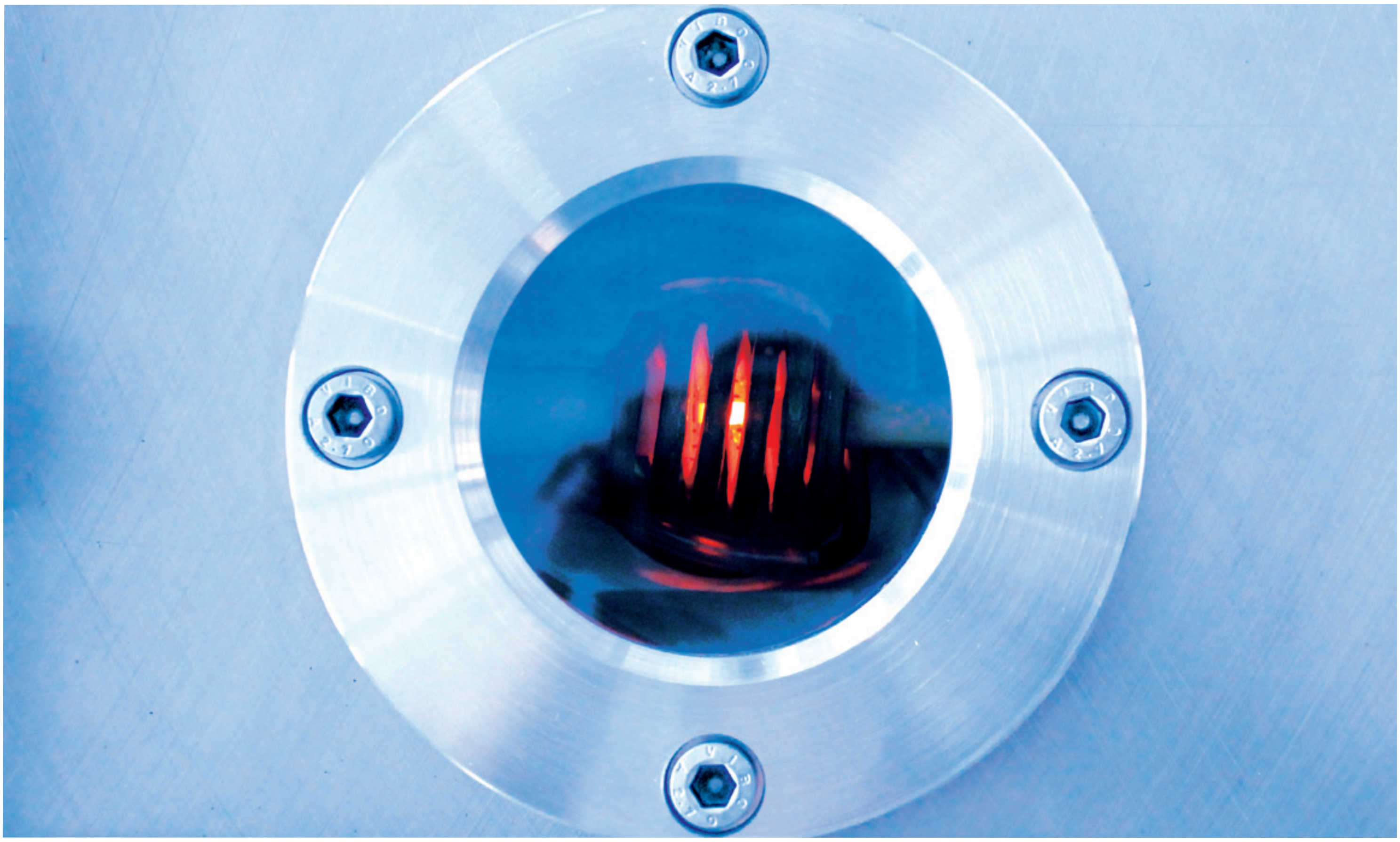
THERMAL ANALYSIS

Quenching & Deformation Dilatometer

DIL L78 Q/D/T



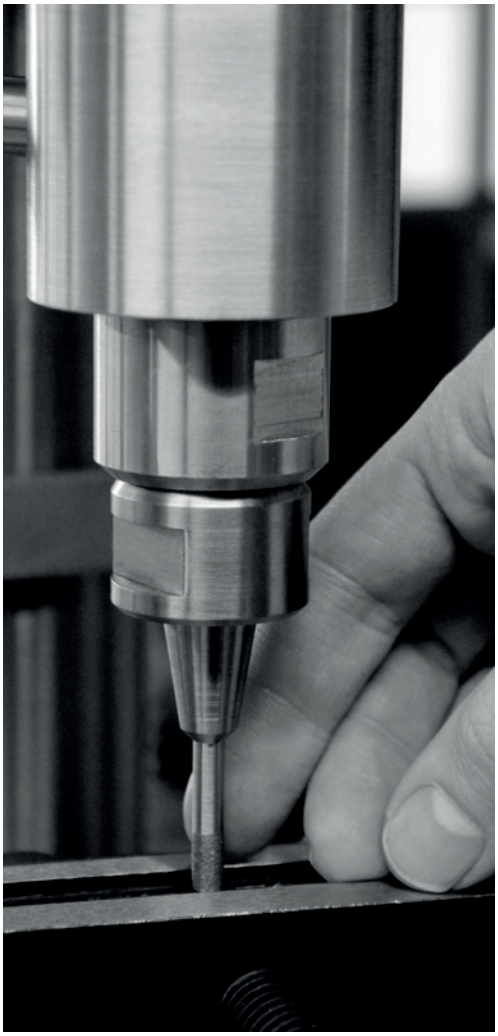
Since 1957 LINSEIS Corporation has been delivering outstanding service, know how and leading innovative products in the field of thermal analysis and thermo physical properties.

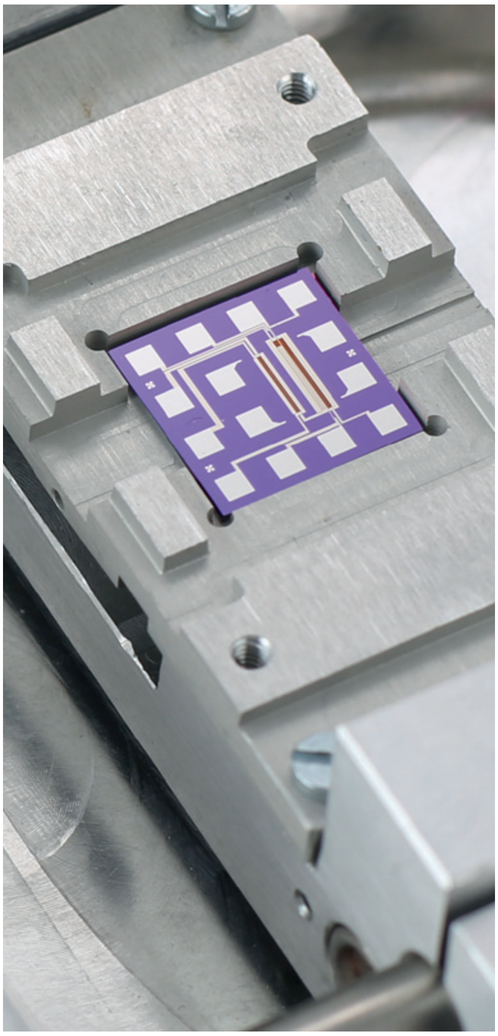
We are driven by innovation and customer satisfaction.

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 thermo analytical 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, thermo physical properties of solids, liquids and melts can be analyzed.
LINSEIS provides technological leadership. We develop and manufacture thermo analytic and thermo physical 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 thermo analytical 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
Managing Director





German engineering

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

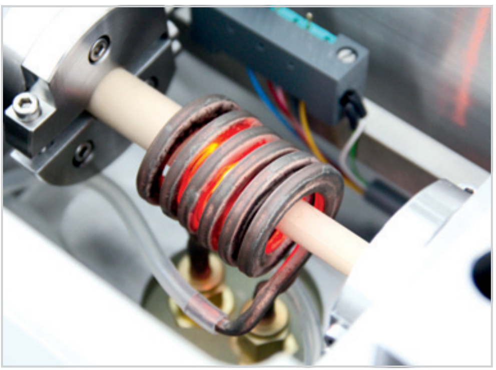
Innovation

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 constantly develop new technologies to enable continued discovery in Science.

