LINSEIS

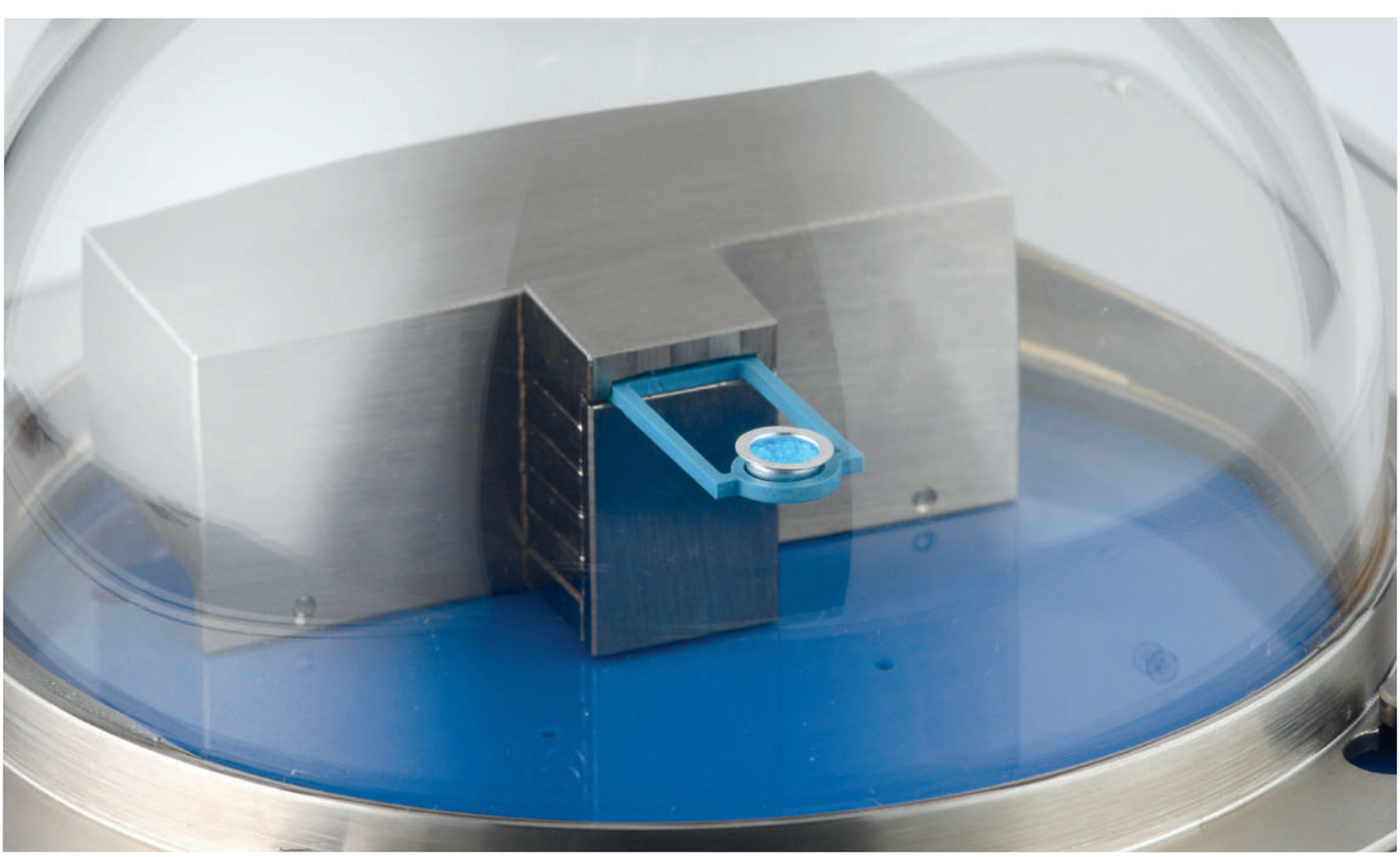
THERMAL ANALYSIS

# DIFFERENTIAL SCANNING CALORIMETER

Chip-DSC 100

Chip-DSC 10

Chip-DSC 1



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

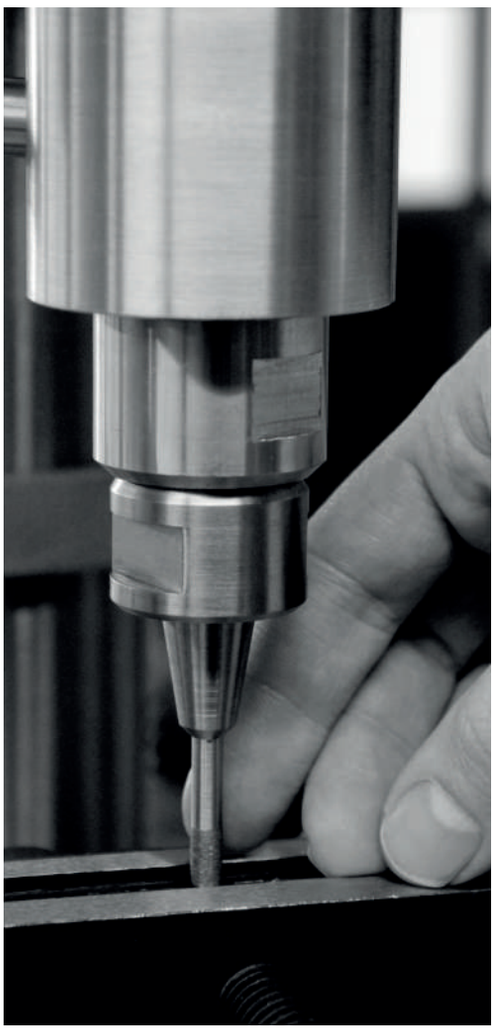
Customer satisfaction, innovation, flexibility and high quality are what LINSEIS represents. Thanks to these fundamentals our company enjoys an exceptional reputation among the leading scientific and industrial organizations. LINSEIS has been offering highly innovative benchmark products for many years.

