

# NETZSCH

Proven Excellence.



## Advanced Materials Testing

Thermal Analysis, Methods for Determination of Thermophysical Properties, Cure Monitoring, Rheology, Fire Testing, Accelerating Rate and Isothermal Calorimetry

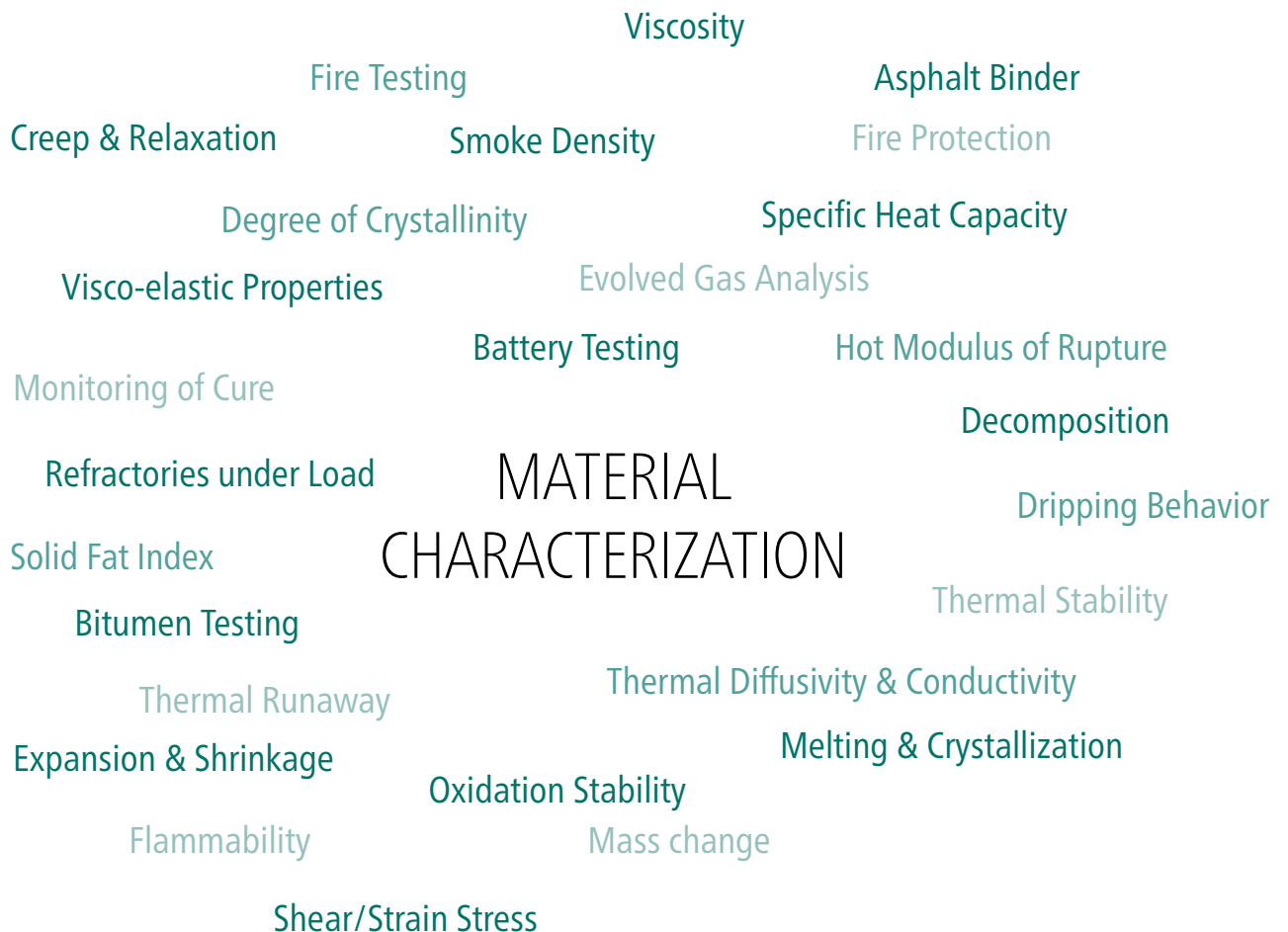
Analyzing & Testing

# *Leading Thermal Analysis*

Since 1962, NETZSCH-Gerätebau GmbH has consistently provided our customers with the latest thermal analysis techniques, the broadest range of highest quality products, the most complete technical support and the most comprehensive service.

Thanks to our experienced team, NETZSCH Analyzing & Testing consistently offers the "utmost": the most complete product line, the widest temperature range and the highest measurement pressure, to name a few. The series of patents and international R&D awards which we have received attest to our products' leadership in terms of technique and quality. Our branches, representative offices and application laboratories worldwide offer our customers excellent instruments and technical support, wherever on the globe they may happen to be.

At NETZSCH, we regard customer satisfaction as our first priority. We are looking forward to working with you.



# Product Portfolio

At NETZSCH, you will find solutions for Thermal Analysis, thermophysical properties testing, cure monitoring, dynamic-mechanical testing, multiple module and accelerating rate calorimetry as well as for rheology and fire testing.

Our instruments and methods allow for material characterization and the study of properties such as specific heat capacity, enthalpies, weight change, Young's modulus, dimensional changes, thermal conductivity, thermal diffusivity, viscosity and evolved gases including determinations with regard to purity and composition, poly-morphism, thermal stability and application temperature limits, aging and thermomechanical behavior, visco-elastic properties, processing conditions, and fire behavior.

NETZSCH Analyzing & Testing develops sensitive, versatile, and reliable instrumentation for research and development, quality control, process safety and failure analysis. We offer our customers broad applications knowhow through publications, demonstrations, contract testing, seminars and users' meetings.

Let NETZSCH open up a whole new perspective on the materials in your world.

Diversified  
Product Range  
for Eclectic  
Applications

## Thermal Analysis

- DSC/DTA
- TGA
- STA (TGA-DSC, TGA-DTA)
- DIL
- TMA
- DEA
- Coupling to EGA (MS/FT-IR/GC-MS)

## Dynamic-Mechanical Testing

- DMA
- High-Force DMA

## Rheology

- Rotational Rheometer
- Capillary Rheometer

## Thermal Conductivity and Thermal Diffusivity

- HFM
- Guarded Hot Plate (GHP)
- LFA
- Guarded Hot Pipe

## Seebeck Coefficient and Electrical Conductivity

## Refractory Testing

- RUL/CIC
- HMOR

## Accelerating Rate Calorimetry/ Battery Testing

- ARC®
- MMC

## Fire Testing Systems

- KBT, SBI TBB, TNB, KBK, TRDA, UL94, LOI, HBK

## Standard and Advanced Software

- Proteus® Standard Software
- Thermokinetics
- Peak Separation
- Temperature-Modulation

# DIFFERENTIAL SCANNING CALORIMETRY

Differential Scanning Calorimetry (DSC) determines transition temperatures and enthalpy changes in solids and liquids under controlled temperature change. DSC is the most frequently used method in the field of Thermal Analysis. Rapid analyses, high significance for research and quality control tasks, and easy handling of the measuring instrument contribute to its versatility.

