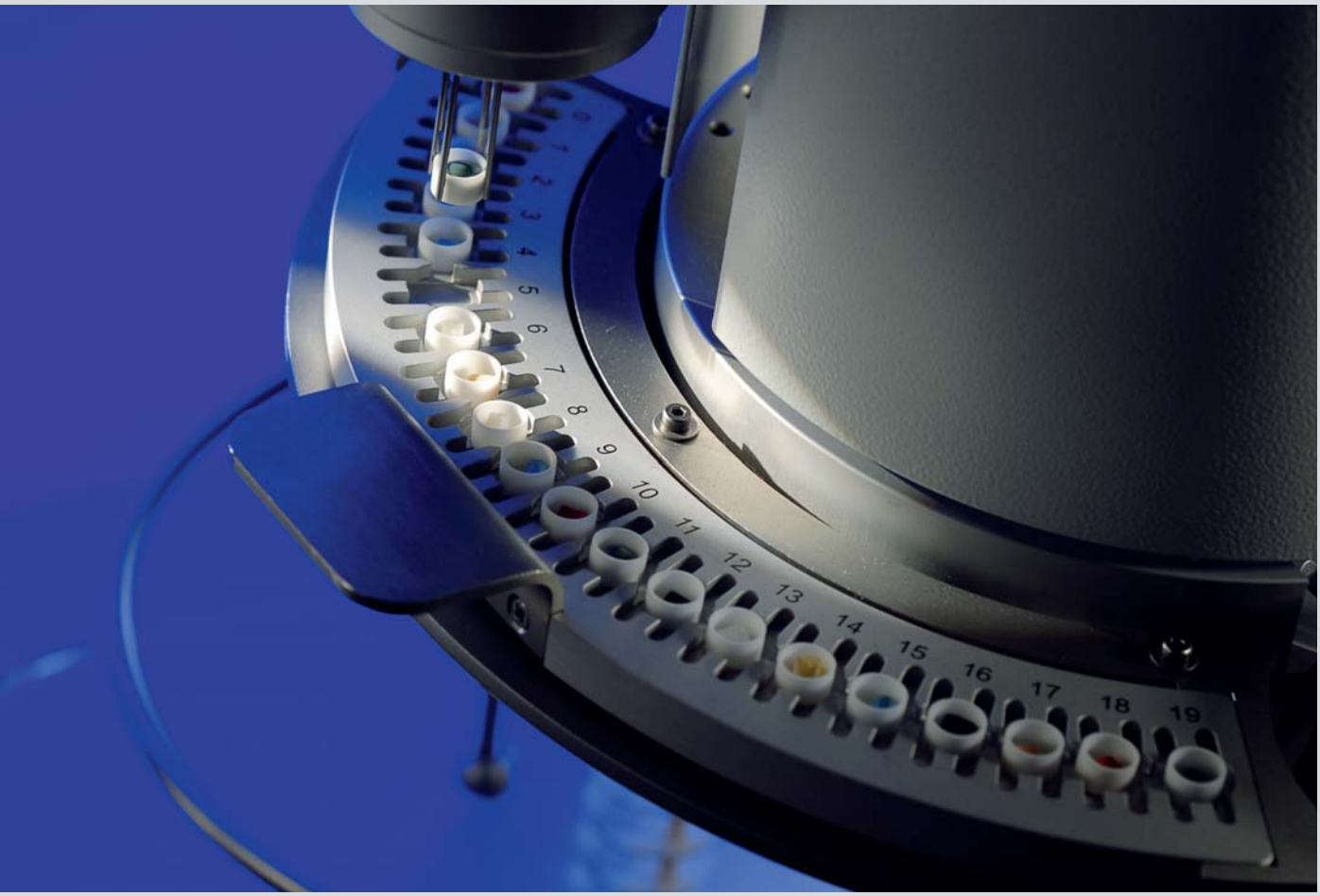
NETZSCH

Simultaneous Thermal Analysis



STA 449 ***F1***

Jupiter®

Leading Thermal Analysis.

