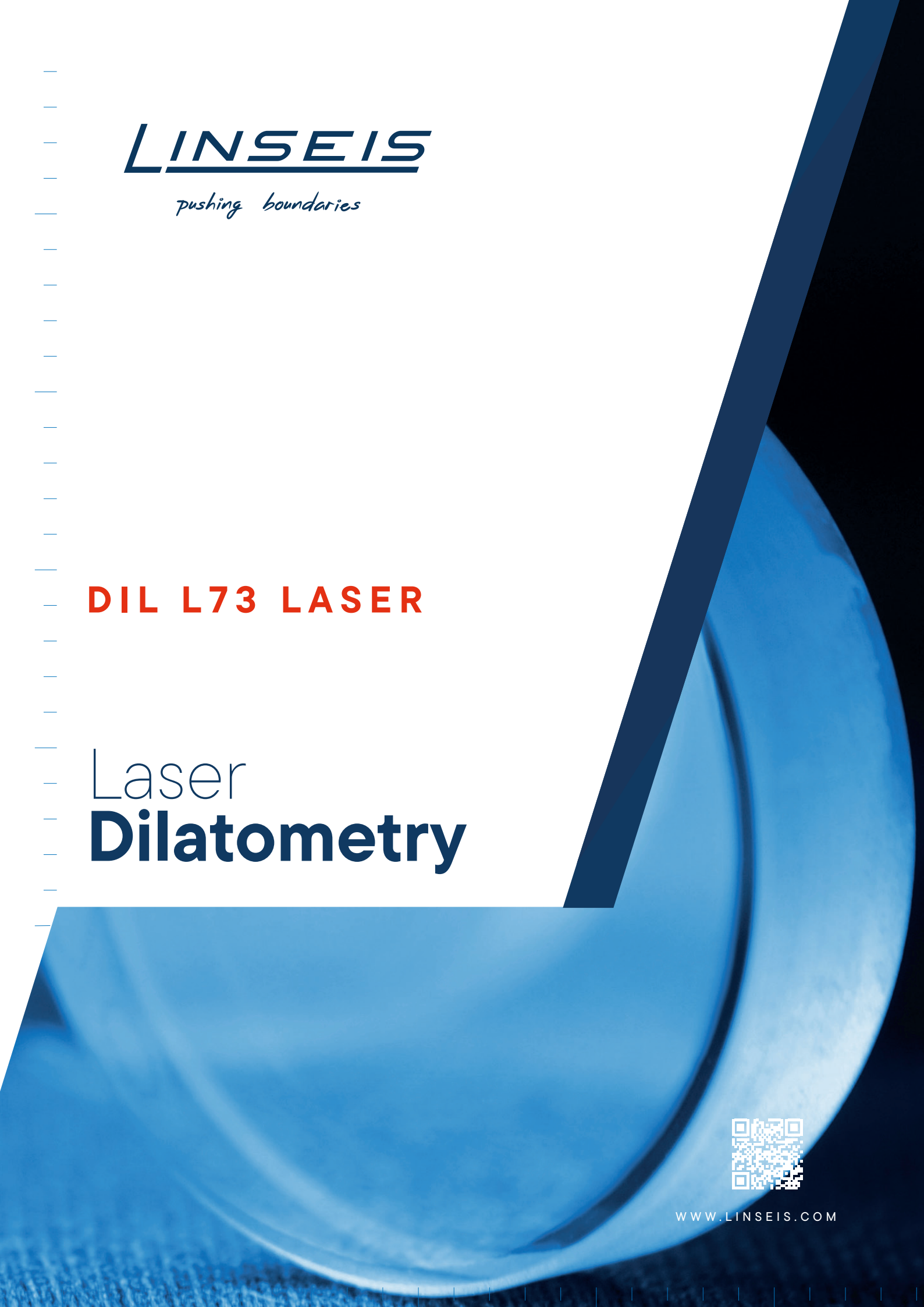
LINSEIS

pushing boundaries

DIL L73 LASER

Laser Dilatometry



WWW.LINSEIS.COM

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.

C L A U S L I N S E I S

C E O D I P L . P H Y S .

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.