## The Pathfinders

The premium systems DSC 204 **F1 Phoenix**<sup>®</sup> and DSC 404 **F1/F3 Pegasus**<sup>®</sup> integrate a number of hardware and software features which are useful in the lower temperature range including application fields such as polymers, foods, pharmaceuticals, composite materials and the higher temperature range including application fields such as inorganics, metals, alloys, and ceramics, etc.

### DSC 204 **F1 Phoenix**<sup>®</sup>

- Temperature range:  
-180°C to 700°C
- Gas-tight
- Highest Indium Response Ratio
- Choice of sensors for high resolution and high sensitivity
- Correction modes: Advanced *BeFlat*<sup>®</sup> and *Tau-R*<sup>®</sup>
- *AutoEvaluation* and *Identify* for curve evaluation and interpretation
- Temperature-modulation\*
- Automatic sample changer\*: up to 192 samples and 12 references
- UV-extension\*



DSC 204 **F1 Phoenix**<sup>®</sup>  
with UV extension

### DSC 404 **F1/F3 Pegasus**<sup>®</sup>

- High-temperature DSC:  
-150°C to 2000°C  
(DTA above 1750°C,  
 $c_p$  determination up to 1500°C)
- Defined atmospheres or vacuum
- Quickly interchangeable sensors (DSC- $c_p$ , DSC, DTA)
- Automatic sample changer\* or double-furnace operation
- Temperature-modulation\* for DSC 404 **F1 Pegasus**<sup>®</sup>



DSC 404 **F1/F3 Pegasus**<sup>®</sup>  
with two furnaces

\* Optional feature



## Day-to-Day Excellence – The Benchmarks of NETZSCH

### DSC 214 *Polyma*

This DSC takes the entire analytical process chain into account, from sample preparation to evaluation and interpretation of this resulting data.

- Temperature range: -170°C to 600°C
- Heating/cooling rates up to 500 K/min
- High Indium Response Ratio
- Automatic sample changer\*
- *AutoEvaluation* and *Identify* for curve evaluation and interpretation



DSC 214 *Polyma*

### DSC 204 HP *Phoenix*®

The high-pressure DSC features one of the highest working pressures. It is well-suited for energy materials (e.g., hydrogen storage) and petrochemistry (e.g., oxidation of oils).

- Temperature range: -150°C to 600°C
- Pressure range: vacuum up to 15 MPa
- Inert, reducing, oxidizing atmospheres under static or dynamic conditions
- Precise flow control (precision 0.02 bar)\*



DSC 204 HP *Phoenix*®

### DSC 3500 *Sirius*

This is the ideal tool for daily work in your laboratory. This gas-tight instrument is a reliable entry-level heat-flux DSC for quality assurance and failure analysis.

- Temperature range: -170°C to 600°C
- Various cooling systems\*
- Automatic sample changer\*
- Easy-to-use
- Low cost of ownership



DSC 3500 *Sirius*



# THERMOGRAVIMETRY SIMULTANEOUS THERMAL ANALYSIS

Thermogravimetry (TG)/Thermogravimetric Analysis (TGA) investigates materials' thermal stability and decomposition, whereas Simultaneous Thermal Analysis (STA) combines thermogravimetric analysis and differential scanning calorimetry in one measurement giving perfectly identical test conditions (same atmosphere, gas flow rate, etc).

## More than Trapping Mass Changes – TG 209 **F1 Libra**®, TG 209 **F3 Tarsus**®

TGA is used for quality control and assurance of raw materials and incoming goods as well as for failure analysis of finished parts, especially in the polymer processing industry. Various international standards describe the general principles of TGA for polymers (ISO 11358) or other specific applications, such as compositional analysis for rubber (ASTM D6370) and evaporation loss of lubricating oils (ASTM D6375).

### TG 209 **F1 Libra**®

- Temperature range: 10°C to 1100°C
- Weighing range/sample load: 2000 mg
- Resolution: 0.1 µg
- Automatic evacuation
- Vacuum-tight: 10<sup>-2</sup> mbar
- 3 mass flow controllers
- Cooling speed: <11 min (to 25°C) in He atmosphere
- c-DTA®, SuperRes®\*, TGA-BeFlat®
- AutoEvaluation and Identify for curve evaluation and interpretation
- Automatic sample changer\* for 192 samples + 12 references with lid piercing device
- Optimized for coupling\*: MS, FT-IR, GC-MS



TG 209 **F1 Libra**®

### TG 209 **F3 Tarsus**®

- Temperature range: RT to 1000°C
- Air-cooled
- Weighing range/sample load: 2000 mg
- TGA-resolution: 0.1 µg
- Gas-tight
- Atmospheres: inert, oxidizing
- c-DTA®
- SuperRes®\*
- AutoEvaluation\* and Identify\*
- Automatic sample changer\*: 20 samples
- Easy sensor change



TG 209 **F3 Tarsus**®



## STA 449 **F1/F3/F5** *Jupiter*® Series – The Result of 50 Years in Fulfilling Customer Requirements

The STA *Jupiter*® series combines DSC and TGA methods and is thus capable of measuring both heat flow and mass change. The application fields of the STA series include plastics, rubbers, resins, fibers, coatings, oils, ceramics, glass, cements, refractories, metals, fuels, pharmaceuticals, etc.

	<b>F1</b>	<b>F3</b>	<b>F5</b>
Temperature range	-150°C to 2000°C	-150°C to 2400°C	RT to 1600°C
Furnaces	9, incl. water-vapor, high-speed	9, incl. water-vapor, high-speed	SiC furnace
Sample weight, weighing range	5 g	35 g	35 g
TGA resolution	0.025 µg	0.1 µg	0.1 µg
Vacuum	10 <sup>-4</sup> mbar	10 <sup>-4</sup> mbar	10 <sup>-2</sup> mbar
Sensors	TGA, TGA-DSC, TGA-DSC-c <sub>p</sub> , TGA-DTA	TGA, TGA-DSC, TGA-DSC-c <sub>p</sub> , TGA-DTA	TGA, TGA-DSC, TGA-DTA
Temperature-modulation	Yes	–	–
Automatic sample changer*	20 samples	20 samples	20 samples
DSC-BeFlat®	Yes	Yes	–
Tau-R® Mode	Yes	Yes*	Yes*
TGA-BeFlat®	–	Yes* <sup>1</sup>	Yes
Glove box version	Yes	–	–

\* If configuration is compatible to STA 449 **F5**

## STA 2500 *Regulus*

This TGA-DTA analyzer uses a differential balance system which cancels out buoyancy and convection influences over a broad temperature range. Time-consuming correction measurements are no longer required.