QUENCHING & DEFORMATION DILATOMETER

up to 4500 K/s

- The Quenching and Deformation Dilatometer L78 RITA is especially suitable for the determination of deformation paramenter and of TTT, CHT, CCT and DCCT diagrams.
- The special induction furnace allows heating and cooling at controlled speeds up to 2500 K/s.
- Different cooling gases can be used, e.g. argon, helium and nitrogen. The system complies with ASTM A1033.
- All critical parameters such as heat up and cool down speed, gas control and safety features are software controlled.
- The professional software LINSEIS TA-WIN operates exclusively under the Microsoft© operation system. All routine (creation of CHT/CCT/DCCT/TTT diagrams) and demanding applications are solved by the unique Software package that comes with the instrument.
- Export functions in ASCII-format as well as graphic output are available.
- The used linerar actuator machanical system makes it possible to achieve deformation rates from 0.01 up to 100 mm/s in single or multiple hits.



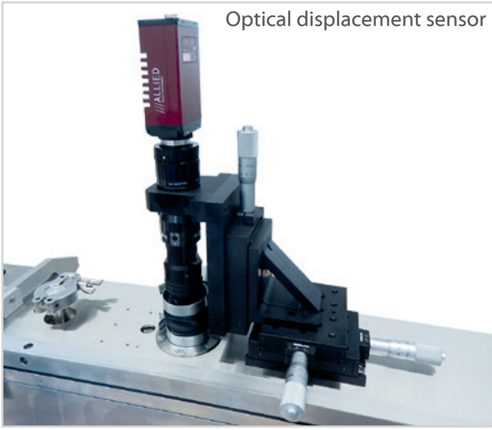
System configurations

L78 Q/D/T Dilatometer Modules

- CTE option (dilatation)
- Cryogenic option
  (temperature range: –170°C)
- DSC option (up to 1100°C / 1450°C on request)
- ODS optical displacement sensor
- Deformation mode
- Tension mode

Turbo Molecular Pump

OPTICAL DISPLACEMENT SENSOR



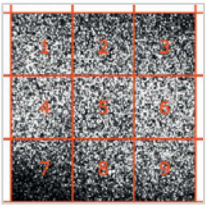
Optical displacement sensor

Laser Speckles

If coherent light like a laser hits an optical rough surface, the multiple-beam interference causes a granular structure in the intensity distribution. The picture on the right shows the camera image of a rough surface that was illuminated by a laser. The bright areas are the intensity peaks of the multiple-beam interference. They are called speckles. Because the speckles are evoked by the surface structure they move with the surface. For small movements they do not change their shape very much. This property of the speckles allows us to track the movement of the surface by tracking the movement of the speckles.

Detection

For the detection of the length change of a sample LINSEIS does not track only the movement of one speckle but all speckles in a certain region of the camera image:

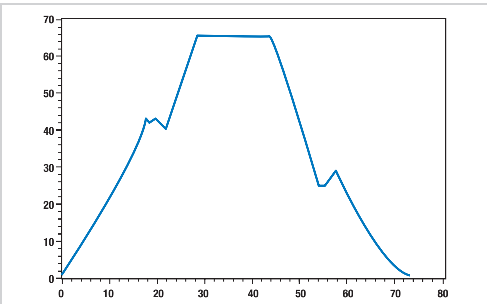


Detection areas in a speckle field

First the camera image is divided in several regions. In Figure 2 nine regions are shown, but there can be used up to 256 regions. For every region the displacement between two subsequent images is calculated by an algorithm, that uses a cross correlation with some special adaptions.

If this is done for all camera images, we get a vector field for every image that shows the movement between the subsequent images. On this field, several evaluation methods are possible.

One is to calculate something like the average divergence of the vector field. This has the benefit, that the whole image is used for the calculation and not only some special regions or speckles.



Average divergence of the vector field over the time

The result is very similar to a length change curve of a conventional quenching dilatometer, but the camera image is only about 1.6mm x 1.6mm large. So the transformation points are much sharper and even very weak transformations can be observed.
Additionally it is possible to calculate the absolute length change between two certain regions to get a result in µm.

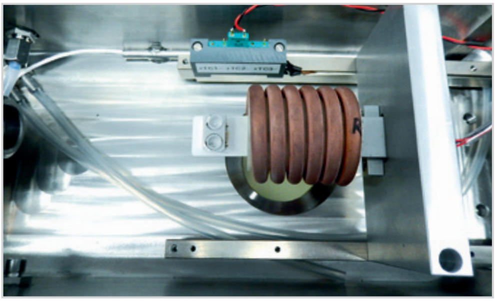
Technical Specifications

Resolution	1024x1024 px
Framerate	50 fps
Image size	1.6 x 1.6mm³ … 11 x 11mm²

DSC – DIFFERENTIAL SCANNING CALORIMETRY

Differential Scanning Calorimetry (DSC) is the most popular thermal analysis technique. It measures endothermic and exothermic transitions as a function of temperature.