STA 449 ***F1*** *Jupiter*® – Introduction to the Method

For over 45 years, NETZSCH Analyzing & Testing has been a leading manufacturer of high-performance thermal analysis systems – flexible, sophisticated and technically outstanding. Our customers' wishes and requirements are our guidelines. This, combined with experience and innovation, allows us to consistently set new benchmarks and standards in the field of thermal analysis instrumentation. Our success is a result of the creativity and enthusiasm of our engineers and scientists and our close cooperation with you as our customer.

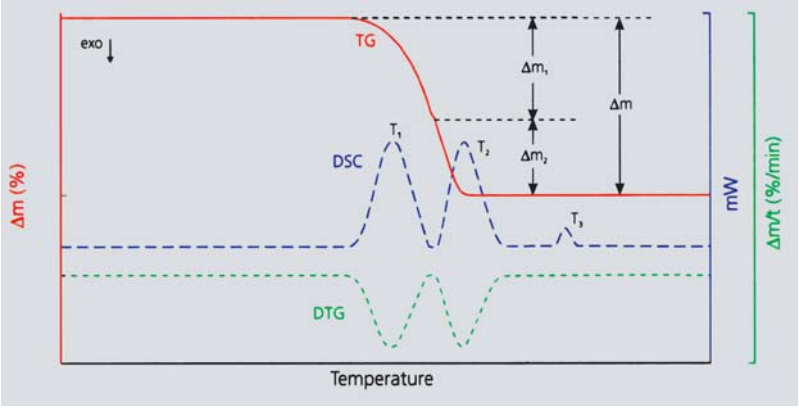
Simultaneous Thermal Analysis generally refers to the simultaneous application of Thermogravimetry (TG) and Differential Scanning Calorimetry (DSC) to one and the same sample in one instrument. The advantages are obvious: The test conditions are perfectly identical for the TG and DSC signals (same atmosphere, gas flow rate, vapor pressure on the sample, heating rate, thermal contact to the sample crucible and sensor, radiation effect, etc.). Furthermore, it improves sample throughput as more information is gathered from each test run. Since the early years of its existence, NETZSCH has given high priority to the development and continuing optimization of its Simultaneous Thermal Analyzers yielding the new STA 449 ***F1*** *Jupiter*®. It meets nearly all respective instrument and application standards for TG and DSC systems including: ISO 11357, ISO 11358, ASTM E 967, ASTM E 968, ASTM E 793, ASTM D 3895, DIN 51004, DIN 51006, DIN 51007.

DSC analysis possibilities:

- Melting/crystallization behavior
- Solid-solid transitions
- Polymorphism
- Degree of crystallinity
- Glass transitions
- Cross-linking reactions
- Oxidative stability
- Purity determination
- Specific heat
- *Thermokinetics*

TG analysis possibilities:

- Mass changes
- Temperature stability
- Oxidation/reduction behavior
- Decomposition
- Corrosion studies
- Compositional analysis
- *Thermokinetics*



Measured signals in an STA

Simultaneous Thermal Analyzer STA 449 ***F1*** *Jupiter*®

The NETZSCH STA 449 ***F1*** *Jupiter*® allows determination of caloric effects (transformation temperatures and enthalpies) and mass changes at the same time with outstanding reliability, resolution and accuracy. The top-loading Simultaneous Thermal Analyzer can easily be adjusted to almost any application by selecting the optimum furnace, installing the ideal sensor and using the proper accessories. It combines a high-performance Heat-Flux DSC with the world's first Thermo-Nanobalance, offering top-level DSC sensitivity and resolution with a high accuracy, long-time stable and top-resolution thermo-balance.

The STA 449 ***F1*** *Jupiter*® comprises a balance system representing the new benchmark for high-performance thermobalances and a DSC system capable of even specific heat measurements over an unmatched temperature range. The system can operate from -150°C to 2000°C using various interchangeable sensors and furnaces. The optional double furnace hoist or automatic sample changer (ASC) system can improve sample throughput and the ASC allows operation during the night or over the weekend.