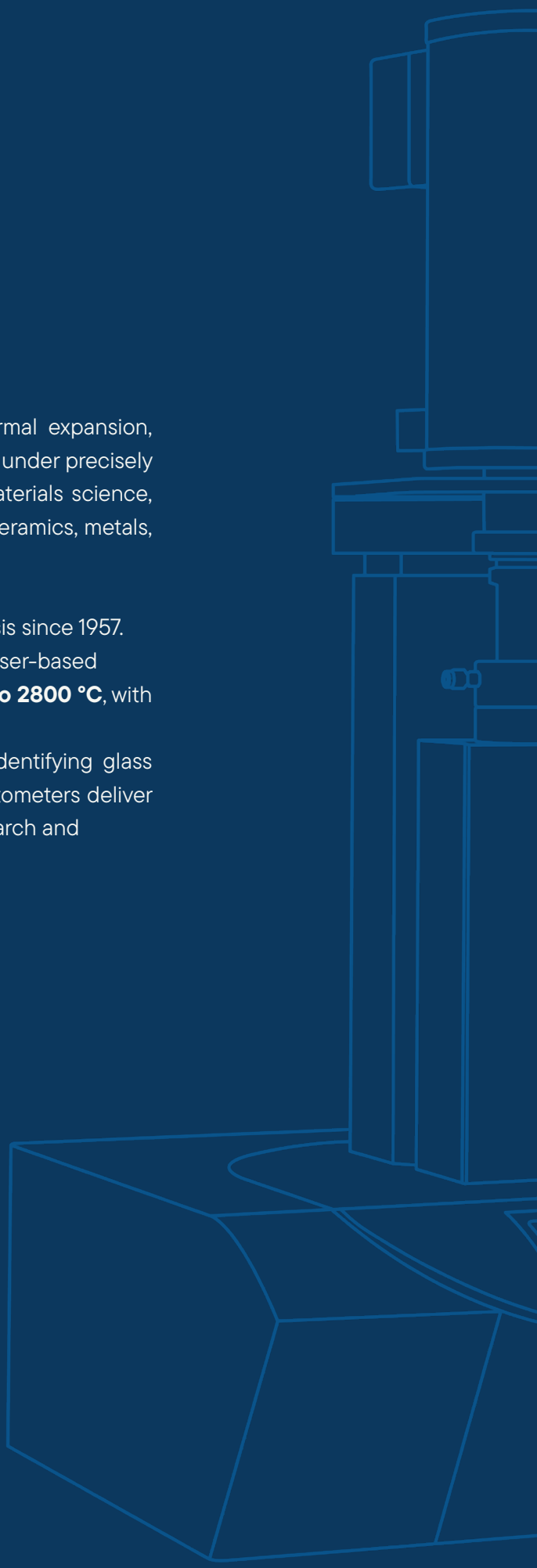
We want to deliver the latest and best technology for our customers. LINSEIS continues to innovate and enhance our existing thermal analyzers. Our goal is to constantly develop new technologies to enable continued discovery in Science.