• Endothermic = heat flows into a sample
• Exothermic = heat flows out of the sample



SOFTWARE

Features -Software

In respect to thermal and mechanical sample treatment numerous different mathematical functions can be selected.

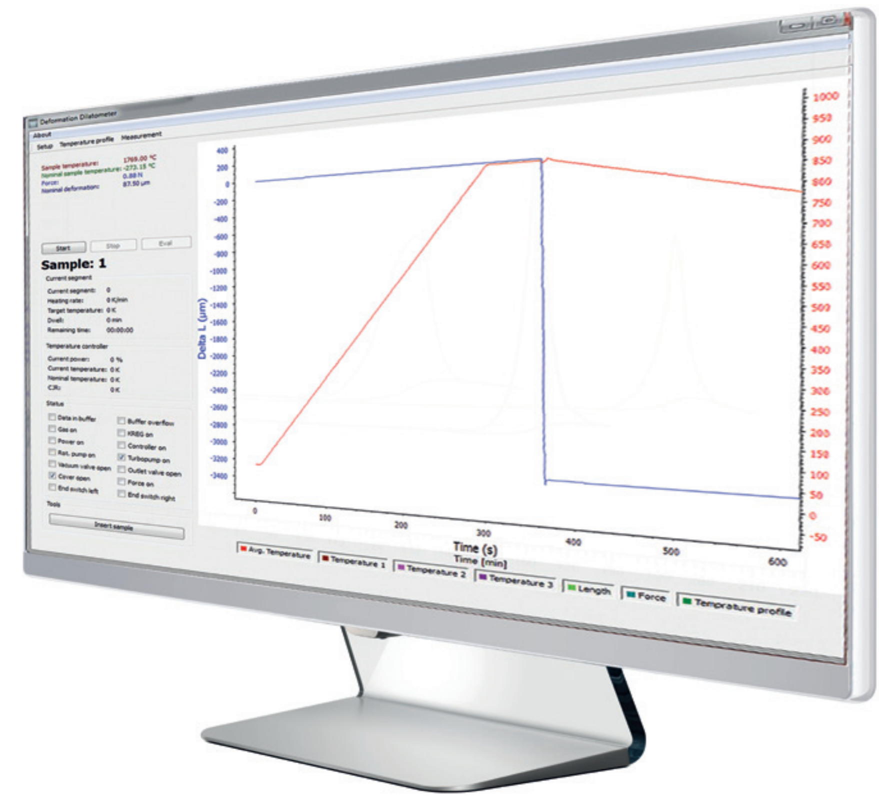
- Zoom function
- User-friendly
- Multi-methods analysis (DSC TG, TMA, DIL, etc.)
- Online help menu
- Report generator
- Data export to MS Excel
- Export and import of data ASCII
- Program capable of text editing
- Data security in case of power failure
- Thermocouple break protection
- Repetition measurements with minimum parameter input
- Evaluation of current measurement
- Storage and export of evaluations
- Programmable gas control
- Statistical evaluation package
- Smoothing of total or partial measurement
- Tangent intersection determination (automatic or manual)
- Free scaling