The STA 449 ***F1*** *Jupiter*® offers highest TG resolution (0.025 µg, 25 ng) combined with a broad measurement range of 5 grams. The various DSC sensors offer true DSC performance over an unmatched temperature range (-150…1750°C). Small phase transitions as well as specific heat can be analyzed with high accuracy.

The vacuum tight design, along with high resolution, metal housed MFC systems, make the system an ideal tool for top-level TG and DSC research in academia and industry.

This fully equipped thermal analyzer can easily analyze small amounts of a new active pharmaceutical substance, minimal contaminations on a semiconductor waver, electronic component or medical implant, or deviations in the composition of an inorganic mixture. Try out our STA 449 ***F1*** *Jupiter*® and see the difference.

For evolved gas analysis, the system can be coupled to a QMS or FTIR system – or to both at the same time – even if equipped with an automatic sample changer.

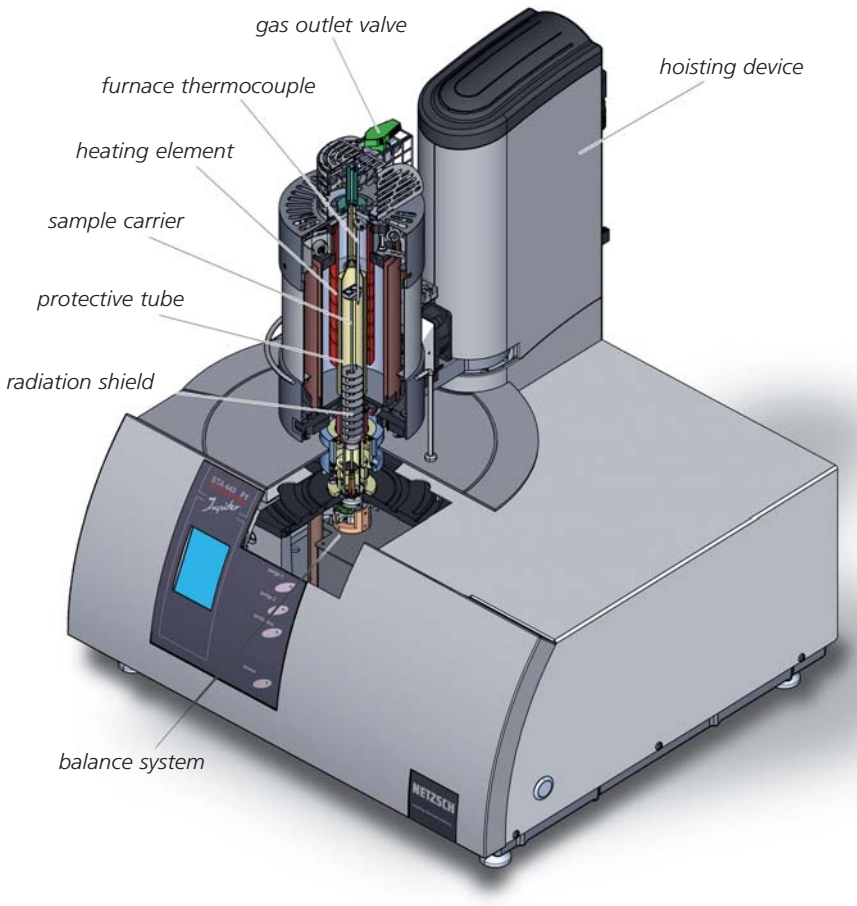
STA 449 ***F1*** *Jupiter*® – Groundbreaking Technology

Top-Loading – the standard for balance systems

The STA 449 ***F1*** *Jupiter*® is a top-loading system using a balance design that has been standard for a long time for other types of scales – in laboratories and even in the kitchen at home or in a supermarket, most balances have been top-loading for decades. The reasons are simple. These systems combine ideal performance with easy handling. Why should your thermobalance be any different?