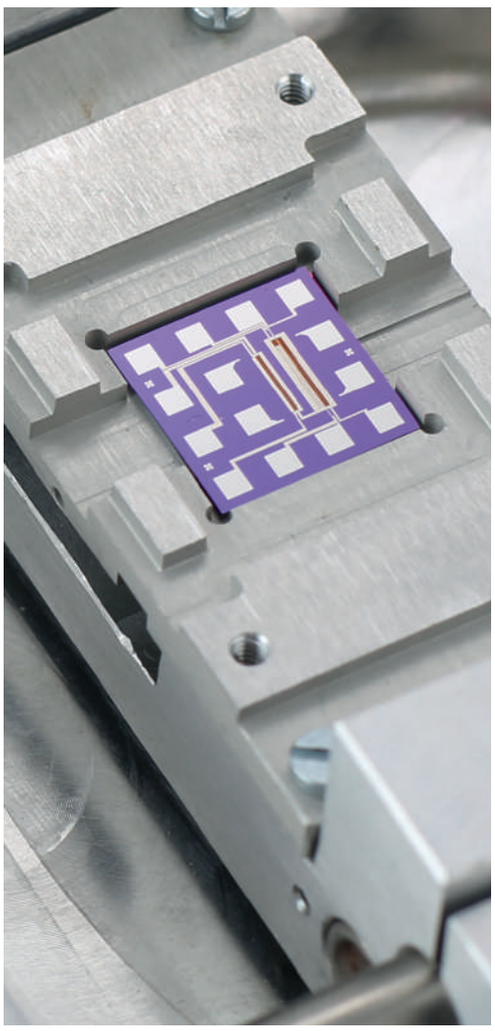
The LINSEIS business unit of thermal analysis is involved in the complete range of thermoanalytical equipment for R&D as well as quality control. We support applications in sectors such as polymers, chemical industry, inorganic building materials and environmental analytics. In addition, thermophysical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

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**
Managing Director





## German engineering

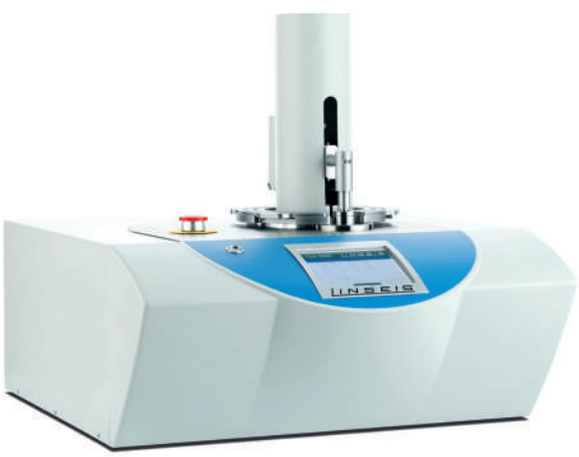
The strive for the best due diligence and accountability is part of our DNA. Our history is affected by German engineering and strict quality control.

## 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.

# DIFFERENTIAL SCANNING CALORIMETER

Chip-DSC 1



Chip-DSC 100

Chip-DSC 10

## The DSC Principle

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

The instrument is used to characterize polymers, pharmaceuticals, foods/biologicals, organic and inorganic chemicals. Transitions measured include Tg, melting, crystallization, curing, cure kinetics, onset of oxidation and heat capacity.

### Unsurpassed performance

- Revolutionary sensor design – combined heat flux sensor and furnace in one chip.
- Unsurpassed sensitivity – for detection of melts and weak transitions
- Benchmark resolution – precise separation of close lying events
- Reliable automation – up to 40 or 80 position autosampler
- Widest temperature range – from -180 °C to 600°C in one measurement

The LINSEIS Differential Scanning Calorimeters (DSC) operate in agreement with national and international standards such as: ASTM C 351, D 3417, D 3418, D 3895, D 4565, E 793, E 794, DIN 51004, 51007, 53765, 65467, DIN EN 728, ISO 10837, 11357, 11409.

# INTEGRATED CHIP TECHNOLOGY

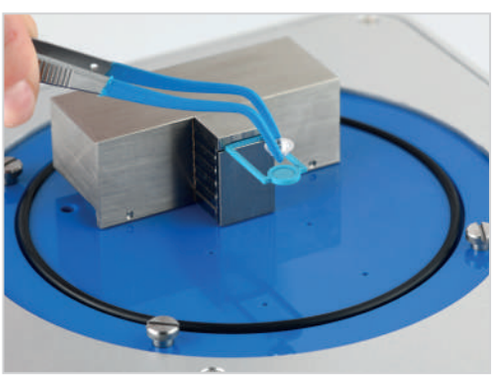
## Reinventing Differential Scanning Calorimetry (DSC)- Integrated chip technology for your application needs

