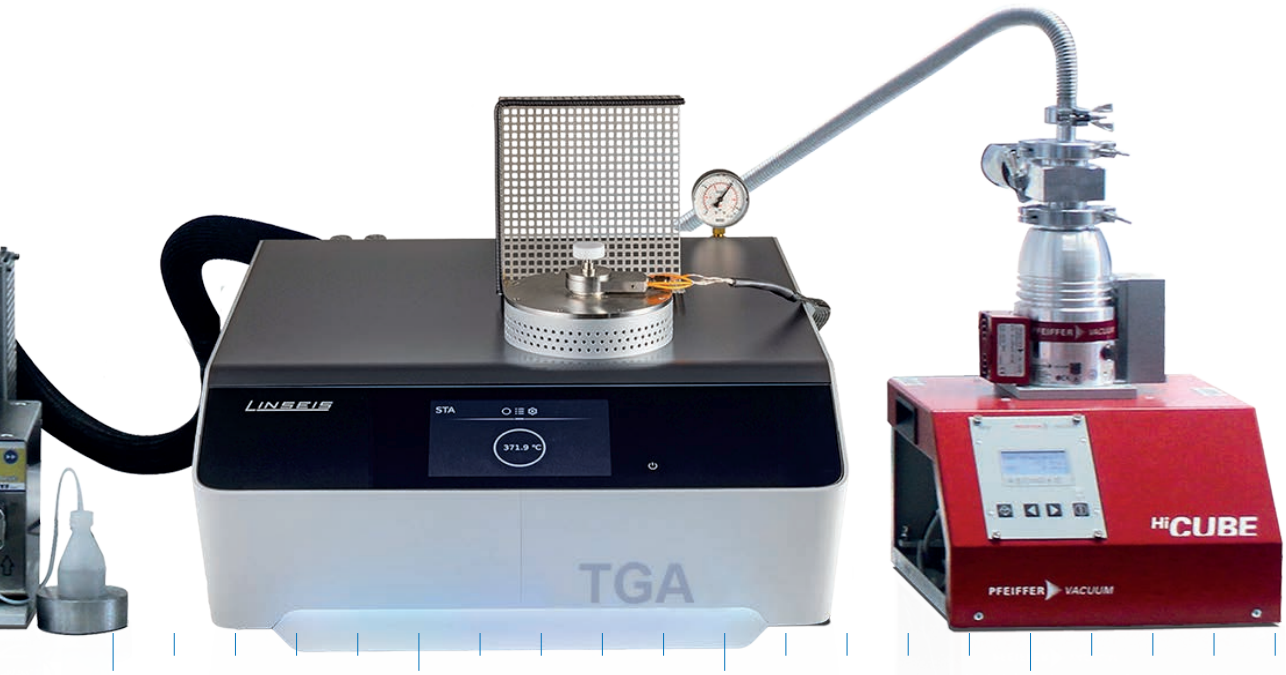
- Automatic evacuation function
- Gas flow control for multiple gases including water vapor and hydrogen
- Emergency shutdown function
- Gas detector system (H_2, CO, CO_2, etc...
- optional burn off unit
- Continuous monitoring to ensure safe operating conditions

Fig. 1

Linseis equipment for operation under water vapor and controlled relative humidity

For many applications in thermal analysis, the atmosphere plays an important role as it may affect the sample behavior or activate reactions. Humidity influence on building materials, storage time of pharmaceuticals and foods or influence on mechanical properties of polymers are just some of the most common examples. Of course, the Linseis instruments are suitable for such experiments, however there is one fact that is often causing confusing and must be considered carefully: The difference between water vapor and relative humidty.

Relative Humidity Generators are most commonly used for experiments around room temperature, while water vapor applications are most often at higher temperatures. When water is heated to its boiling point or higher than that, the water changes its aggregate form from liquid to gaseous. It is then existing as water vapor (steam). If this steam is introduced into any kind of reaction chamber or instrument, it is called water vapor application. In contrast, every gas can transport and contain a certain amount of water at a given temperature. This is called humidity. Considering air as an example, there is always an amount of water contained in the air, even below the boiling point of water, which is defined as grade of humidity or relative humidity.