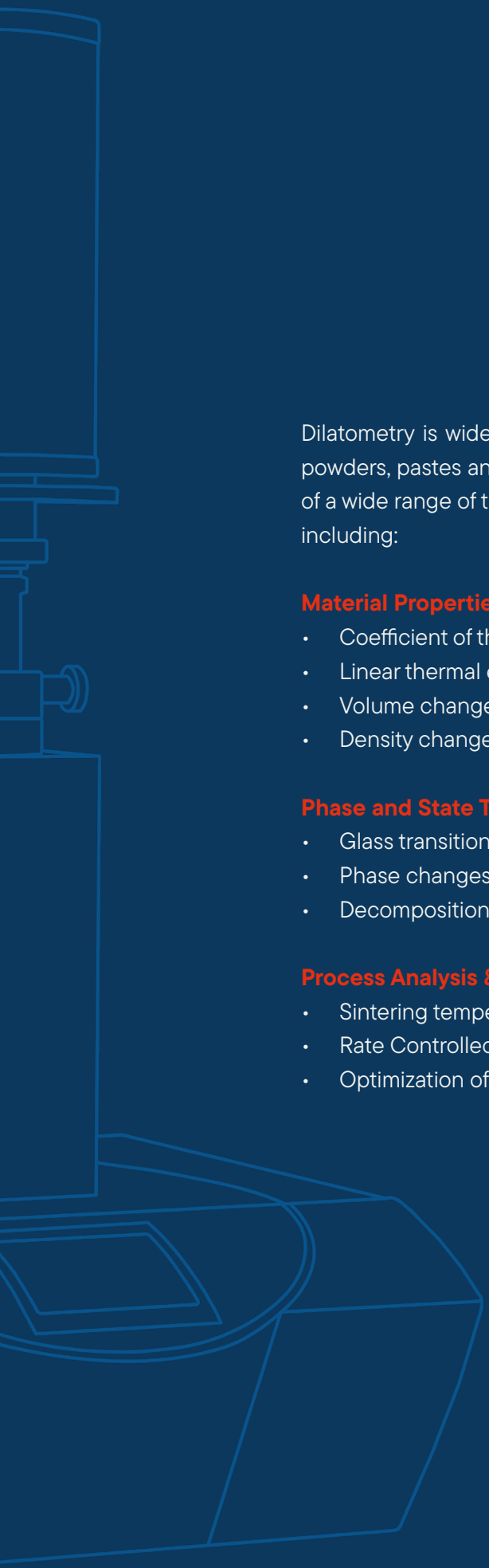
Dilatometry

Dilatometry (DIL) is a key technique for characterizing thermal expansion, shrinkage, phase transitions and sintering behavior of materials under precisely controlled temperature conditions. It plays a critical role in materials science, quality assurance and industrial process development across ceramics, metals, polymers, glasses and composites.

LINSEIS has been a leading innovator in thermo-physical analysis since 1957. Our portfolio includes single-, dual-, differential-, optical- and laser-based dilatometers covering a wide temperature range from **–263 °C to 2800 °C**, with resolutions down to 0.05 nm.
Whether determining thermal expansion coefficients (CTE), identifying glass transition points or monitoring sintering kinetics – LINSEIS dilatometers deliver the accuracy, stability and flexibility demanded by modern research and production environments.

- **Unmatched resolution**
- **Unmatched precision**
- **Absolute measurement technique**





Dilatometry is widely used in research, development and quality control for solids, powders, pastes and even liquids. The technique enables the precise determination of a wide range of thermo-mechanical properties and process-critical transitions, including:

Material Properties

- Coefficient of thermal expansion (CTE)
- Linear thermal expansion (ΔL, δl)
- Volume changes and densification
- Density change during heating

Phase and State Transitions

- Glass transition temperature (Tg)
- Phase changes and structural transformations
- Decomposition reactions

Process Analysis & Control

- Sintering temperature and shrinkage steps
- Rate Controlled Sintering (RCS)
- Optimization of firing and heat treatment processes

LINSEIS Contract testing

LINSEIS general dilatometry series

Horizontal Dilatometer L75/L76:

- Multipurpose system
- Highest temperature uniformity
- L75 Horizontal is perfect for Research and Development

Vertical Dilatometer L75:

- Friction free sample holder
- Push-rod contact is always guaranteed
- Possible field of application: Rate Controlled Sintering (RCS)
- Best arrangement for low and high temperature applications

  From -263 °C up to 2800 °C

Dilatometry Overview

Classic vs. Laser Dilatometer

Classic push-rod dilatometers measure the change in length of a sample via mechanical contact. Two sensor systems record the initial length (L_o) and the thermal change in length (ΔL):
L_o is determined using an optical encoder that detects position changes relative to a reference point via incremental coding. ΔL is measured using a high-resolution LVDT that converts the position of a movable core into an electrical signal. This dual-sensor approach combines the large measuring range and directional sensitivity of the optical encoder with the high resolution and repeatability of the LVDT, effectively balancing their respective strengths and limitations.

Despite compensation for hysteresis, non-linearities, drift and offset, the system remains sensitive to mechanical and thermal influences. To compensate for these, calibration with reference standards is necessary.

Laser dilatometers represent a fundamental advance in this area:
They measure L_o and ΔL simultaneously and absolutely; without contact, using laser interferometry. The total length change is calculated directly from the phase shift of two superimposed laser beams. This completely eliminates mechanical couplings and calibration artifacts.

Optical errors such as offset or phase shifts are automatically corrected by advanced algorithms. The result: measurements with sub-nanometer resolution (up to 0.3 nm*) and maximum long-term stability – even for samples with very low expansion or sensitive surfaces.