- Temperature range: RT to 1600°C
- Top-loading
- Sample load (incl. crucible): 1 g
- Weighing range: ± 250 mg
- TGA resolution: 0.03 µg
- Vacuum: 10<sup>-4</sup> mbar
- Built-in mass flow controllers
- Low cost of ownership



STA 2500 *Regulus*



STA 449 **F1** *Jupiter*®  
with two furnaces

# THE NETZSCH NEVIO LINE – A NEW CONCEPT FOR UNPARALLELED EASE OF USE

Carrying out investigations in the fields of pharmacy, cosmetics or foodstuffs?  
Your top choice is the new NETZSCH Nevio instrument line.

## DSC 204 **F1** Nevio

Premium differential scanning calorimeter

- Various exchangeable sensors optimized for different applications
- Extremely efficient – automatic sample changer for up to 192 samples and 12 references, automatic piercing device\*
- Unsurpassable indium response ratio (outstanding sensitivity with simultaneous high resolution)

## DSC 214 Nevio

Heat-flux DSC with the fastest heating and cooling rates on the market

- Space-saving design
- Perfectly synchronized sensor/crucible arrangement for excellent reproducibility
- High sample throughput thanks to the automatic sample changer for up to 20 samples\*



DSC 204 **F1** Nevio



DSC 214 Nevio

NETZSCH – MORE THAN 60 YEARS OF EXPERIENCE IN  
MANUFACTURING TOP-CLASS THERMAL ANALYSIS DEVICES

\* Optional feature





## TG 209 **F1** Nevio

High-quality ultra-microbalance for research and development

- Vacuum-tight design
- Corrosion-resistant ceramic furnace
- c-DTA® for monitoring caloric effects
- Large filter system for direct trapping of decomposition products
- Pre-configured for coupling to gas analyzing systems (FT-IR, MS or GC-MS)
- High sample throughput for measurements over night or during the weekend – automatic sample changer for up to 192 samples and 12 references, automatic piercing device\*



TG 209 **F1** Nevio

## TG 209 **F3** Nevio

The workhorse for quality assurance and process optimization

- Robust and extremely reliable
- Variety of sample carriers for greatest flexibility
- c-DTA® for monitoring caloric effects\*
- Large filter system for trapping decomposition products\*
- Gas-tight design
- High sample throughput thanks to the automatic sample changer for up to 20 samples\*



TG 209 **F3** Nevio

## STA 449 **F3** Nevio

Specialized for demanding tasks

- Modular setup, adjustable to a variety of requirements, e.g., for measurements under relative humidity
- Vacuum-tight
- Pre-configured for coupling to gas analyzing systems (FT-IR, MS or GC-MS)
- Automatic sample changer for up to 20 samples\*



STA 449 **F3** Nevio

# DYNAMIC-MECHANICAL ANALYSIS

NETZSCH offers the widest range of Dynamic-Mechanical Analysis (DMA) instruments and testing machines for the investigation of the temperature-dependent visco-elastic properties by applying an oscillating force – up to the highest force range— to the sample. The product range includes flexometers, also for thermal fatigue tests of rubber materials and instruments for the measurement of the dynamic shore hardness or the adhesive properties (autohesion), for instance for rubber compounds before vulcanization.

## DMA 242 E Artemis® – The All-Rounder in the Lower Force Range

This all-rounder offers a high resolution of the deformation measuring system which enables precise measurements on both very rigid and very soft samples. The system offers a variety of deformation types, digital signal filtering, kinetic evaluation and frequency extrapolation.

- Temperature range: -170°C to 600°C
- Frequency range: 0.01 Hz to 100 Hz
- Modulus range:  $10^{-3}$  MPa to  $10^6$  MPa
- Force range: up to 24 N (static and dynamic)
- High resolution force range: 8 N
- Deformation modes: bending, tension, shearing, compression/ penetration
- Accessories\*: immersion bath, humidity generator (see picture), UV lamp, dielectric analyzer (DEA)
- Fast Fourier Transformation (FFT)



DMA 242 E Artemis®

## GABOMETER® Series – Tests up to 4000 N

The GABOMETER® series can be used as Goodrich flexometers for heat build-up tests and upgraded for fatigue tests in tension, compression and shear mode. The GABOMETER® fulfill: ASTM D623, DIN 53 533, ISO 4666/3, 4, BS 903 part A50 and JIS K 6265.

- Temperature range: -160°C to 300°C
- Sample diameter: 17.8 mm to <40 mm\*
- Sample thickness: 25 mm
- Force range: up to max. 4000 N
- Static strain: up to 60 mm\*
- Dynamic strain: up to  $\pm 10$ mm\*
- Automatic sample changer
- Compression set
- Heat build-up
- Blow out test
- Temperature measurements in the sample and on the surface
- Dynamic visco-elastic properties\*
- Tension flexometers\*



## EPLEXOR® Series High-Force DMA up to 6000 N

Various EPLEXOR® systems with different maximum forces and strains are available. A fully automatic testing instrument is realized by the automatic sample changer. The instruments are based on: DIN 53513, ISO 6721/1 und 4, ISO 6721/5, ISO 6721/6, ISO 4664, ASTM D4065, ASTM D4473.

- Temperature range: -160°C to 1500°C
- Two independent drives for static and dynamic load
- Force range: up to 6000 N
- Changeable force transducers
- Frequency range: 0.01 Hz to 200 Hz
- Deformation modes\*: bending, tension, shear, compression/penetration
- Accessories\*: immersion bath, humidity chamber, automatic sample changer
- Special sample holders\* for liquids, fibers or tire cord testing
- Tackiness extension



EPLEXOR® 500

## GABO DiPLEXOR® – Simultaneous DMA-DEA Analyzer

Simultaneous dielectric (DEA) and dynamic mechanical (DMA) analyses allow for the determination of dielectric material properties under different mechanical loads. The DMA part investigates the visco-elastic properties of substances such as carbon black-filled rubber blends and compounds, the DEA part the intrinsic structure and distribution of the cluster within the polymer.

- Dynamic force range: up to 500 N
- Static force range: up to 1500 N
- Dynamic deformation: up to  $\pm 1.5$  mm (3 mm); optional:  $\pm 6$  mm (12 mm<sup>1</sup>)
- Frequency of the dielectric broadband analyzer: 0.01 Hz up to 10 MHz

<sup>1</sup> peak-to-peak

# RHEOLOGY

Rheology is the study of flow and deformation of materials under applied forces which is routinely measured using a rheometer. The measurement of rheological properties is applicable to all materials from fluids such as dilute solutions of polymers and surfactants through to concentrated protein formulations, to semi-solids such as pastes and creams, to molten or solid polymers as well as asphalt.