Software

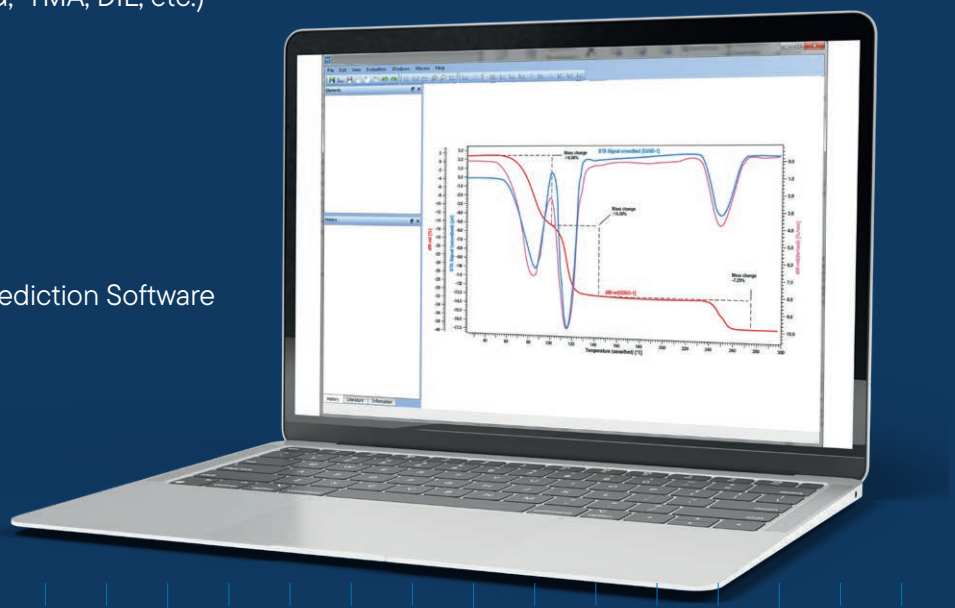
All LINSEIS thermo analytical instruments are PC controlled. The individual software modules exclusively run under Microsoft® Windows® operating systems. The complete software consists of 3 modules: temperature control, data acquisition and data evaluation. The 32 bit software incorporates all essential features for measurement preparation, execution, and evaluation of a Thermogravimetric measurement. Thanks to our specialists and application experts, LINSEIS was able to develop comprehensive easy to understand user friendly application software.

Features-Software:

- Program capable of text editing
- Data security in case of power failure
- Thermocouple break protection
- Repetition measurements with minimum parameter input
- Evaluation of current measurement
- Curve comparison up to 32 curves
- Storage and export of evaluations
- Export and import of data ASCII
- Data export to MS Excel
- Multi-methods analysis (DSC TG, TMA, DIL, etc.)
- Zoom function
- 1 and 2 derivation
- Programmable gas control
- Statistical evaluation package
- Free scaling
- Automatic calibration
- Optional Kinetic and Lifetime Prediction Software packages

TG – Features:

- Mass Change as % and mg
- Rate Controlled Mass Loss
- Evaluation of Mass Loss
- Residue Mass Evaluation



Technical Specifications

Product Overview

	TGA L83
Design	Top-loading
Temperature range	RT up to 1100 °C
Heating and cooling rates	0.001 to 250 °C/min
Sample weight	Max. 5 g
Resolution	0.1 µg
Gas atmospheres	Inert, oxidizing, reducing, vacuum
Vacuum	Up to $10E^{-3}$ mbar
Gas Dosage	Built-in MFC block with 3 gases (one purge gas and two reaction gases)
Cooling rate	< 12 min (1100 °C - 100 °C)
Sample holder	TGA
Sample robot	90 positions
Crucible	Pt, Al_2O_3, Au, Al, Ag etc. more on request
EGA Couplings	Optional FTIR and/or MS or GC-MS
Interface	USB