* tested in laboratory environments

Absolute length measurement using interferometric path difference

The **LINSEIS DIL L73 Laser** uses a homodyne Michelson interferometer with a frequency-stabilized helium-neon laser (λ=632.8 nm) to directly detect thermally induced length changes. The high coherence length of the laser allows precise detection of minimal path differences as phase shifts (γ_{ref}) in the interference signal – even with varying sample geometries and complex surfaces, without the linearity deviation of classic LVDT sensors. With a resolution of up to 0.3 nm*, the absolute length of the sample (s) is dynamically recorded in relation to the temperature profile.

*tested in laboratory environments

$$s = \frac{1}{k_{IF} k_1} \gamma_{rel} = \frac{\lambda}{k_{IF}} \cdot \frac{\gamma_{rel}}{2\pi}$$

s = Sensitivity

k_{IF}= Interference constant

γ_{rel}= Phase shifts

k_1= Wave number of radiation

λ = Wavelength of the laser

Design and measuring principle

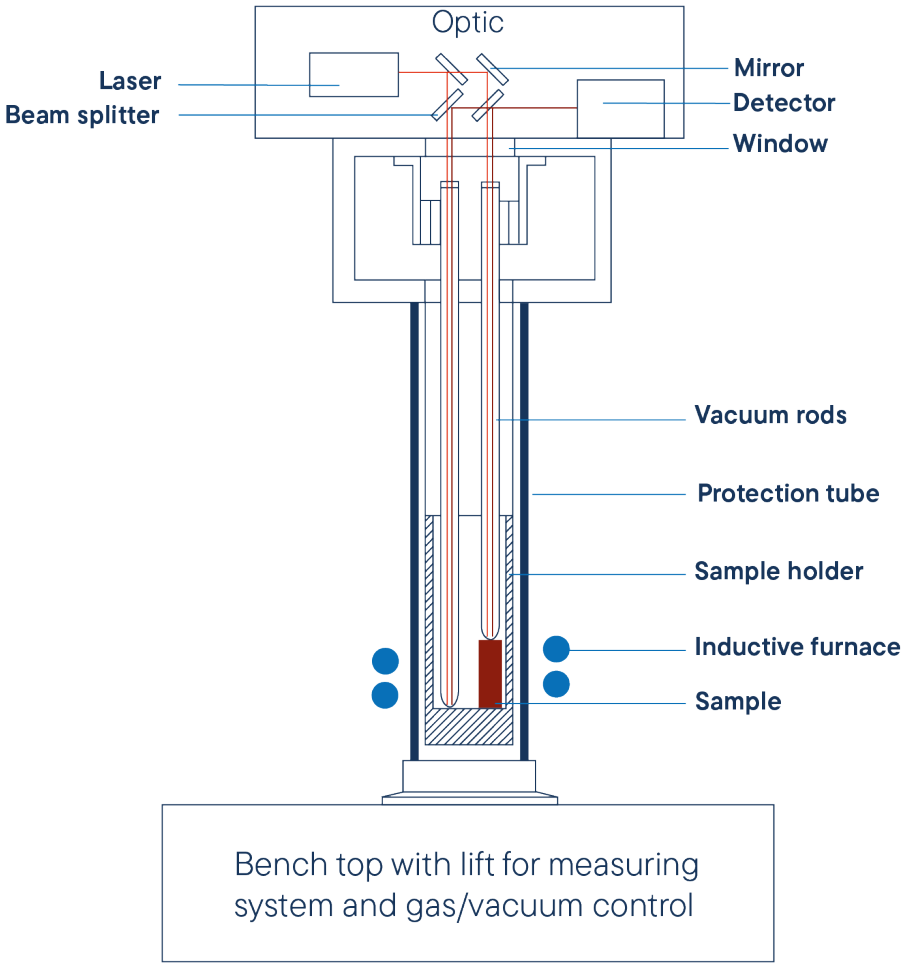
The **DIL L73 Laser** is based on a highly stable metrology frame in which the interferometer and sample form a closed measuring circuit. This is fully retracted into the furnace, forming a vacuum- and pressure-tight measuring chamber – ideal for analyses under defined atmospheres.

The vertical arrangement uses gravity as a constant reference value. A finely adjustable sample contact pressure ensures reproducible contact conditions for every measurement. The entire geometry is designed for maximum stability – optical disturbances caused by kinking, bending or tilting are effectively minimized.

The heating furnace is thermally limited to the relevant sample area. Thanks to LINSEIS many years of furnace expertise, the system achieves homogeneous temperature distribution, high heating rates and precise control – without influencing the optical measurement technology.