## Kinexus Series

The Kinexus isn't just a rheometer – it is redefined the way it interacts with you. Kinexus is the next generation rotational rheometer platform that's been developed from extensive market feedback, integrating innovative instrument design with a revolutionary software interface, to deliver a solution that will exceed your rheological expectations. The Kinexus series includes standard rheometers (Kinexus lab+, Kinexus pro+) and rheometers for advanced testing (Kinexus ultra+).

- Temperature Range: -40°C to 350°C
- Torque Range: 0.5 nNm to 250 mNm, depending on instrument version
- Torque resolution: 0.05 nNm to 0.1 mNm, depending on instrument version
- Force Range: 0.001 N to 50 N



Kinexus ultra+



Kinexus DSR+

## Kinexus DSR Series – Especially for Asphalt Binder and Bitumen Testing

The Kinexus DSR Series is the next generation rotational rheometer platform for asphalt testing that's been developed from extensive market knowledge and feedback, integrating innovative instrument design with a revolutionary software interface, to deliver an intelligent solution that will exceed your rheological expectations.

- Temperature Range: -40°C to 350°C
- Torque Range: 1 nNm to 225 mNm
- Torque resolution: 0.1 nNm
- Force Range: 0.001 N to 50 N
- Heating Range: up to 50°C/minute





## Advanced Capillary Rheometers for Research, Product Development and Quality Control

### ROSAND RH7/RH10

The current RH7 and RH10 models retain the robust *H* frame design principle, which lies at the heart of the instruments' ability to operate under high loading conditions. A new digital drive system gives the RH7 and RH10 unsurpassed performance in terms of speed control, accuracy, and dynamic operating range. This hardware is supported by the latest generation of Windows® based software, Flowmaster™, with many new experimental possibilities.

- Temperature Range: Ambient to 400°C (500°C optional), 5°C to 200°C (low temperature cooling coil option)
- Force Range:
  - RH7: 50 kN
  - RH10: 100 kN
- Maximum Speed:
  - RH7: 600 mm/min
  - RH10: 1200 mm/min
- Bore diameter: 15 mm standard (9.5, 12, 19 and 24 mm bore options)



Rosand RH10



Rosand RH2000

### ROSAND RH2000

The Rosand RH2000 series of benchtop capillary rheometers are compact systems capable of most testing requirements encountered in capillary rheometry.

- Temperature Range: Ambient to 400°C (500°C optional), 5°C to 200°C (Low temperature cooling coil option)
- Maximum Speed: 600 mm/min standard (1200 mm/min high speed option)
- Bore diameter: 15 mm standard (9.5, 12, 19 and 24 mm bore options)



# THERMOMECHANICAL ANALYSIS

## DILATOMETRY

Many materials undergo changes to their thermomechanical properties when they are exposed to temperature changes, e.g., phase changes, sintering steps or softening which can occur in addition to thermal expansion. TMA analysis provides valuable insight into the composition, structure, or application possibilities for materials such as plastics, elastomers, paints, composites, adhesives, films, fibers, ceramics, glass, and metals. Dilatometry (DIL) is the method of choice to study length change phenomena of ceramics, construction materials, glasses, metals, etc.

### More than just Thermal Expansion – TMA 402 **F1/F3** Hyperion®

With its compact design and user-friendly operation, the TMA 402 sets new standards for the analysis of a variety of materials. The sample holder (for expansion, penetration, bending or tension measurements) is freely accessible once the top-mounted furnace has been raised. This ensures easy sample selection for fast measurement start.

- Temperature range: -150°C to 1000°C and RT to 1550°C via two interchangeable furnaces
- Measurements down to -70°C using mechanical cooling and down to -150°C using LN<sub>2</sub>
- Measurement of length change and corresponding force
- Vacuum-tight thermostatic measuring system
- Easily interchangeable sample holders made of fused silica or alumina
- Max. sample length 30 mm
- High resolution: 0.125 nm/digit
- Force range: 1mN to 4 N (only for **F1**, 3N for **F3**)
- Modulated force\* (only for **F1**)



TMA 402 **F3** Hyperion® Polymer Edition



## Dilatometry Redefined – DIL 402 *Expedis* Series

The dilatometer DIL 402 *Expedis* series offers state-of-the-art technology and is designed for a wide range of sophisticated applications. All instruments of the DIL *Expedis* series feature the revolutionary *NanoEye* measuring cell – a unique dimension in measuring range and accuracy.

### DIL 402 *Expedis Classic*

The *Classic* version stands out by its all-in-one design and ease of use which make it very suitable for routine measurements in the fields of ceramics, building materials and glasses.



DIL 402 *Expedis*® *Classic*

### DIL 402 *Expedis Select/Supreme*

The comprehensive, fully-equipped *Supreme* model and the upgradable *Select* type are designed for research & development and sophisticated industrial applications.



DIL 402 *Expedis*® *Supreme*

	<i>Classic</i>	<i>Select/Supreme</i>	<i>Supreme HT</i>
Temperature range	RT to 1150°C, RT to 1600°C	-180°C to 2000°C, Various furnaces	RT to 2800°C
Type	Single or double dilatometer	Single or double dilatometer	Single or double dilatometer
Measuring range	10 mm	25 mm/50 mm	50mm
<i>NanoEye</i>	Yes	Yes	Yes
$\Delta l$ resolution	2 nm/digit	1 nm/0.1 nm/digit	0.1 nm
Automatic sample length detection	Yes	Yes	Yes
Controlled contact	Yes	Yes	Yes
Force range	0.01 N to 3 N	0.01 N to 3 N	0.01 N to 3 N
Force modulation	–	Optional/yes	Yes
Sample length	0 to 52 mm	0 to 52 mm	0 to 52 mm
Vacuum-tightness	–	$\approx 10^{-5}$ mbar	$\approx 10^{-5}$ mbar

# EVOLVED GAS ANALYSIS – COUPLED TO THERMAL ANALYSIS

Our Thermal Analysis equipment incorporates vertical gas flow systems in the furnaces. This yields perfect gas transport in the natural upward flow direction and requires only low purge gas flow rates, resulting in low dilution of the evolved sample gases. Sensitive and complete detection and analysis of evolved gas species result from our many years of experience in coupling gas analyzers. The temperature range of the coupling is according to the coupled thermal analysis instrument.