Technical data may vary depending on furnace and components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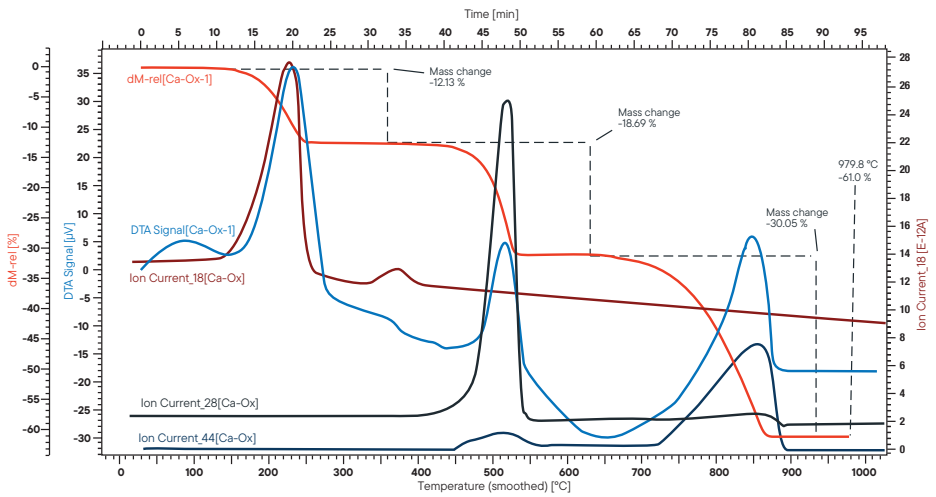
Applications
TGA L83

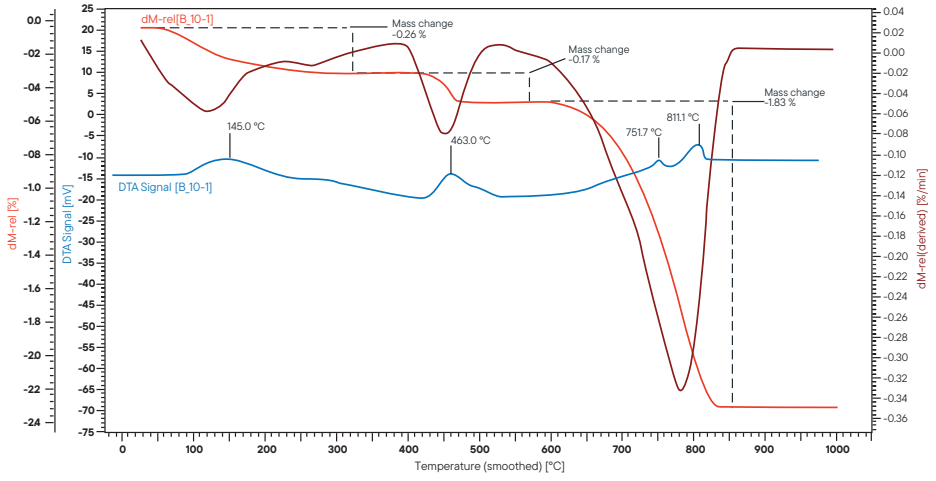
Decomposition of $CaC_2O_4 \cdot H_2O$



The curves on the left show a calcium oxalate reference run. On the blue and red curves (relative and absolute Δm), three mass loss steps are visible: the first step corresponds to the release of H_2O, the second to the loss of CO, and the third to the loss of CO_2. The resulting calcium oxide (CaO) subsequently reacts with the water from the first step, which remains in the reaction chamber if the atmosphere is static. This reaction forms calcium hydroxide ($Ca(OH)_2$) during cooling at around 580 °C.

This final step is difficult to observe with a standard TGA due to typically slow cooling rates. However, in this case, a full measurement cycle was completed 20 minutes. The heating and cooling rates were 2 K/s but can easily be increased to up to 100 K/s using an inductive TGA.