The world's first Nanothermobalance

The STA 449 ***F1*** *Jupiter*® comprises a balance system representing the new benchmark for high-performance thermobalances. The system allows measurements on samples of up to 5 grams in weight and up to 5 ml in volume. Therefore, most complications resulting from sample inhomogeneity are simply eliminated by the large sample sizes that the STA 449 ***F1*** *Jupiter*® is capable of analyzing. You only have small sample masses available? No problem. The STA 449 ***F1*** *Jupiter*® is the first commercial thermobalance with a digital resolution in the nano range (0.025 µg). This resolution spans the entire measurement range (5 grams). Further outstanding features of the balance section of this STA include lowest noise in the range of only a few digits and a microgram stability over hours.



Vacuum tight design – optimal atmosphere control

The STA 449 ***F1*** *Jupiter*® is vacuum-tight by design. Practically every component is designed to fulfill the requirements of high vacuum applications. Using a turbo molecular pump system, vacuum levels better than 10^{-4} mbar can be reached. The OTS™ accessory can be used to reduce the oxygen concentration at the sample below 1 ppm. This, together with the built-in mass flow control system (MFC) for purge and protective gases, offers optimum control of the atmosphere around the sample (e.g. pure inert conditions). This is crucial for an accurate interpretation of the measured effects, e.g. to differentiate between oxidation and decomposition reactions.

Various furnace systems

The STA 449 ***F1*** *Jupiter*® can be equipped with a wide range of different furnaces accommodating different temperature and application ranges. A double furnace hoist allows the simultaneous installation of two different furnaces for improved sample throughput or low- and high-temperature tests on the same instrument. The furnaces can easily be changed by the operator. Therefore, the system is adaptable to any future application range.

Furnaces:

Furnace type	Temperature range	Cooling system
Steel furnace	-150 ... 1000°C	liquid nitrogen
Platinum furnace	RT ... 1500°C	forced air
Silicon carbide furnace	RT ... 1550°C	forced air
Rhodium furnace	RT ... 1650°C	forced air
Graphite furnace	RT ... 2000°C	tap water
Water vapor furnace	RT ... 1300°C	forced air

Various sensors

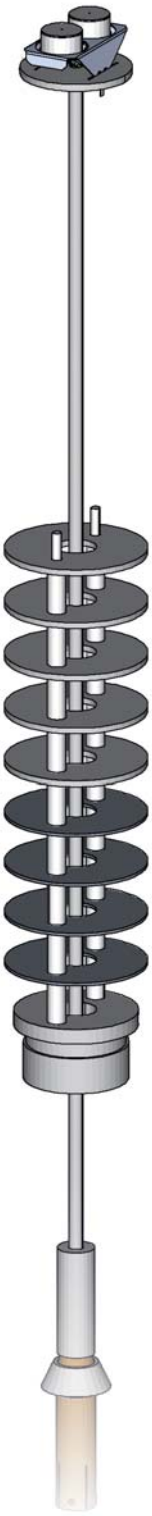
The STA 449 ***F1*** *Jupiter®* can be equipped with different sensor types. TG sensors with plates or large crucibles (up to 5 ml) allow tests on large sample volumes and masses. TG-DTA sensors can be used for applications such as routine tests or measurements on aggressive sample substances. The TG-DSC and TG-DSC-c_p sensors are used for most tests and allow quantitative DSC testing simultaneous to the TG runs. The c_p versions additionally allow determination of the specific heat with high accuracy. For special applications such as tests under corrosive atmospheres, the protected sensors can be employed. The Fast-Fix connection of the sensors to the instrument allows sensors to be changed within seconds. The system can therefore easily be adapted among the various required applications.

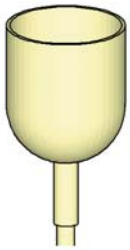
Automatic sample changer

An automatic sample changer for up to 20 samples is optionally available. The sample changer guarantees optimum crucible placement and effective use of the instrument. Pre-programming allows measurements to be carried out during the night or over a weekend.