Measuring system of an DIL L73 Laser

The measuring system is based on a vertically aligned laser interferometer. The laser beam enters the evacuated measuring chamber through an optical window and is precisely aligned with the sample via mirrors. The sample is located in a holder inside a protective tube and is heated by an inductive furnace. Evacuated quartz rods ensure an optically pure measuring path and prevent refractive index and convection influences. The completely closed chamber enables measurements under inert gas, vacuum or reactive atmospheres.




deliv
outst
ser


ering
anding
vice

Unique features

Vacuum and controlled atmosphere

The pressure- and vacuum-tight measuring chamber supports high vacuum, inert, reducing, oxidising and humidified conditions. atmospheres.

Stable and precise displacement signal

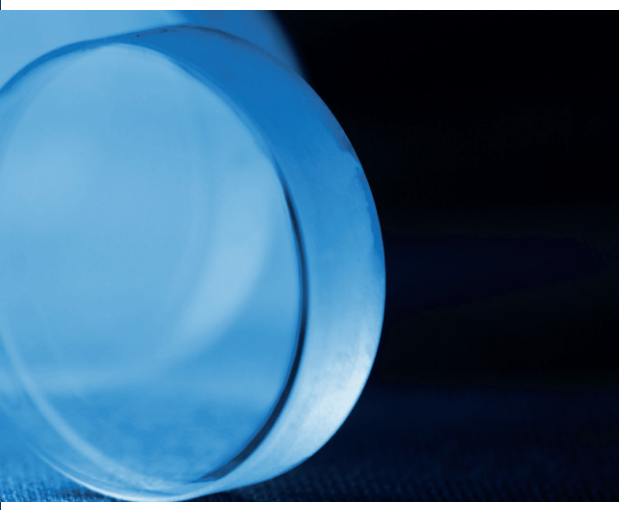
The measurement provides an absolute, linear signal, free from hysteresis and drift effects. Integrated signal stabilization with automatic corrections of offset, amplitude and frequency reliably suppresses interference such as noise, laser drift or modulation errors. This ensures stable and highly accurate results at all times.

Wide temperature range -180 °C to 1000 °C

A welded Type K thermocouple directly on the sample provides the actual local temperature and allows the expansion behavior to be precisely assigned to the thermal signal. This enables precise furnace control with simultaneous measurement signal validity—even at high heating and cooling rates.

Highest resolution

The laser dilatometer system achieves significantly higher resolution than conventional push rod dilatometer systems thanks to contact-free interferometry. Its sub-nanometric measurement capability eliminates mechanical limitations and increases precision in the long term.



Integrated LINSEIS platform

The integrated LINSEIS software offers a comprehensive solution, combining both hardware and software for maximum process security and precision. By providing a unified platform, it ensures seamless integration of components and devices from external partners, resulting in a highly robust system.

Customization

Close collaboration with the customers to tailor unique solutions, leveraging LINSEIS expertise to meet their specific needs.

Service

Our international presence across every continent enables us to deliver the best and fastest service possible.

Accessories

Accessories available include equipment for precise sample preparation and calipers for manually or electronically inputting sample length. There are also gas supply units available in manual, semi-automatic or MFC-controlled versions. Other accessories include the rate-controlled sintering (RCS) software module, various rotary and turbomolecular vacuum pumps, and LN_2-based cooling systems.

High precision
Laser interferometer for sub-nanometer resolution

Contactless laser measurement
Adjustable measuring force on the sample, non-contact determination of the expansion

Wide temperature range
Operation from RT to 1000 °C/
-180 °C to 500 °C/
-180 °C to 1000 °C/

User friendly software
Comprehensive data analysis and reporting

Extended cooling options
Air, liquid, nitrogen or closed cooling circuit

Technical **Specifications**

Feature	Value
Temperature range	-180 °C up to 500 °C/ -180 °C up to 1000 °C/ RT up to 1000 °C
Resolution	0.3 nm*
Heating/cooling rates	0.01 K/min to 50 K/min**
Sample length	up to 50 mm
Sample diameter	up to 7 mm
Sample holder	fused silica
Atmosphere	inert, oxic., red., vac.
Interfaces	USB