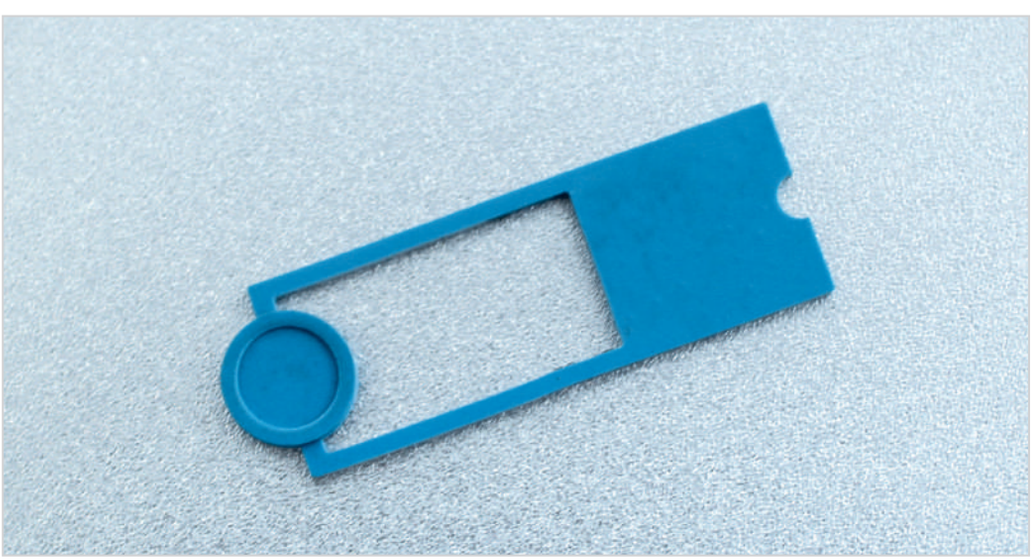
### Revolutionary Sensor Concept

The all new Chip-DSC integrates all essential parts of DSC, furnace, sensor and electronics in a miniaturized arrangement. The chip-arrangement comprises the heater and temperature sensor in a chemically inert ceramic arrangement with metallic heater and temperature sensor.

This arrangement allows superior reproducibility and due to the low mass outstanding temperature control and heating rates of up to 1000 K/min. The integrated sensor is easily user exchangeable and available at a low cost.

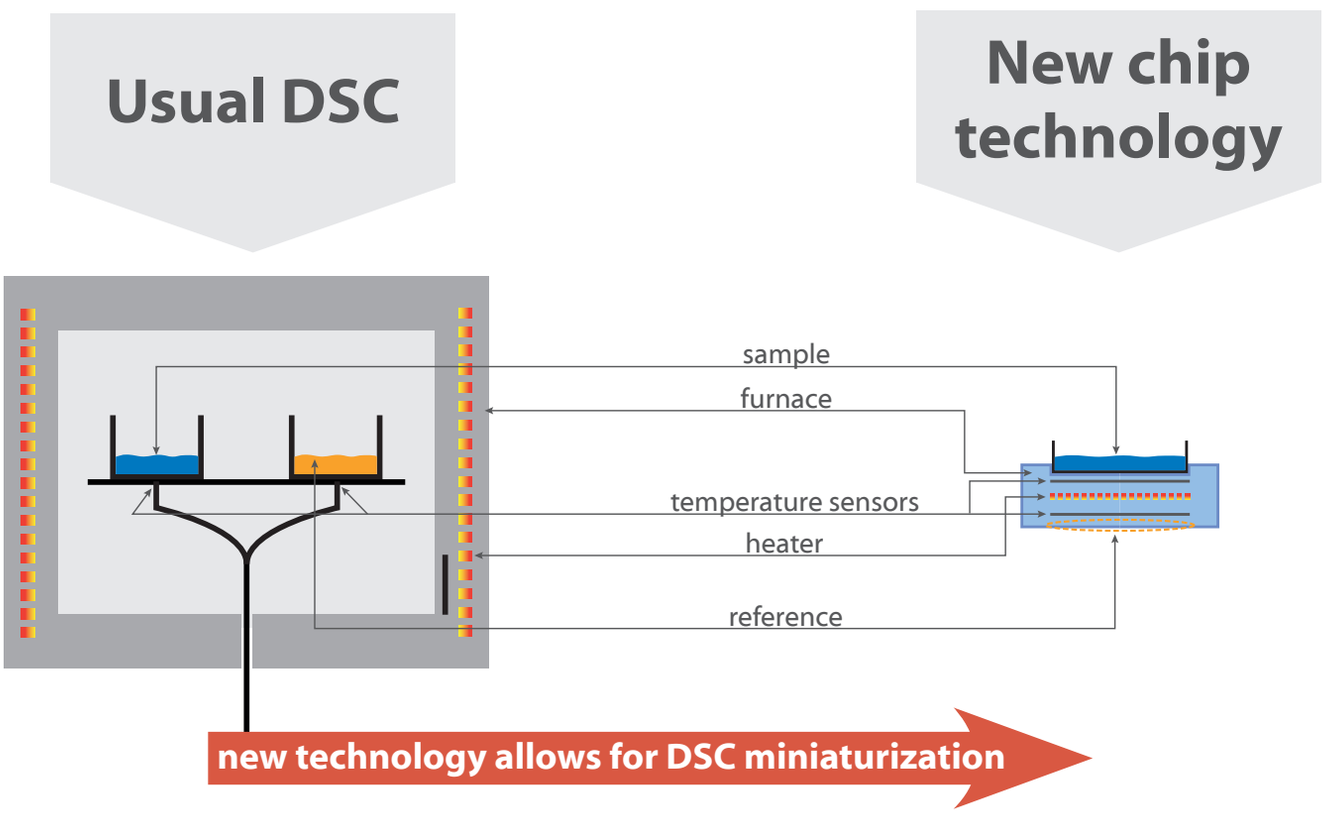
The integrated design of the chip-sensor delivers superior raw data, which enables a direct analysis without pre- or post-processing of heat flow data.





### Small Footprint

The compact construction leads to a significant reduction in production cost which can be passed on to our customers. The low energy consumption and unrivaled dynamic response results in unsurpassed performance of this revolutionary DSC-concept.