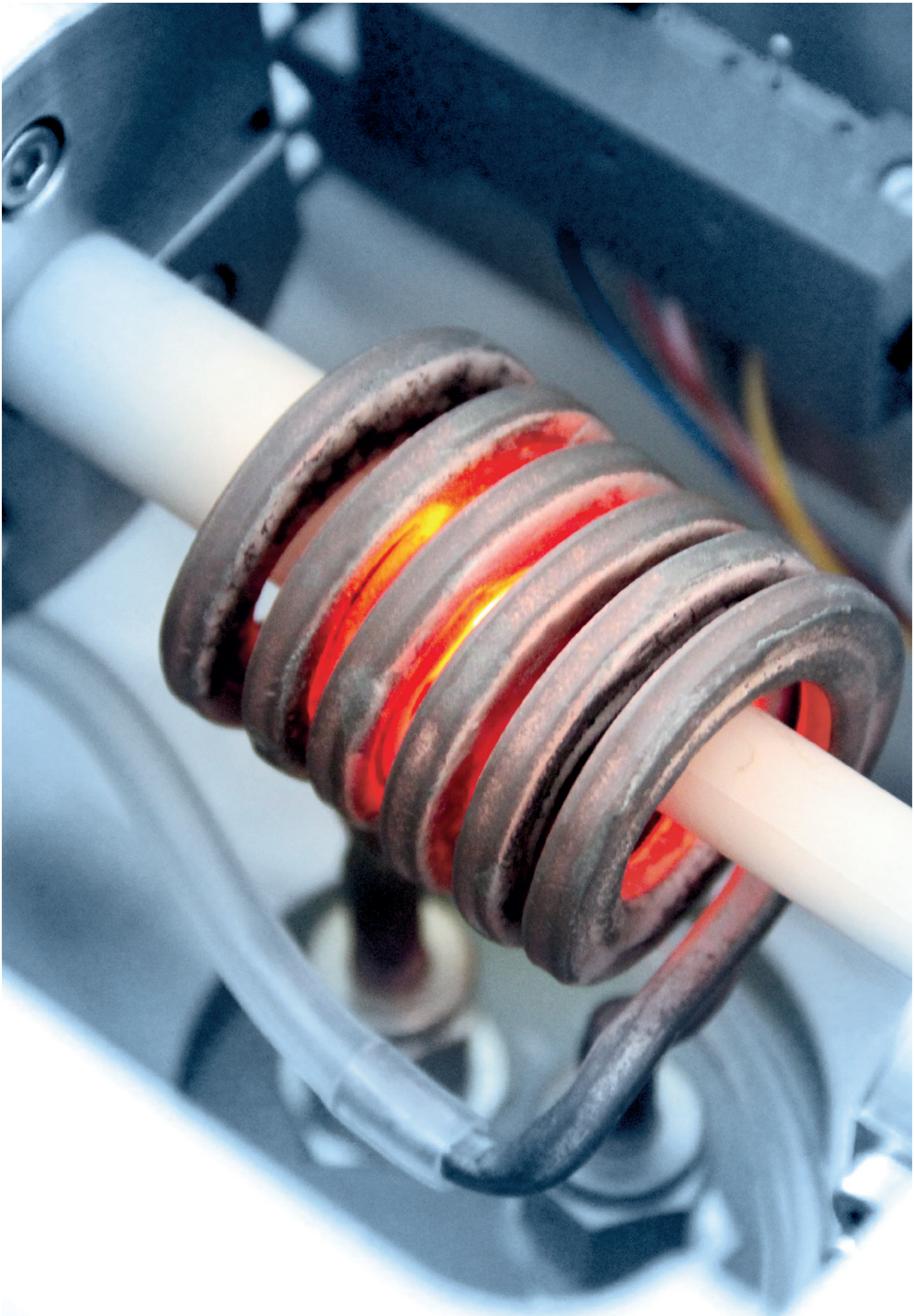
The information of a thermo analytical measurement can be increased when using the broad range of specialized Software.

Control and Evaluation Software

- Latest Windows operaing system
- Software for creation of CHT, CCT, DCCT and TTT diagrams
- all necessary measuring parameter are included in the menu structure
- Multiple forming steps during measurement
- Free choice of all control parameters
- Specification of temperature-time force-gradient and strain rate and deformation degree
- Control rate input by user or selection of industry parameter, i.e. quenching rates based on T 8/5 times
- Individual commentaries
- Heat up and cool down speeds
- End of the heating curve as well as duration of holding temperature
- Programmable heating / cooling and isothermal segments
- Function menus are easy to handle
- Graphical evaluation software with many functions to get complete results of all measured data
- Free assignment of axes
- The evaluation software includes freely scalable isothermal and continuous diagrams
- Manual entry of transition points
- Correction of individual data points
- Insertion of text
- ASCII Export

- Calculation of Delta L, Alpha physical, Alpha technical (CTE)
- Mathematical calculation of curves
- Statistical evaluation of curves with mean and confidence interval
- Print out of the results as curve or table
- Evaluation can be done simultaneously to an ongoing measurement / multi tasking
- Function menus are easy to handle
- Graphical evaluation software with many functions to get complete results of all measured data
- Free assignment of axes
- The evaluation software includes freely scala ble isothermal and continuous diagrams