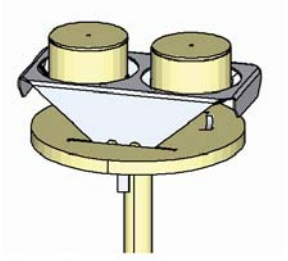
***BeFlat®*, DSC correction and TM-DSC**

Innovative software features such as *BeFlat®* and DSC correction allow a fully automatic baseline correction as well as correction for system time constants. All routines are fully software based and can be optimized for your specific measurement conditions. Furthermore, the raw data signal can be accessed at any time. The STA 449 ***F1*** *Jupiter®* is the first simultaneous thermal analyzer capable of doing modulated DSC measurements (The feature is not available in North America and in Japan).

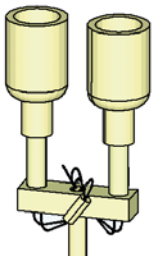




TG



DSC-c_p



DTA

Sensors:

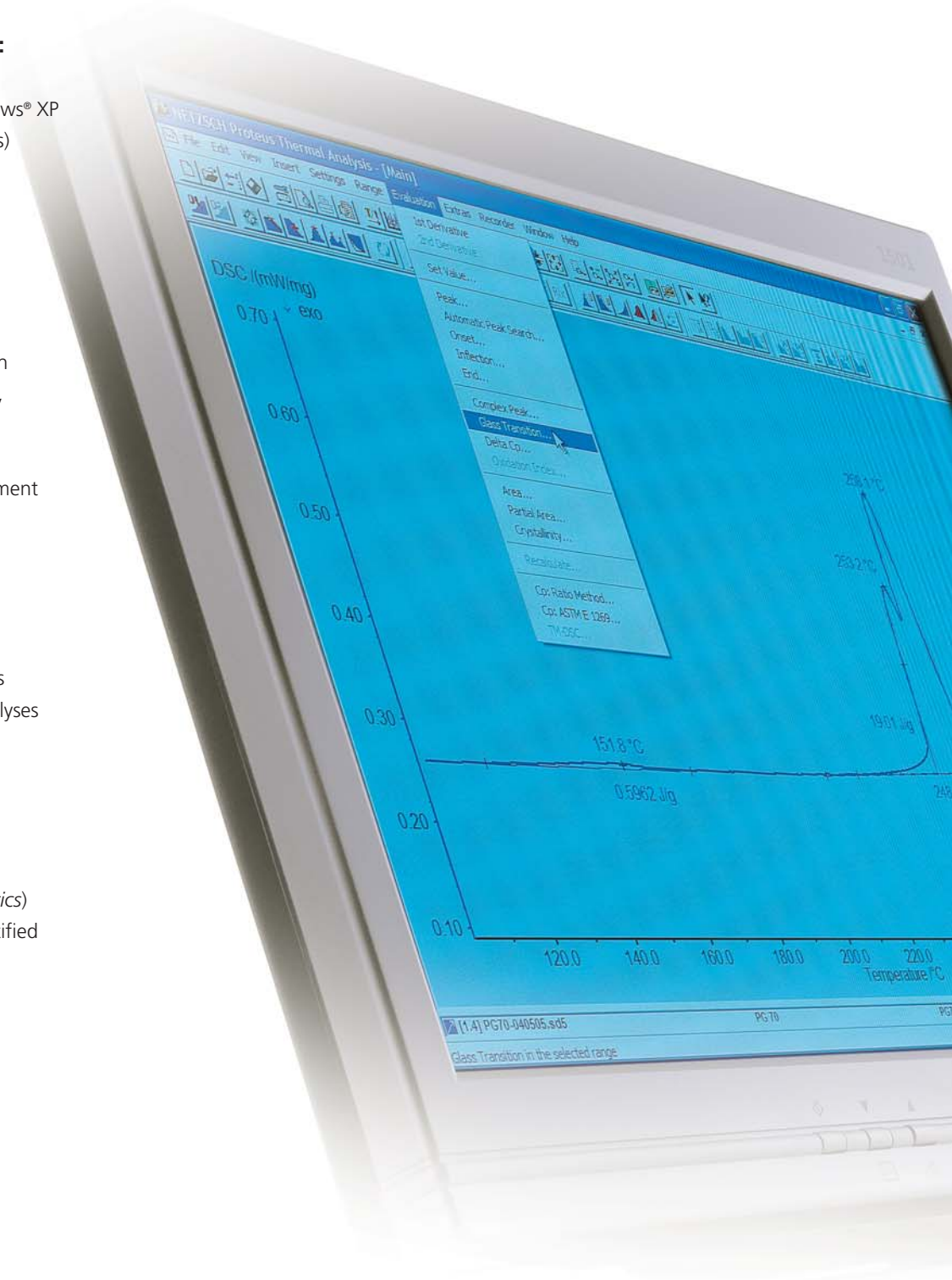
Sensor thermocouple	Temperature range	Sensor types	Atmospheres
Type E	-150 ... 700°C	TG, TG-DTA, TG-DSC (c_p)	inert, oxid., vac.
Type K	-150 ... 800°C	TG, TG-DTA, TG-DSC (c_p)	inert, oxid., red., vac.
Type S	RT ... 1650°C	TG, TG-DTA, TG-DSC (c_p)	inert, oxid., red., vac.
Type B	150 ... 1750°C	TG, TG-DTA, TG-DSC	inert, oxid., red., vac.
Type W	RT ... 2000°C	TG, TG-DTA	inert, red., vac.
Type S protected	RT ... 1600°C	TG, TG-DTA	inert, oxid., red., vac., corr.