Chip reduction: similar to the memory cards

# ACCESSORIES

### Peltier-cooling system (0 – 600°C)

This is a Peltier cooled heat exchanger. The simple to install accessory reduces the starting temperature of the DSC-sensor to 0°C. Due to the low thermal mass of the sensor the DSC can now reach linear heating from 10°C onwards. With this starting temperature 90% of polymer applications can be covered.

### Closed-loop intracooler (-100 – 600°C)

Closed cycle refrigerated cooling system. Can cool down to -100°C. This intracooler eliminates the need of refilling LN2 for cooling purposes.

### $LN_2$-cooling system (-150 – 600°C)

Controlled cooling system for ultra-low temperature application down to -150°C. This accessory provides the opensest flexibility and cooling capacity of all available options.

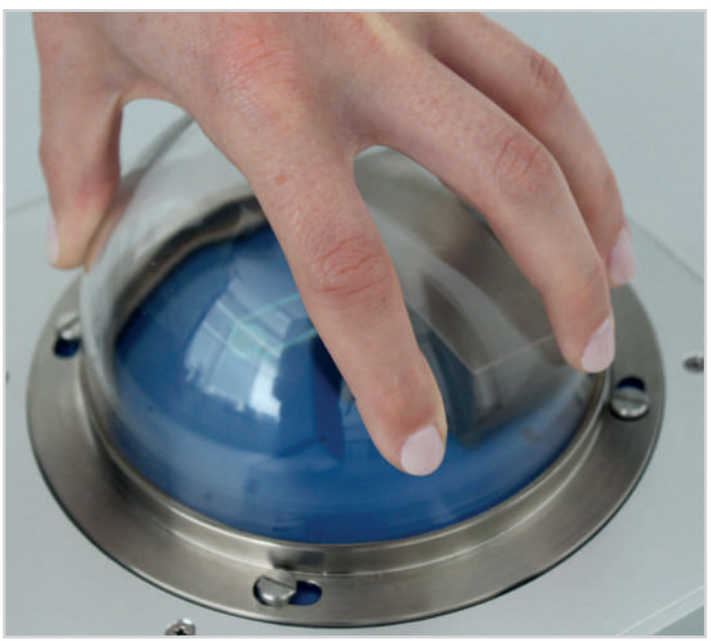
### Quench-cooling-system, (-180 – 600°C)

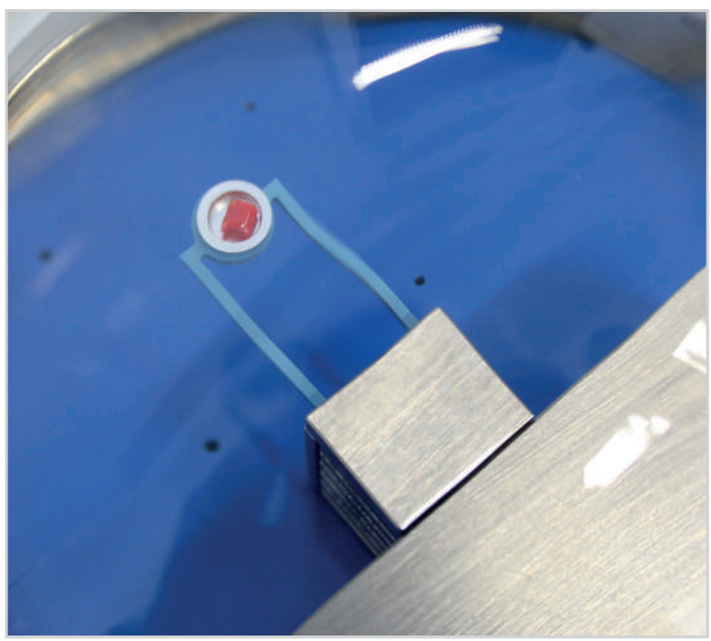
The quench-cooling accessories provides and open cooling container surrounding sensor and sample. Coolant dependent, e.g. dry ice or $LN_2$, sample temperature can go down to -180°C. This system does not allow defined gas atmospheres while measuring, as outgasing will surround the sample.

### DSC-sample-press

For optimum sample preparation two different ergonomic sample presses are available. One for pressure crucibles and one for standard crucibles and hermetic pans.

## OBSERVABLE DSC MEASUREMENT IN A SMALL HOUSING





# SOFTWARE

## Smart Software Solutions from LINSEIS

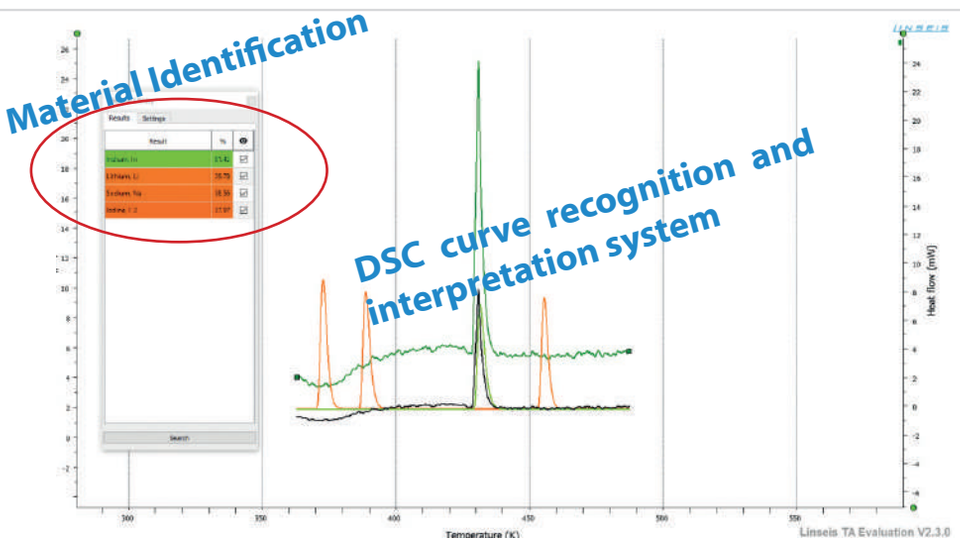
The all new Rhodium software greatly enhances your workflow as the intuitive data handling only requires minimum parameter input.
AutoEval offers a valuable guidance for the user when evaluating standard processes such as glass transitions or melting points.
Thermal library product identification tool, provides a database with 600 polymers permitting an automatic identification tool for your tested polymer.
Instrument control and/or surveillance through mobile devices gives you control wherever you are.