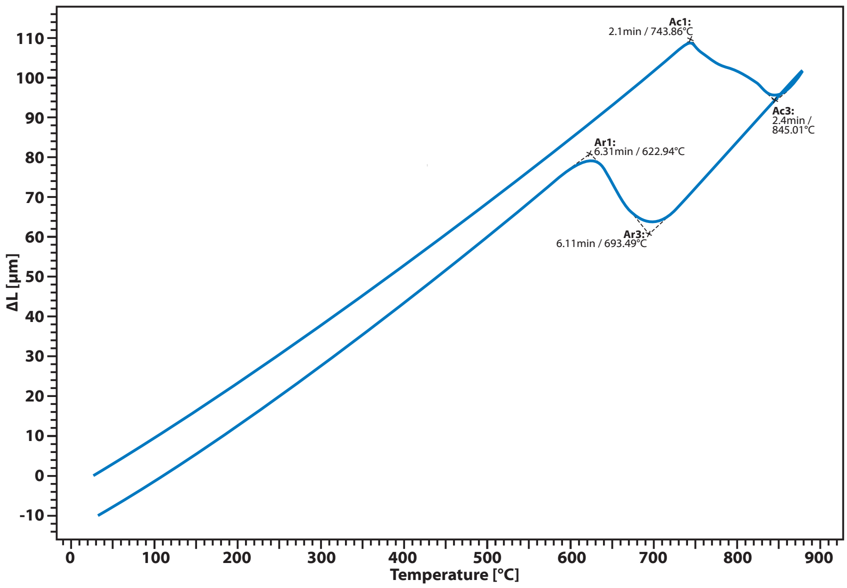


SPECIFICATIONS

	L 78 Q Stand alone Quenching Dilatometer	**L 78 RITA Q/D** Modular Quenching + Deformation + Tension	**L 78 RITA Q/D/T** Modular Quenching + Deformation + Tension
Temperature range	-150 up to 1600°C	-100 up to 1600°C	-100 up to 1600°C
Sample geometry	solid and hollow samples	solid and hollow samples	solid samples
Sample diameter	ø 3 mm	ø 3 mm	ø 5 mm
Sample length	10 mm	approx. 4–6 mm 10 mm	approx. 8–10 mm 10 mm
Heating rates	≤ 4000 K/s	≤ 4000 K/s	≤ 125 K/s
Cooling rates	≤ 4000 K/s	≤ 2500 K/s	≤ 125 K/s
Heating and cooling rates (combined deformation)			max. 100K/s
Deformation force			22 kN
Deformation rate			0.01 up to 100 mm/s (more on request)
True strain			0.02 to 1.2
Length change measurement	± 2.5 mm / ± 5 mm	± 1.2 mm (resolution 0.01 µm)	± 5 mm (resolution 0.05 µm)
Data sampling rate (for temperature, lenght, force)		≤ 1 kHz	≤ 1 kHz
Minimum pause between two deformation steps			60 ms
Atmospheres			protective gases, vacuum down to 10^{-5}mbar
Mechanical control modes			stroke, force, rate, strain (optional)