Cement

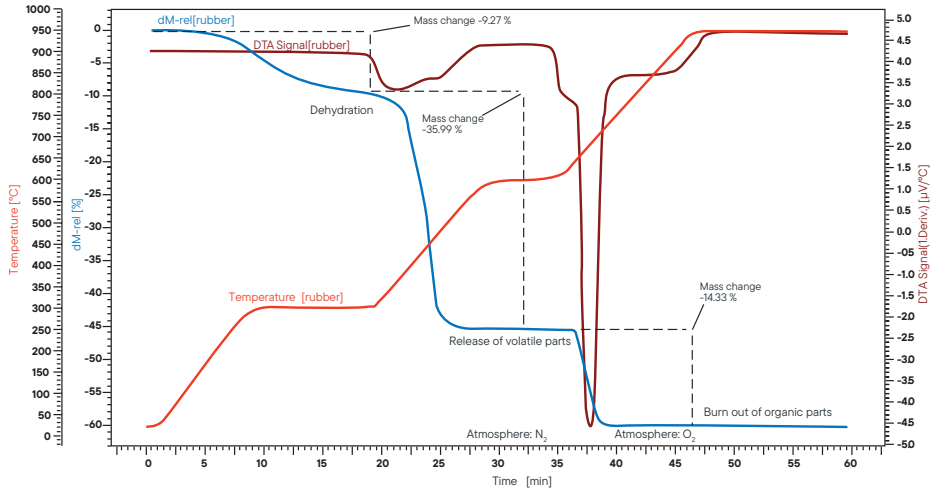


The measurement on the left was carried out with a TG-DSC. The main parts of cement are tri-calcium silicate, di-calcium silicate and tri-calcium aluminates.

After mixing the raw cement with water, different hydrates slowly form. When put in a STA, the absorbed water evaporates first during thermal decomposition, then hydrates of the calcium silicate decompose and at 570 °C the hydroxides of calcium, magnesium and aluminum follow.

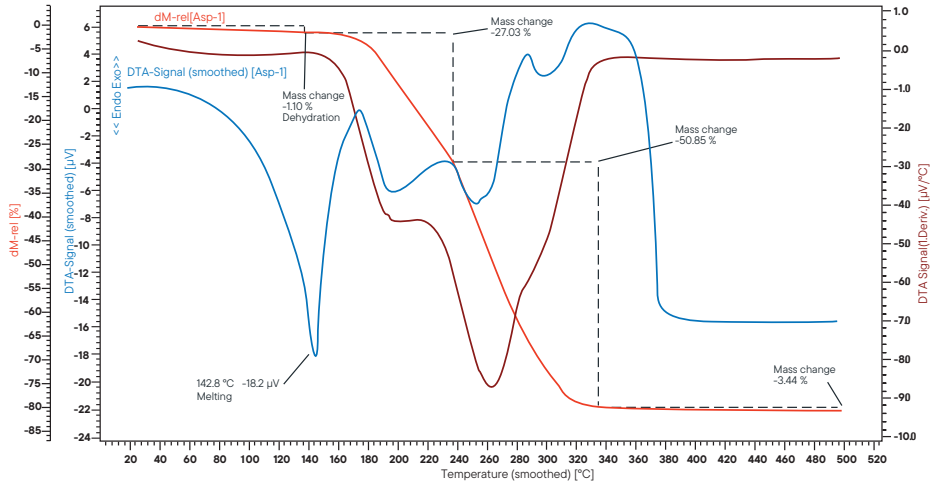
You can see this effect as mass loss steps (red curve) with parallel endothermic effects on the DSC signal (blue curve). Subsequently, carbon dioxide is released from the carbonates, showing a huge mass loss step at around 800 °C.

Decomposition of rubber



The measurement of an industrial rubber sample was conducted using a simultaneous thermal analyzer (STA PT 1000) in a nitrogen atmosphere. The sample was heated in three steps at a rate of 30 K/min each. The blue curve shows the relative weight loss. In the first step, dehydration of the sample occurs, releasing 9.3% water, with no effect observed on the corresponding DTA signal (dark red curve). In the second reaction step, volatile components (36.0%) are released by pyrolysis under nitrogen, identified by an exothermic peak on the DTA curve. In the third step, the atmosphere changes to oxygen, leading to the combustion of the remaining carbon, resulting in a 14.3% weight loss. The remaining 40.4% consists of inorganic components like ash, lime, or fillers.

Aspirin



In this application acetylsalycylic acid (Aspirin) was measured by STA PT 1000 with focus on the DSC-signal. By DSC, decomposition reactions can be observed and substances such as pharmaceuticals compounds can be investigated and identified. The measured ASS sample shows the following effects: At the beginning of the heating process, some adsorbed water is released, resulting in a weight loss of about 1 %. At 140°C the melting point of the aspirin is reached, resulting in an endothermic reaction, measured on the DTA trace. At 60°C, decomposition of the molten drug takes place in several stages.

The decomposition products are volatile, resulting in a total weight loss of almost 100 %.

LINSEIS

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