- Software packages are compatible with latest Windows operating system
- Set up menu entries
- All specific measuring parameters (User, Lab, Sample, Company, etc.)
- Optional password and user levels
- Undo and redo function for all steps
- infinite heating, cooling or dwell time segments
- multiple language versions such as English, German, French, Spanish, Chinese, Japanese, Russian, etc. (user selectable)
- Evaluation software features a number of functions enabling a complete evaluation of all types of data
- Multiple smoothing models
- Complete evaluation history (all steps can be undone)
- Data acquisition and evaluation can be performed simultaneously
- Data can be corrected using zero and calibration correction
- Data evaluation includes: peak separation software signal correction and smoothing, first and second derivative, curve arithmetic, data peak evaluation, glass point evaluation, slope correction, zoom / individual segment display, multiple curve overlay, annotation and drawing tools, copy to clipboard function, multiple export features for graphic and data export, reference based correction

## Thermal Library

The LINSEIS Thermal Library software package comes as an option for the well-known, user friendly LINSEIS Rhodium evaluation software that is integrated in almost all our instruments.

The Thermal Library allows you the comparison of the complete curves with a data base providing hundreds of references and standard materials within only seconds.




Measured and matching reference curves (green) and reference curves with poor fit (red).

## Multi-Instrument

All LINSEIS instruments DSC, DIL, STA, HFM, LFA, etc. can be controlled from one software template.

## Report Generator

Convenient template selection to generate customized measurement reports.

## Data Base

State of the art data base design enables easy data handling.

## Multi-Lingual

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

## Multi-User

The administrator can generate different user levels providing different rights to operate the instrument. An optional Log file is available, too.

## Kinetic software

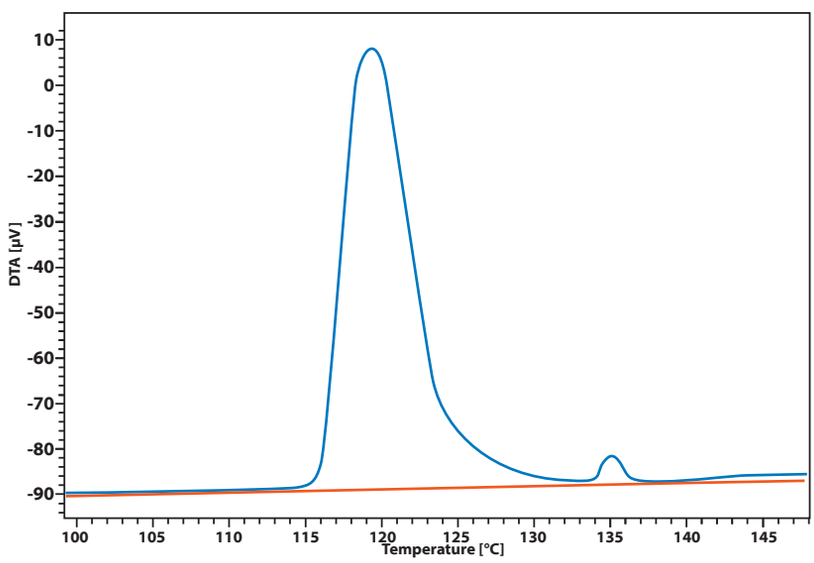
Kinetic analysis of DSC, DTA, TGA, EGA (TG-MS, TG-FTIR) data for the study of the thermal behavior of raw materials and products.

# SPECIFICATIONS

| | Chip-DSC 1 | Chip-DSC 10 | Chip-DSC 100 |
|---|---|---|---|
| **Temperature range** | RT up to 450 °C<br>(no cooling option available) | RT up to 600°C<br>-180 up to 600°C (with optional $LN_2$ quench cooling) | –150°C up to +600°C<br>(depending on optional cooling systems: Peltier, closed-loop intracooler, $LN_2$) |
| **Heating and cooling rates** | 0.001 up to 100 K/min<br>ballistic cooling with up to 500 K/min | 0.001 up to 300 K/min<br>ballistic cooling with up to 500 K/min | 0.001 up to 1000 K/min |
| **Temperature accuracy** | +/- 0.2K | +/- 0.2K | +/- 0.2K |
| **Temperature precision** | +/- 0.02K | +/- 0.02K | +/- 0.02K |
| **Cool down time 400°C to 50 °C** | 2.7 min | 2.7 min | 2.7 min |
| **Digital resolution** | 16.8 million points | 16.8 million points | 16.8 million points |
| **Resolution** | 0.03 µW | 0.03 µW | 0.03 µW |
| **Atmospheres** | inert, oxidizing (static, dynamic) | inert, oxidizing (static, dynamic) | inert, oxidizing (static, dynamic) |
| **Measuring range** | +/-2.5 up to +/-250mW | +/-2.5 up to +/-250mW | +/-2.5 up to +/-250mW |
| **Calibration materials** | included | included | included |
| **Calibration** | recommended 6-month interval | recommended 6-month interval | recommended 6-month interval |