* tested in laboratory environments

** depends on furnace

DIL L73 Laser

Software

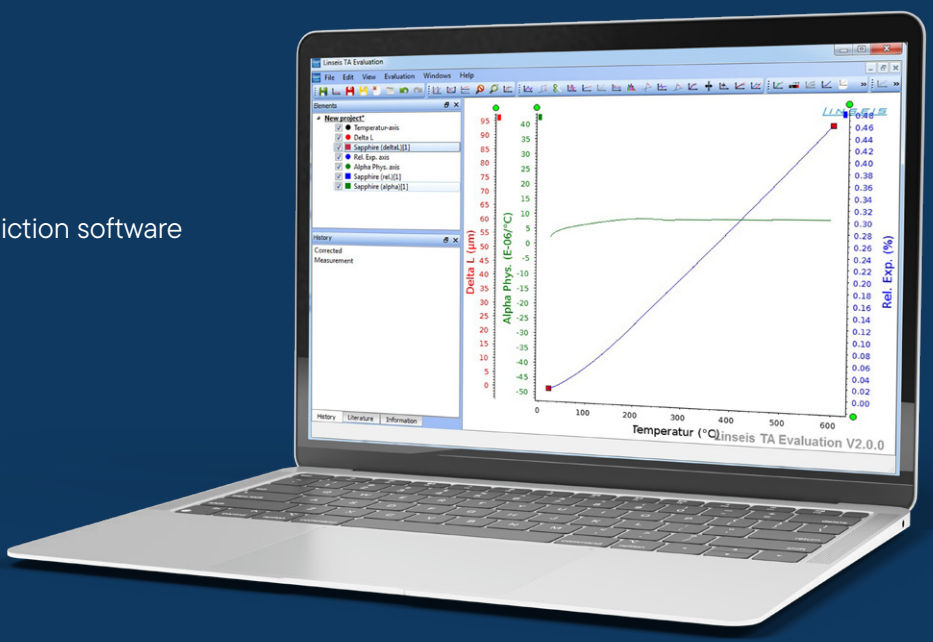
All LINSEIS thermo analytical instruments are PC controlled. The individual software modules exclusively run under Microsoft® Windows® operating systems. The complete software consists of 3 modules:
temperature control, data acquisition and data evaluation. The 32 bit software incorporates all essential 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 detection
- 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
- 1st and 2nd derivation
- Programmable gas control
- Statistical evaluation package
- Free scaling
- Automatic calibration
- Optional kinetic and lifetime prediction software packages

DIL Features:

- Rate Controlled Sintering (RCS) software
- Interchangeable thermocouples for various atmospheres
- Sinter process evaluation
- Glass transition and softening point evaluation
- Softening point determination and system shut down
- Linear thermal expansion evaluation
- Several system correction features
- Automatic zero point adjustment
- Auto-scheduler for up to 16 subsequent runs



The **LINSEIS Thermal Library** is available as an optional extension to the well-established and user-friendly **LINSEIS LiEAP** (Linseis Evaluation and Acquisition Platform) software, which is integrated into almost all of our instruments. With the Thermal Library, sample materials can be identified within just 1–2 seconds by comparing the measurement curve against a comprehensive database containing thousands of references and standard materials.

Multi-Instrument

LINSEIS instruments such as DIL, DSC, STA, TGA & LFA can be controlled with the same powerful LiEAP software platform.

Multi-User

The administrator can generate different user levels providing different rights to operate the instrument. A optional Log file is also available.

Report Generator

Convenient template selection to generate customized measurement reports.