## The All-Encompassing Coupling to Gas Chromatograph-Mass Spectrometer (GC-MS) and Infrared Spectrometer (FT-IR)

All vacuum-tight thermobalances (TGA) and Simultaneous Thermal Analyzers (STA) are the ideal basis for coupling with one or two evolved gas analyzers (EGA) – even when equipped with the automatic sample changer (ASC). Simultaneously recorded data about weight changes, enthalpy changes and evolved gases provides an optimum platform for comprehensive material characterization.

The coupling to thermal analyzers is possible in the following combinations: STA 449 **F1/F3/F5 Jupiter**® or TG 209 **F1 Libra**® + GC-MS+FT-IR, DSC 404 **F1/F3 Pegasus**® or DSC 204 **F1 Phoenix**® + MS+FT-IR.

- Analysis of decomposition steps
- Solid-gas reactions
- Evaporation, outgassing
- Detection of volatiles
- Analysis of additives
- Compositional analysis
- Analysis of aging processes
- Desorption behavior



Bruker INVENIO with external gas cell

STA 449 **F1 Jupiter**®

## *PulseTA*® – Quantification, Adsorption and Desorption

The unique *PulseTA*® is the perfect tool for achieving quantitative gas detection. It allows for the studying of gas-solid reactions and simplifies adsorption/desorption experiments.



Mass spectrometer

Gas chromatograph

PERSEUS® STA 449 **F1 Jupiter**®

\* Optional feature



## Mass Spectrometer Coupling via Capillary or SKIMMER

### STA 449 Jupiter® – QMS 403 Aëolos Quadro

The STA systems offer fast atmosphere adjustment, especially with very pure and non-oxidizing sample atmospheres.

- Optimized gas transfer
- No dead volume or cold spots
- Low dilution – high sensitivity
- Up to 300 u/512\* u
- 3D presentation of results
- Detection limit:  
> 100 ppb  
(gas dependent)



STA 449 **F1** Jupiter® coupled to QMS 403 Aëolos Quadro

### STA-MS SKIMMER Coupling

The MS SKIMMER coupling is the shortest possible solution for the transfer of gas from the sample to the QMS. All components of the system are heated to at least the sample temperature, thus preventing the possibility of any condensation. Even metal vapors are detected by this unrivalled coupling system.

- Temperature range: RT to 2000°C
- Mass range: 1 u to 512/1024 u
- Electron impact ionization
- MID, scan, scan/bar-graph
- Detection limit:  
> 100 ppb



STA 409 CD SKIMMER

## PERSEUS – Integrated FT-IR Coupling

### PERSEUS TG 209 F1/PERSEUS STA 449 F1/F3

The PERSEUS coupling is an alliance between the TG 209 **F1** Libra® or STA 449 **F1/F3** Jupiter® and a compact FT-IR spectrometer by Bruker Optics. Its design is both unprecedented and unmatched, and sets a benchmark for coupling techniques.

- Affordable gas analysis
- No separate transfer line
- Built-in heated gas cell
- Optimized low-volume design
- Space-saving



PERSEUS TG 209 **F1** Libra®

# THERMAL CONDUCTIVITY

Thermal conductivity is a significant thermophysical property and can be determined by means of heat flow meters or the Guarded Hot Plate.

## Accurate Thermal Conductivity Testing of Insulation Materials

### HFM 446 *Lambda* Series

The Heat Flow meter is suitable for insulation and building materials such as different fiber boards, loose fill fiberglass, cellular plastics, powders, foams, evacuated panels, etc.

- Temperature range of plates: -20°C to 90°C
- Thermal conductivity range<sup>1</sup>: 0.02 W/(m·K) to 2.0 W/(m·K)
- Thermal resistance range<sup>1</sup>: 0.02 to 3.0 (m<sup>2</sup>·K)/W
- Sample dimensions<sup>1</sup>: from 203 mm x 203 mm up to 611 mm x 611 mm and thickness up to 200 mm
- Repeatability: 0.5% (verified with NIST SRM 1450D)
- Four-corner thickness determination
- Variable contact force, density variation of compressible materials
- Based on ASTM C518, ISO 8301, JIS A1412, and EN 12667

<sup>1</sup> Depending on the instrument; when testing near the limits of these ranges, special precautions must be taken



HFM 446 *Lambda Small*



HFM 446 *Lambda Medium*



HFM 446 *Lambda Large*

\* Optional feature

## Absolute Measurement of the Thermal Conductivity by means of Guarded Hot Plate

All NETZSCH and NETZSCH TAURUS Instruments GHP systems are based on various international standards including ISO 8302, ASTM C177, EN 1946-2, EN 12664, EN 12667, and EN 12939.

### GHP 456 *Titan*®

For the absolute determination of the thermal conductivity, the GHP 456 *Titan*® is the ideal tool for researchers and scientists. It features outstanding reliability and accuracy.

- Temperature range<sup>1</sup>: from -160°C up to 600°C
- Accuracy: typically 2%
- Symmetric test configuration for one or two specimens
- Thermal conductivity range: 0 to 2 W/(m·K)
- Atmospheres: inert, oxidizing, vacuum
- Sample thickness: up to 100 mm
- Plate dimensions<sup>1</sup>: up to 500mm x 500mm
- 31 separately calibrated sheeted Pt-100 temperature sensors for optimum temperature measurement

<sup>1</sup> Depending on the instrument version



GHP 456 *Titan*®





## GHP 500 and GHP 600

Measuring devices of the GHP series (GHP 500/600/900) are robust cabinet devices which are especially suited for testing thicker specimens. Thanks to the integrated single board computer (SBC), the Lambda software and the high-resolution color touch display, the devices are very user-friendly.

- Measuring range\*: 0.005 to 2.0 W/(m·K)
- Specimen size (L x W): 500 mm x 500 mm/600 mm x 600 mm
- Temperature range:
  - Cooling plate: -15°C to 60°C
  - Heating plate: -5°C to 70°C
- Specimen thickness:
  - 1x 15 mm to 200 mm (1-specimen)
  - 2x 15 mm to 100 mm (2-specimen)

\* depending on material and thickness



GHP 500

## GHP 900 and GHP 900 S

The GHP 900 permits samples to be inserted into the test chamber from any side. The GHP 900 S offers a tiltable test chamber especially for insulating glass, e.g., windows and skylights. It is able to measure the thermal conductivity as a function of temperature and mounting angle. Both designs allow for the insertion of heavy and complex samples without damaging the measuring plates.