# APPLICATION TAWN TEST

## TAWN Test – Resolution




LINSEIS Chip-DSC TAWN I Resolution Test 20K/min

### Scope

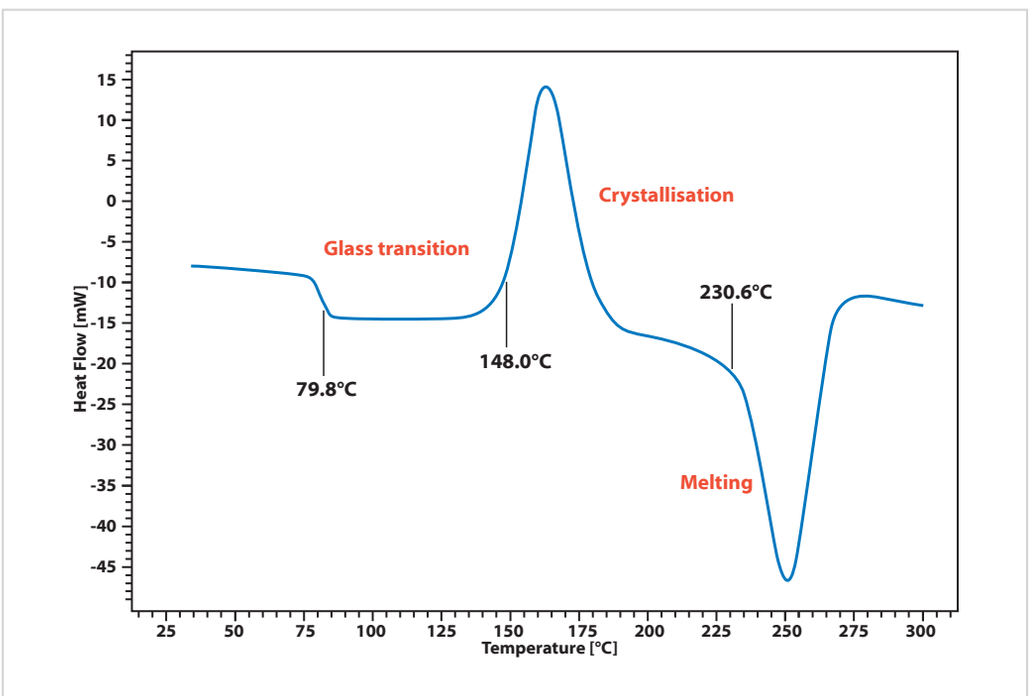
4,4´-Azoxyanisole reference material was used to perform the so called TAWN test. The substance forms a liquid crystalline phase at 120°C which transforms into a further liquid phase at 134°C with a small activation energy barrier in a second step.

This "double peak" is used in the TAWN test to investigate sensitivity and resolution of a DSC system and compare different DSC instruments with each other.

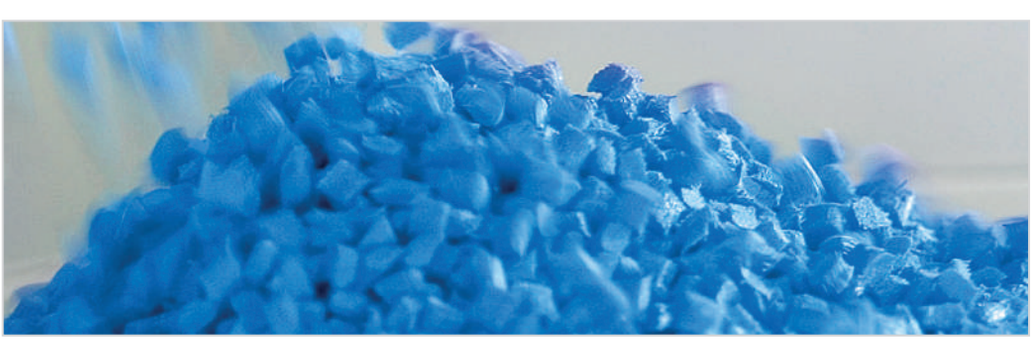
For the test an open aluminum crucible has to be used. The atmosphere must be air, argon or nitrogen, in this case we used air. The resolution is investigated with 5 mg of test substance and a heating rate of 20 K/min. The distance between the baseline to the minimum of the curve between the two peaks is measured. The ratio of this height to the height of the second peak is the resolution. The result of 0.13 is an excellent one.