Database

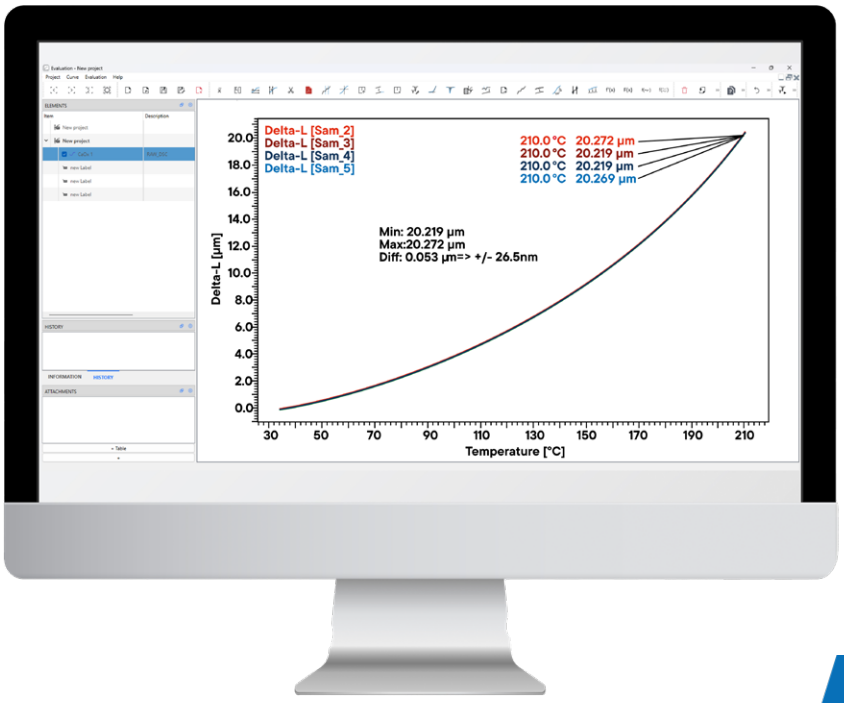
State of the art database design enables easy data handling.

Kinetic software

Kinetic analysis of DIL, DSC, DTA, TGA, EGA (TG-MS, TG-FTIR) data for the study of the thermal behavior of raw materials and products.

Multi-Lingual

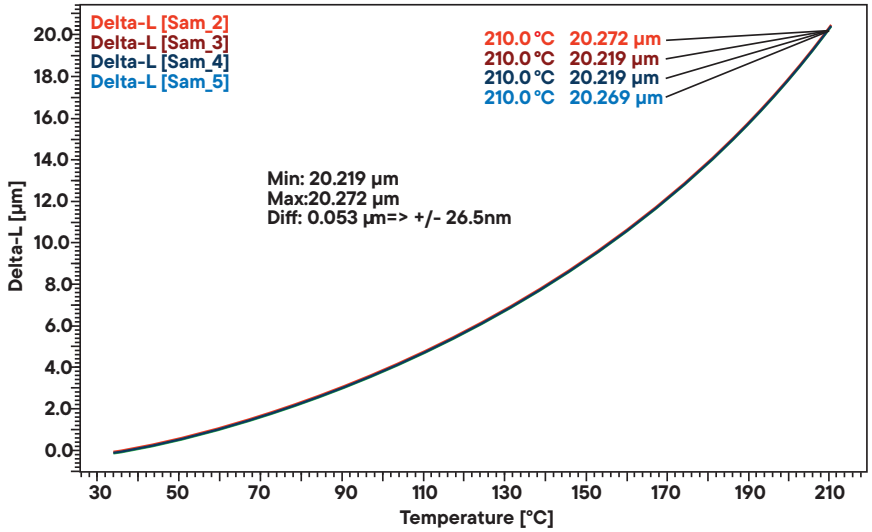
Our software is available in many different user exchangable languages, such as: English, Spanish, French, German, Chinese, Korean, Japanese, etc.



More Applications

Applications

Reproducibility of an Invar sample



An Invar sample was measured with four times from room temperature up to 210 °C in air using a LINSEIS DIL L73 Laser.
To assess reproducibility, the results of the four consecutive runs were compared. The system demonstrated an outstanding reproducibility of 0.01 % of the full measurement range, as illustrated in the adjacent figure. Compared to a conventional push-rod dilatometer, the laser-based system achieved a 33-fold improvement in reproducibility. In addition to its superior precision, the laser dilatometer provides absolute expansion values without the need for baseline correction or reference materials.

LINSEIS

pushing boundaries

LINSEIS GmbH Germany

Vielitzerstr. 43
95100 Selb

Tel.: (+49) 9287 880 0
E-mail: info@linseis.de

LINSEIS Inc. USA

109 North Gold Drive
Robbinsville, NJ 08691

Tel.: (+1) 609 223 2070
E-mail: info@linseis.com

LINSEIS China

Kaige Scientific Park
Room 120, Building T3, No.1220
Yuqiao Road, Pudong, Shanghai

Tel.: (+86) 61 90 12 03
Tel.: (+86) 50 55 06 42
E-mail: info@linseis.com.cn

LINSEIS India

Plot 65, 2nd Floor, Sai Enclave,
Sector 23, Dwarka05-800
110077 New Delhi

Tel.: (+91) 11 42883851
E-mail: sales@linseis.in

WWW.LINSEIS.COM

11/2025