- Measuring range\*: 0.005 to 2.0 W/(m·K)
- Specimen size (L x W): 900 mm x 900 mm
- Temperature range:
  - Cooling plate: -10°C to 60°C
  - Heating plate: 0°C to 70°C
- Specimen thickness:
  - GHP 900:
    - 1x 15 mm to 280 mm (1-specimen)
    - 2x 15 mm to 140 mm (2-specimen)
  - GHP 900 S:
    - 1x 15 mm to 380 mm (1-specimen)
    - 2x 15 mm to 180 mm (2-specimen)

\* depending on material and thickness



# THERMAL DIFFUSIVITY

The characterization of highly conductive materials at cryogenic and moderate temperatures or ceramics and refractories at elevated temperatures is of high interest. Many challenges can only be met with precise knowledge of the thermal diffusivity and conductivity. One accurate and robust solution for the direct determination of the thermal diffusivity is offered by the Laser/Light Flash Methods (LFA). The thermal conductivity is then calculated by using the LFA results. The software already includes various corrections, calculation models and mathematical operations for improved evaluation of the LFA data.

## LFA 467 *HyperFlash*® Series – Optimized Field of View Between -100°C and 1250°C

The *HyperFlash*® series features an intelligent lens system, *ZoomOptics*, between the sample and the detector, an extremely fast data acquisition and a wide temperature range, which is handled by a single instrument setup, without changing either the detector or the furnace. These systems are capable of measuring thin films.

### LFA 467 *HyperFlash*®

- Temperature range: -100°C to 500°C
- Various cooling devices\*
- Thermal conductivity range: 0.1 W/(m·K) to 4000 W/(m·K)
- Light source: Xenon flash lamp
- Data acquisition: up to 2 MHz
- Min. measurement time (10 half times) down to 1 ms → for highly conducting and/or thin samples
- Max. measurement time up to 120 s → for low-conducting and/or thick samples
- Automatic sample changer for up to 16 samples (4 x Ø 25.4 mm, 6 x Ø 12.7, 16 x □ 10 mm)
- Special sample holders\*: liquids, pastes and powder, fibers, etc.
- Model wizard



LFA 467 *HyperFlash*®

### LFA 467 HT *HyperFlash*®

- Temperature range: RT to 1250°C
- Thermal conductivity range: 0.1 W/(m·K) to 4000 W/(m·K)
- Light source: Xenon flash lamp
- Data acquisition: up to 2 MHz
- Min. measurement time (10 half times) down to 1 ms → for highly conducting and/or thin samples
- Max. measurement time up to 120 s → for low-conducting and/or thick samples
- Vacuum: 10<sup>-5</sup> mbar (with turbo pump)
- High-speed mini-tube furnace for up to 4 specimens (4 x Ø 12.7 mm, 4 x □ 10 mm)
- Small foot print
- Model wizard



LFA 467 HT *HyperFlash*®

\* Optional feature



## LFA 457 MicroFlash®

This tabletop LFA system is suitable for the characterization of high-performance and standard materials in automobile manufacturing, aeronautics, astronautics and energy technology. Its innovative infrared sensor technology enables measurement of the temperature increase, even at lowest subambient temperatures.

- Temperature range: -125°C to 1100°C
- Thermal conductivity range<sup>1</sup>: 0.1 to 2000 W/(m·K)
- Vacuum: 10<sup>-2</sup> mbar
- Various specimen dimensions<sup>2</sup>:
  - : 6 x 6, 8 x 8 or 10 x 10 mm<sup>2</sup>,
  - Ø: 6, 8, 10, 12.7 or 25.4 mm;
  - thickness 0.1 mm to 6 mm
- Special sample holder for liquids, pastes, powders, fibers, lamellas, in-plane, etc.
- Automatic Sample Changer (ASC) for up to 3 samples
- Model wizard



LFA 457 MicroFlash®

## LFA 427

The LFA 427 is the most versatile instrument allowing tests on solids, powders, laminates, or even liquid metals and slags up to highest temperatures.

- Temperature range: -120°C to 2800°C
- Thermal conductivity range<sup>1</sup>: 0.1 W/(m·K) to 2000 W/(m·K)
- Vacuum: 10<sup>-5</sup> mbar
- Atmospheres: inert, oxidizing, reducing
- Sample dimensions<sup>2</sup>:
  - : 8 x 8 or 10 x 10 mm<sup>2</sup>,
  - Ø: 6, 8, 10 or 12.7 mm, 20 mm; thickness: 0.1 to 6 mm
- Special sample holder for liquid metals, slags, pastes, powders, etc.
- Model wizard



LFA 427

<sup>1</sup> Lower values possible, depending on sample's properties

<sup>2</sup> Special dimensions on request



# SEEBECK COEFFICIENT AND ELECTRICAL CONDUCTIVITY

NETZSCH offers an all-embracing product line for the determination of the thermophysical properties. When it comes to thermoelectrics, simultaneous determination of the Seebeck coefficient and electrical conductivity under identical conditions is of paramount importance for the determination of the figure of merit ( $ZT$ ).

## SBA 458 *Nemesis*® – Pushing the Limits for Thermoelectric Materials

The clever measurement setup of the SBA 458 *Nemesis*® with fixed thermocouple positions allows for the use of various sample geometries without the need for tools to insert and remove the sample. An outstanding two-heater system immediately identifies deviations in linearity and hysteresis in case of measurement inaccuracies.

- Temperature range: -125°C to 1100°C
- Integrated quality check by two-heater system
- Sample geometries: Square, round, rectangular, strips
- Sample dimensions:  
 Ø 12.7 mm to 25.4 mm  
 Length: 12.7 to 25.4 mm  
 Width: 2.0 to 25.4 mm  
 Thickness: 100 nm to 3 mm, depending on the material's thermophysical properties
- Plug-and-measure sample holder for easy sample change
- Vacuum-tight:  $10^{-2}$  mbar
- Thermocouples with fixed position
- Temperature setting range: Unlimited number of temperature steps



SBA 458 *Nemesis*®

\* Optional feature





## DIELECTRIC ANALYSIS

Dielectric Analysis (DEA, or Dielectric Thermal Analysis (DETA), is a technique for monitoring changes in the viscosity and cure state by measuring variations in the dielectric properties—even during processing. The DEA 288 *Ionic* series is used for most thermosets, adhesives, paints, and coatings, including fast-curing thermosets such as SMC/BMC and UV curing.

### DEA 288 *Ionic* Series – Clear-Cut Determination of the Curing Behavior

The DEA 288 *Ionic* covers a wide range of measurement frequencies in order to accurately determine the changes in dielectric properties during reaction. With their minimum data acquisition time of less than 5 ms, the instruments can handle fast curing systems such as UV curing.

#### Portable Version

With up to 7 channels, this DEA is the flexible version for your day-to-day work. It can be easily transported between different measurement locations.