# APPLICATIONS

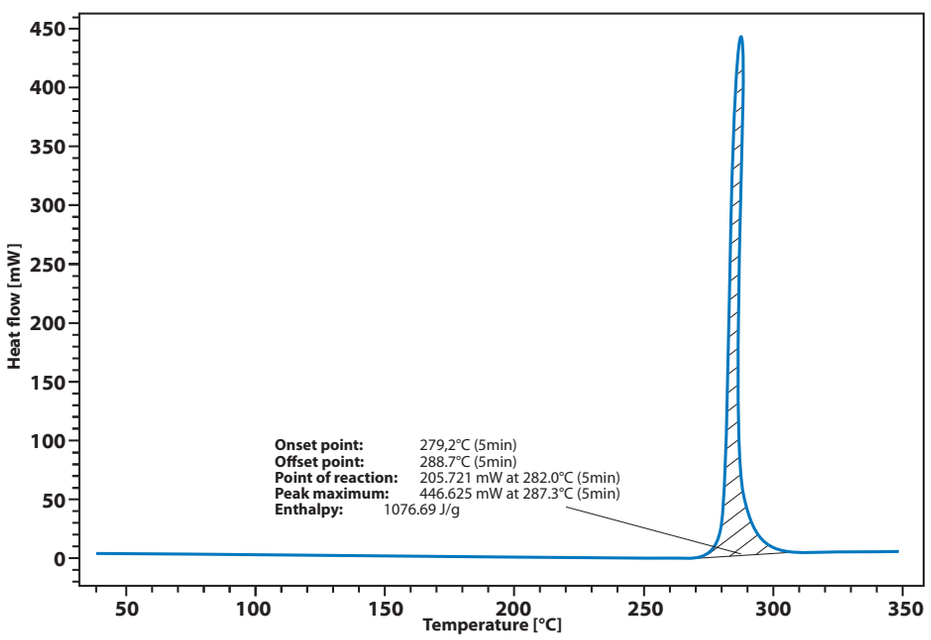
## Measurement of PET granulate




The analysis of polymers is one of the main applications of DSC. Effects like glass transitions, melting and crystallization points are of interest and often very hard to detect. The new LINSEIS Chip-DSC provides high resolution and sensitivity, making it an ideal instrument for this kind of analysis. As an example, a PET granulate was heated, quench cooled to freeze the amorphous state and afterwards analyzed by Chip-DSC with a linear heating rate of 50 K/min. The curve shows a significant glass transition around 80°C, followed by a cold crystallization of the amorphous parts starting around 148°C and a melting peak at 230°C.



## Highly energetic materials

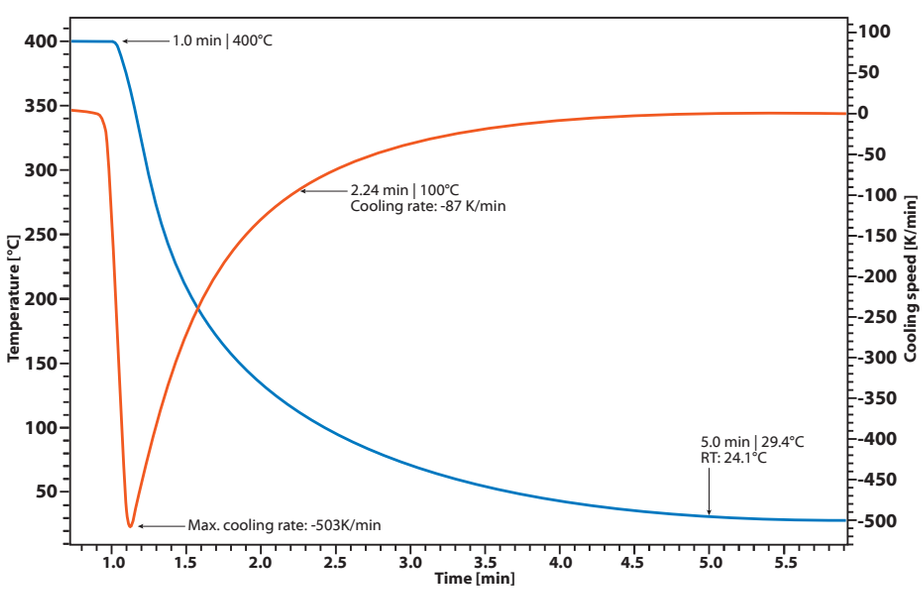



Highly energetic materials are used in airbags, as propellants, blasting materials etc.

For any type of DSC instrument, there is a risk of damaging the sensor and even the furnace. In the Chip-DSC, the chip (integrating sensor and furnace) can be easily replaced by the operator at low cost and in a short time. In case of a damage to the instrument, the downtime of the instrument is reduced drastically. Change oft he sensor needs only some seconds and the calibartion can be done in less than half an hour.

The example shows the DSC diagram of 2,8 mg of airbag igniter.

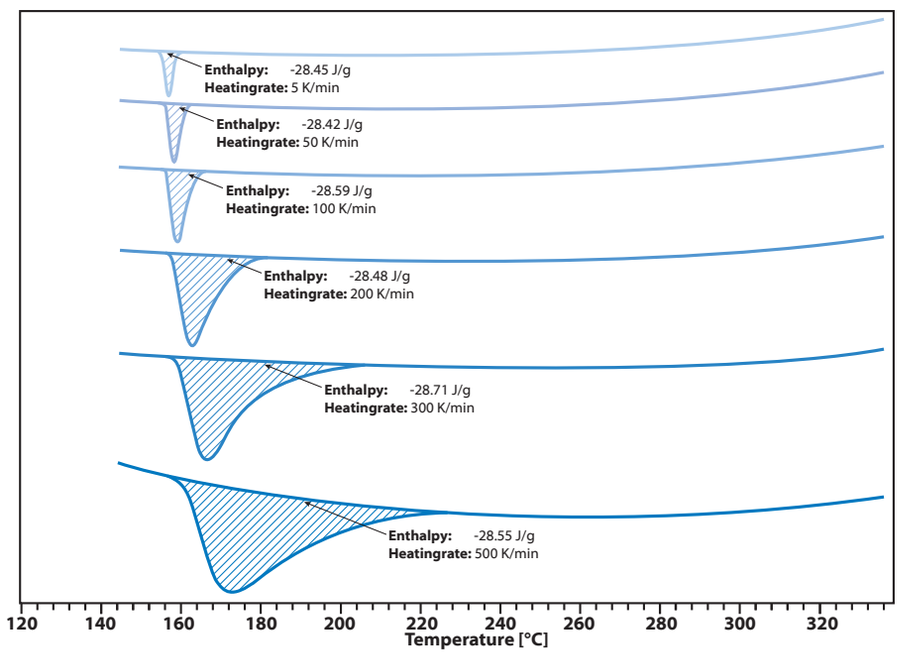
## Rapid cooling rates without active cooling




The LINSEIS Chip-DSC allows fastest possible ballistic cooling rates without any active cooler needed. Due to the low thermal mass and innovative sensor design, cooling rates up to 500 K/min from 400°C on can be reached. Even cooling to 100°C can be done with cooling rates of up to 90 K/min. A cooling from 400°C down to 30°C can be done in 4 minutes just by ballistic colling without need of any additional cooling devices.