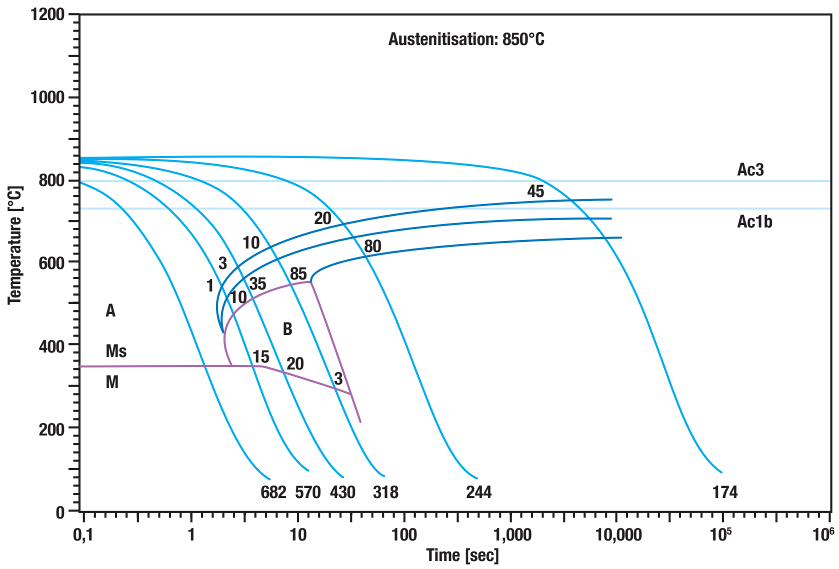
APPLICATIONS

Steel Phase Transformation



With the L78 Q and L78 Q/D Dilatometers the phase transformations in steel can be measured very accurately up to high heating and cooling rates. The transitions between different phases of steel are and the temperatures at which they occur are critical in the construction of the TTT, CCT and CHT diagrams. In this example the steel sample is heated in a first ramp above above its austenitic temperatur. Then the sample is quenched cooled. The plot shows the start (Ar3) and finish (Ar1) of the phase transformation from austenite to ferrite. These two temperature points can then be fitted to a CCT diagram based on the quench rate.

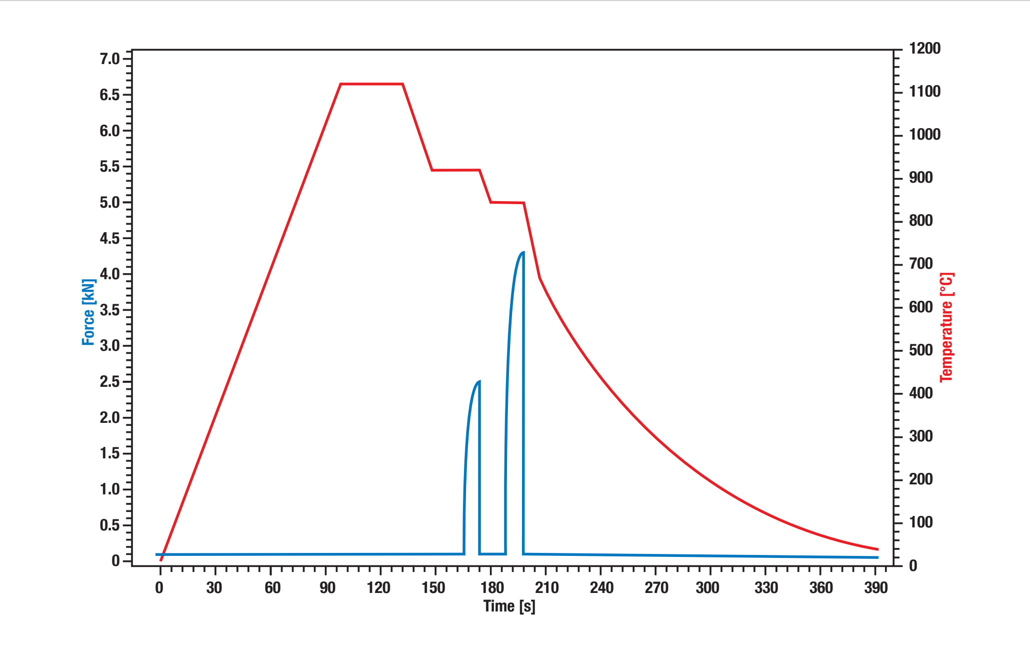
Continuous Cooling Transformation Diagram (CCT)



Picture © Dr. Sommer Werkstofftechnik GmbH, Issum

The CCT phase diagram represents the phase transformation of a material when it is cooled at various controlled rates. CCT diagram allow the prdeiction of the final microstructure of the measured steel. This crystalline structure determines the physical properties of the material. The L78 Q and L78 Q/D is the ideal tool to observe small dimensional changes under extreme conditions of controlled cooling. With the intuitive Software it is easy to prepare CCT, CHT and TTT diagrams from the test results.

2-Step Deformation Test



The L78 Q/D is the ideal instrument for optimizing the quench rate after multi-step deformations. With these measurements the processing of steel can be simulated to control the crystalline structure and the physical properties.

In this example, after the initial heating and resultant thermal expansion, the parcel of steel is held isothermally and goes through a series of 2 deformation steps: an initial 1mm deformation over a 10 s time period followed by a second 1 mm deformation over again 10 s time period. After the deformation steps the material is quenched and the contraction and phase transformation is measured. These data can be used for manufacturers to optimize their production processes for steels with the requested physical properties.

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Services: Service Lab, Calibration Service

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