- Frequency range: 1 mHz to 1 MHz, freely selectable values
- Temperature range: -140°C to 400°C (with furnace)
- True simultaneous operation of all channels
- Minimum data acquisition time: < 5 ms
- Wide spectrum of implantable and reusable sensors
- Accessories\*: furnace, press, and UV lamp

#### Rack Version for Integration into an Industrial Process

The 19" Rack version is designed for an electrical cabinet. It supports 8 simultaneous measuring channels which can be extended up to 16 modules.



DEA 288 *Ionic*: Portable version (left) and Rack version (right)





## REFRACTORIES TESTING

All NETZSCH refractories testing instruments conform to the pertinent instrument and applications standards, e.g., ISO 1893, ISO 3187, ISO 5013, DIN EN 993-7/8/9/12/14/15, DIN 51048, DIN 51053.

### Refractoriness Under Load (RUL) and Creep in Compression (CIC)

#### RUL/CIC 421

Refractoriness under load (RUL) is a measure of the resistance of a refractory product to deform when it is subjected to the combined effects of load, rising temperature, and time. Creep in compression (CIC) refers to the percent of shrinkage of a refractory test piece under a constant load and exposed to a constant high temperature over a long period of time. The RUL/CIC 421 allows for reliable RUL/CIC tests and precise dilatometer measurements on large and even inhomogeneous samples.

- Temperature range: RT to 1700°C
- Specimen size: Ø 50 mm, 50 mm height
- Load range: 1 N to 1000 N, in steps of 1 N and 100 N
- Test atmosphere: static air, inert gas purge\*



RUL/CIC 421

### Comprehensive Refractories Testing – Hot Modulus of Rupture

#### HMOR 422

Measuring the modulus of rupture of refractories at elevated temperatures has become a widely-accepted method of evaluating refractories at operating temperatures. Among others, it is a crucial parameter for quality control which gives information about the behavior of materials used for furnace linings.

- Temperature range: RT to 1500°C
- Chamber furnace with pre-heating zone
- Specimen dimensions:
  - HMOR 422 up to 1500°C: 150 mm x 25 mm x 25 mm
  - HMOR 422 E up to 1450°C: 45 mm x 4.5 mm x 3.5 mm
- Bending mode:
  - HMOR 422: 3-point, 4-point (422 E)
- Load range: 0 N to 5000 N
- Load rate: 10 to 2000 µm/min



HMOR 422

\* Optional feature

# ACCELERATING RATE CALORIMETRY

## BATTERY TESTING

Accelerating Rate Calorimeters help secure safe and cost-effective operations in industry. As highly versatile miniature chemical reactors, they measure thermal and pressure properties of exothermic chemical reactions. The resulting information helps engineers and scientists to identify potential hazards and address key elements of process safety design including emergency relief systems, process optimization, and thermal stability. For all NETZSCH Accelerating Rate Calorimeters with internal heaters, the patented *VariPhi*® option enables measurements at constant heating rates (exo/endo) and monitoring pressure data.

### Multi-Module Calorimeter

#### MMC 274 Nexus®

Interchangeable calorimeter modules of the MMC 274 Nexus® allow adiabatic and scanning tests accompanied by pressure measurements.

For coin cell studies a dedicated coin cell module is available. Data generated from the MMC test is merged seamlessly with the data generated from the cyclizer/analyzer.

- ARC and scanning module:
  - Tracking rate of 50 K/min
  - Temperature range: RT to 500°C
  - Max. pressure: 100 bar
- Max. tracking rate: 50 K/min
- Container volume: 0.1 to 8.5 ml
- Module for testing coin cells (e.g., CR2032):
  - Temperature range: RT to 300°C
  - Discharge tests, battery cycling



MMC 274 Nexus®

### Accelerating Rate Calorimeters – Tracking Exothermic Reactions

#### ARC® 244/254

The models allow to safely measure the amount and rate of heat release associated with the processing or storage of chemicals. In addition, the 254 model offers options for the stirring, venting, *VariPhi* and injection of chemicals.

- Temperature range: RT to 500°C
- Max. pressure: 200 bar
- Max. tracking rate:
  - ARC 244 20 K/min
  - ARC 254 200 K/min
- Sample volume: 0.5 ml to 7 ml



ARC® 244

# FIRE TESTING

For preventive fire protection, the appropriate choice of materials and components is essential in order to prevent fires completely or prevent them from spreading. Fire tests are according to German, European and international standards and used to classify the flammability and the burn rate of materials for the construction, textile, automobile and electrical industry. Material development and production should consider low flammability, prevention of rapid ignition and generation of the least possible amount of smoke.

## Preventive Fire Protection

The selection of materials is decisive for fire prevention and the spread of fire. Fire tests according to German, European and international standards for classifying the flammability and burn rate of materials for the construction, textile, automotive and electrical industries play a major role.

## Building Materials

The fire resistance of components and the fire reaction of building materials with the resulting parameters of flammability, flame spread, flaming droplets, flammability, heat release, calorific value, smoke production and toxicity are particularly important for the construction industry.

## Mobility

Tests in the field of mobility focus on the flammability and flame spread rate of materials are for the interior of vehicles (e.g., lining, trim, seats and floor coverings of aviation vehicles, railed and road vehicles, etc).

## Electrical Industry/Cable

Reactions to fire – especially issues such as flame spread and flaming droplets for electronic and electrical parts, smoke density, insulation integrity and the formation of corrosive gases upon flame impact for electrical, control and data cables.

## Textile Products

Upholstery fabrics, curtains and drapes, decorative materials, floor coverings and protective clothing are primarily tested and classified for flammability, reaction to fire, and dripping behavior.



UL 94 – Fire tester



TBB – Floor  
Radiant Panel



TNB –  
Non-Combustibility Tester



SBI – Single  
Burning Item



Product	KBT	SBI	TBB	TNB	KBK	TCC	UL 94	LOI	HBK	TRDA/ TRDL
Heat release	x	x				x				
Smoke development	x	x	x			x				x
Flame spread	x	x	x							
Flaming droplet	x	x					x			
Non-combustibility				x						
Ignitability					x					
Burning time/speed		x					x		x	
Time to ignition						x				
Mass loss						x				
Heat of combustion						x				
Combustion gas						x				
Oxygen index								x		
Euro classification/ Euro fire testing lab		x	x	x	x	x	x			Mostly integrated
Industry	Cables	Building	Building	Building	Building	Building, Automotive, Polymers	Electronics, Polymers	Polymers	Automotive	Single/ Stand-alone
Standards	EN 50399, IEC 60332-3	EN 13823	EN ISO 9239-1	DIN EN ISO 1182	DIN EN ISO 11925-2	ISO 5660-1, ASTM E 1354	UL 94, DIN EN 60695-11, ISO 9773	ISO 4589-2, DIN 22117, ASTM D 2863	MVSS 302, GB 8410, IS 15061, CMVSS 302, U.T.A.C. 18-502, FAR 25.853	DIN 50055



HBK – Horizontal Burner Box



TRDA – Smoke Density Tester with light measurement system



KBK – Small Burner Box



LOI – Oxygen Index Analyzer

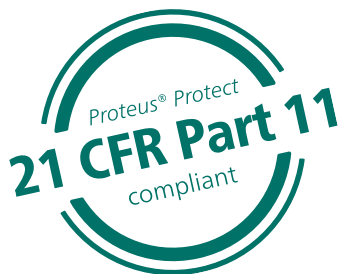


KBT – Fire Testing for Cables

# STANDARD AND ADVANCED SOFTWARE

One of the most complete and easy-to-handle software solutions in Thermal Analysis, *Proteus*®, has grown over the years. Developed by our experienced software team and tested by many application experts, this software for measurement and evaluation supports you with a practice-oriented structure, easy-to-understand user guidelines and a comprehensive help system.