Of course, the signal can still be evaluated during that cooling segment and does not lose sensitivity or accuracy.

## Rapid heating rates

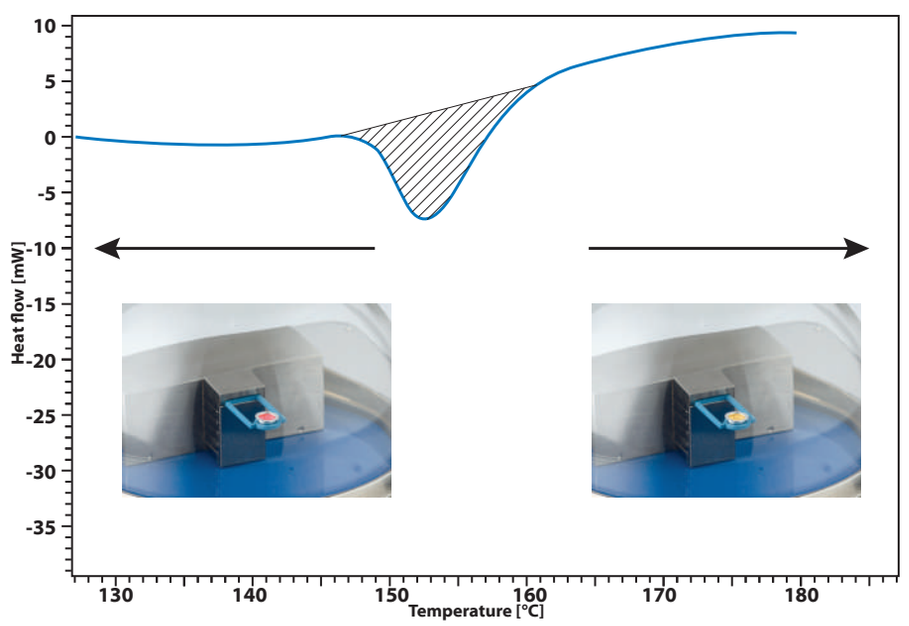



Extremely high heating rates up to 1000K/min can be achieved while the reproducibility of the melting enthalpy remains excellent.

The example shows the melting point of Indium measured with different heating rates (5 K/min; 50 K/min; 100K/min; 200K/min; 300 K/min and 500K/min).

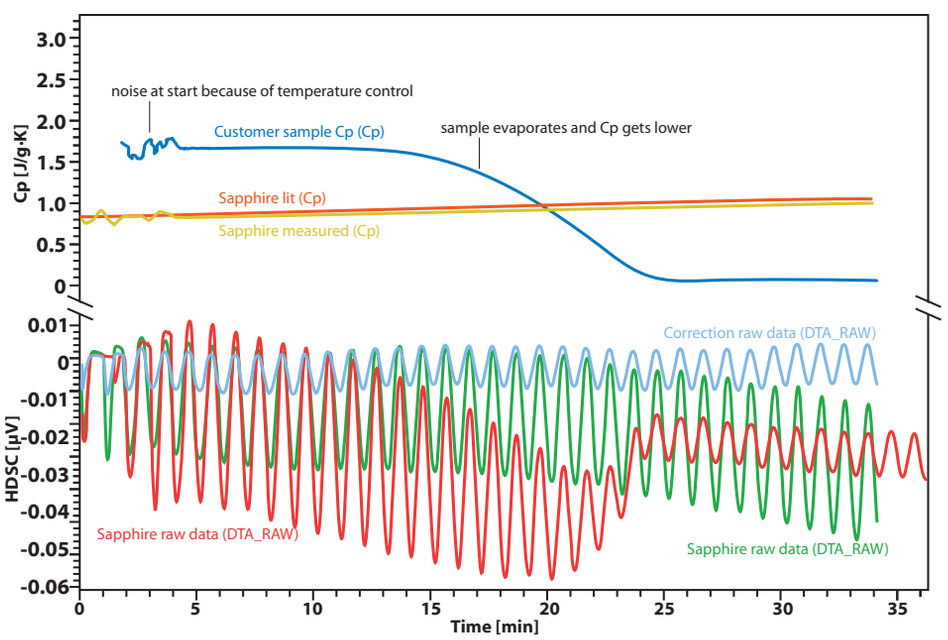
This means that a complete analysis including heating and cooling can be done in only 10 minutes without any need for optional cooling devices.

## Thermochromism




In classical DSC instruments the sample cannot be observed during the measurement. Observation can give further usefull information (forming of bubbles, fumes, change of color, etc.).
The graphic above shows an example of a thermochromic material, showing an endothermic phase transition at 160°C. The phases have different colors and the color change from red to yellow can be seen through the transparent cover. A camera option for recording images is available.

## Cp determination




Beside the caloric measurements of phase transitions, the Chip-DSC is also able to determine the specific heat capacity. The Chip-DSC can realize this with only one crucible by using a definite modulated heating rate. Therefore a calibration measurement with a reference material (like sapphire) is recorded, followed by the measurement of the unknown sample that can be evaluated using this calibration.

The measurement shows the modulated measurement of heat capacity of sapphire at a heating rate of 10 K/min with amplitude of 3 K. Due to the fast changing temperature and the change of the amplitude caused by the heat capacity of the sample, there can be achieved a good signal quality that allows evaluation of heat capacity with an error of only 3.5 %. This is significantly better than most commercial classic DSC devices.

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