## *Proteus*® – Measurement and Evaluation at its Best



- Multi-tasking system
- Combined analysis of different methods
- Storage and restoration of analyses
- *SmartMode*\* – features a clear structure, uniform navigation and user friendliness.
- Wizards contain a set of common pre-defined measurement methods
- User Methods allows users to save methods
- *Expert Mode*
- *AutoEvaluation* – allows for the evaluation – autonomously or at the push of a button – of unknown curves
- *Identify* – is a unique tool for automatic identification and interpretation of curves with only a single click. The database contains a NETZSCH library for typical polymers and can also be extended by adding the user's own materials.
- Automatic baseline correction
- *Purity Determination*
- *Tau-R*® mode (thermal resistance, time constant)
- Specific heat capacity ( $c_p$ )
- *c-DTA*® (calculated DTA for TGA and DIL)
- *Proteus*® *Protect* ensures data integrity and meets the requirements of 21 CFR Part 11 or EU Annex 11
- Rate-controlled mass change, *SuperRes*® (TGA), Rate-controlled sintering (DIL)
- Temperature-modulated DSC/TGA-DSC (STA)
- Context-sensitive help system
- ISO 9001 certified by BVQI





## Advanced Software\* – Extensions for Comprehensive Evaluation



### Temperature-Modulated DSC – TM-DSC

In TM-DSC, the underlying linear heating rate is superimposed by a sinusoidal temperature variation. The benefit of this procedure is the chance to separate overlapped DSC effects by calculating the reversing and the non-reversing signals. The reversing

heat flow is related to the changes in specific heat capacity (e.g., glass transition) while the non-reversing heat flow corresponds to temperature-dependent phenomena such as curing, dehydration or relaxation.

### Kinetics Neo and "Kinetics as a Service"

This software module creates kinetic models of chemical processes based on a series of laboratory measurements under different temperature conditions. It can be used to predict the behavior of chemical systems under user-defined conditions for process optimization.

With "Kinetics as a Service", we offer a complete package for measurements, interpretations and solutions for your process optimization.

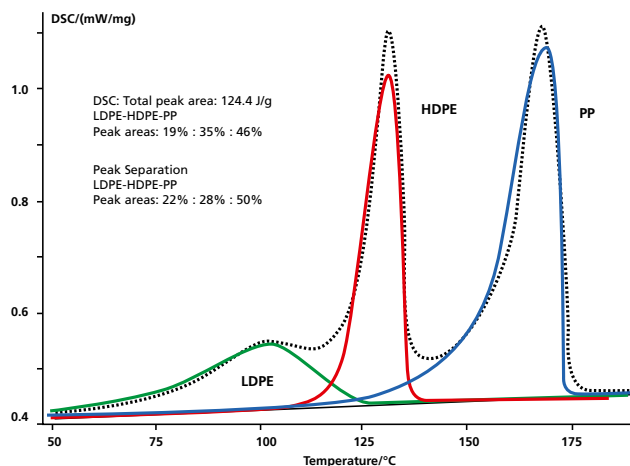
A thermokinetics analysis makes it possible to determine the number of reaction steps and the following values for each step:

- Reaction type
- Activation energy
- Order of reaction
- Other kinetic parameters



### Peak Separation

This program allows for the separation of overlapped peaks using profiles from the following peak types: Gaussian, Cauchy, pseudo-Voigt (linear combination of Gaussian and Cauchy), Fraser-Suzuki (asymmetric Gaussian), modified Laplace (double-sided rounded) and Pearson. With it, the experimental data is fitted as an additive superposition of peaks.





# Expertise in Service

## Our Expertise – Service

All over the world, the name NETZSCH stands for comprehensive support and reliable service, before and after sale. Our qualified personnel from the technical service and application departments are always available for consultation.

In special training programs tailored for you and your employees, you will learn to tap the full potential of your instrument.

To maintain and protect your investment, you will be accompanied by our experienced service team over the entire life span of your instrument.

## Our Expertise – Applications Laboratories

The NETZSCH Thermal Analysis applications laboratories are a proficient partner for nearly any Thermal Analysis issue. Our involvement in your projects begins with proper sample preparation and continues through meticulous examination and interpretation of the measurement results. Our diverse methods and over 30 different state-of-the-art measuring stations will provide ready-made solutions for all your thermal needs.

Within the realm of thermal analysis and the measurement of thermo-physical properties, we offer you a comprehensive line of the most diverse analysis techniques for materials characterization.

Measurements can be carried out on samples of the most varied of geometries and configurations. You will receive high-precision measurement results and valuable interpretations from us in the shortest possible time. This will enable you to precisely characterize new materials and components before actual deployment, minimize risks of failure, and gain decisive advantages over your competitors.

### TECHNICAL SERVICE



Maintenance  
and Repair



Software  
Updates



Exchange  
Service



IQ/OQ  
Documents



Calibration  
Service



Spare Part  
Assistance



Moving  
Service

### TRAINING



Training




Comprehensive  
Instrument and  
Method Training

### LABORATORY



Application Service  
and Contract Testing



The NETZSCH Group is an owner-managed, international technology company with headquarters in Germany. The Business Units Analyzing & Testing, Grinding & Dispersing and Pumps & Systems represent customized solutions at the highest level. More than 3,700 employees in 36 countries and a worldwide sales and service network ensure customer proximity and competent service.

Our performance standards are high. We promise our customers Proven Excellence – exceptional performance in everything we do, proven time and again since 1873.

When it comes to Thermal Analysis, Calorimetry (adiabatic & reaction), the determination of Thermophysical Properties, Rheology and Fire Testing, NETZSCH has it covered. Our 50 years of applications experience, broad state-of-the-art product line and comprehensive service offerings ensure that our solutions will not only meet your every requirement but also exceed your every expectation.

## Proven Excellence.■

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