STA 449 ***F1*** *Jupiter*® – *Proteus*® Software

The STA 449 ***F1*** *Jupiter*® runs under a 32-bit Windows® software package which includes everything you need to carry out a measurement and evaluate the resulting data. Through the combination of easy-to-understand menus and automated routines, a tool has been created that is extremely user friendly and, at the same time, allows sophisticated analysis.

General Software Features:

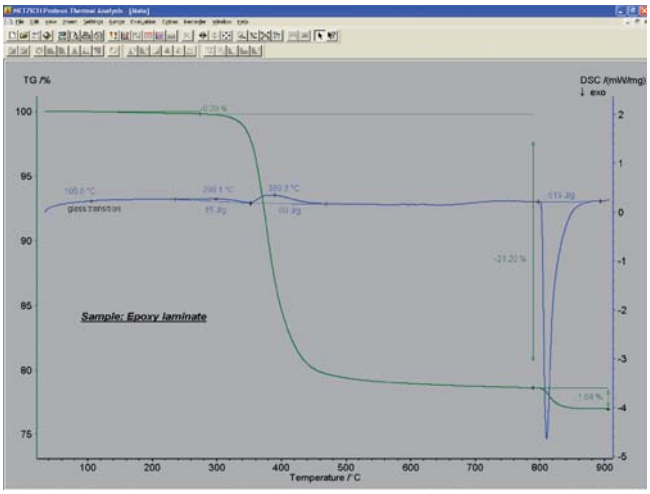
- Windows® software: for Windows® XP and Vista® (Enterprise, Business) operating systems
- Multi-tasking: simultaneous measurement and evaluation
- Multi-moduling: operation of different instruments with one computer
- Combined analysis: comparison and/or evaluation of STA, DSC, TGA, DIL, TMA and DMA measurements in one plot
- Labeling: input and free placement of text elements
- Calculation of 1st and 2nd derivative
- Selectable scaling
- Graphic and data export
- Selectable colors and line types
- Storage and restoration of analyses
- Macro recorder (optional)
- Context-sensitive help system
- Temperature calibration
- Compatible with advanced software packages (Peak Separation, *Thermokinetics*)
- Software produced by ISO-certified company



Certified ISO 9001 by

DSC Features:

- Determination of onset, peak, inflection and end temperatures
- Automatic peak search
- Transformation enthalpies: analysis of peak areas (enthalpies) with selectable baseline and partial peak area analysis
- Comprehensive glass transition analysis
- Automatic baseline correction
- Degree of crystallinity
- O.I.T. (oxidative induction time) evaluation
- Specific heat determination
- *BeFlat®* for automatic baseline correction
- DSC correction: evaluation of exo- and endothermal effects under consideration of system time constants and thermal resistance values



TG Features:

- Mass changes in % or mg
- Automatic evaluation of mass change steps
- Determination of the residual mass
- Extrapolated onset and endset
- Peak temperatures of the 1st and 2nd derivatives of the mass change curve
- Automatic baseline correction
- c-*DTA®* for the calculated DTA signal with evaluation of characteristic temperatures and peak area (optional for TG measurements)

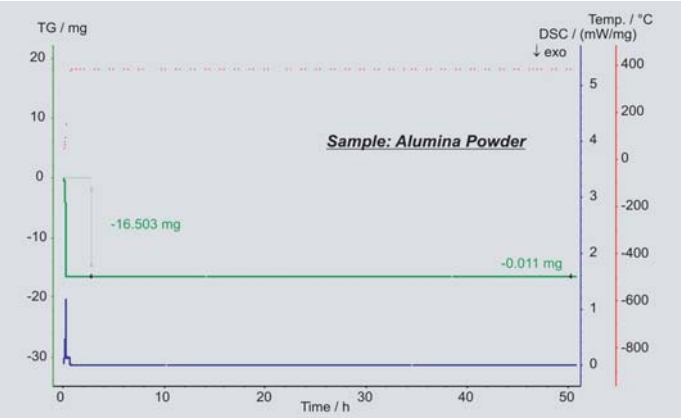
Advanced Software (options)

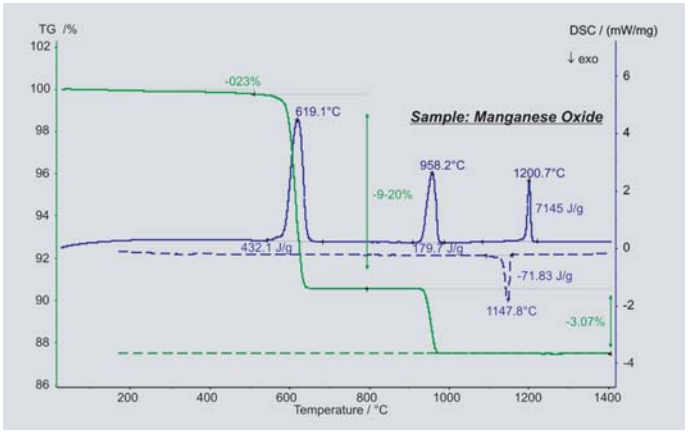
- TM-DSC module software extension for temperature-modulated DSC tests (This feature is not available in North America and Japan.)
- Peak Separation Software: allows accurate separation and evaluation of overlapping transitions
- NETZSCH *Thermokinetics*: allows advanced characterization of reactions and kinetic parameters on the basis of multiple-step kinetic analysis on up to 16 curves, also provides predictions of the process
- Purity determination
- *Proteus®Pharm™* allows measurements and evaluations according to 21 CFR Part 11

STA 449 ***F1*** *Jupiter*® – Applications

Excellent long-term stability

While heating an alumina powder sample (initial mass of 120.0 mg) to 400°C, a mass loss of 16.50 mg occurred caused by the evaporation of humidity. This was accompanied by an endothermic DSC peak. During the 50-hour isothermal phase, the mass changed by only 11 micrograms demonstrating the excellent long-term stability of the balance system.



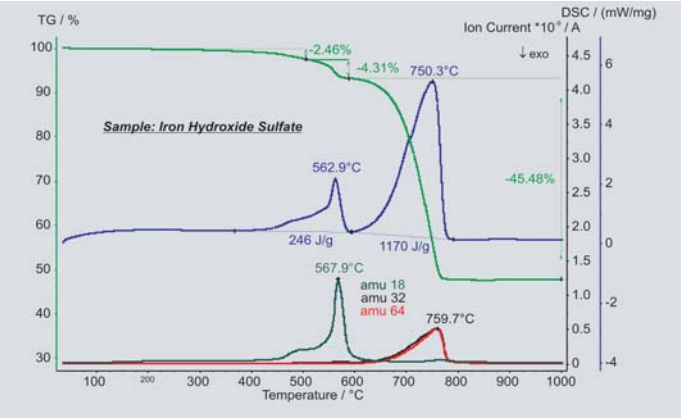


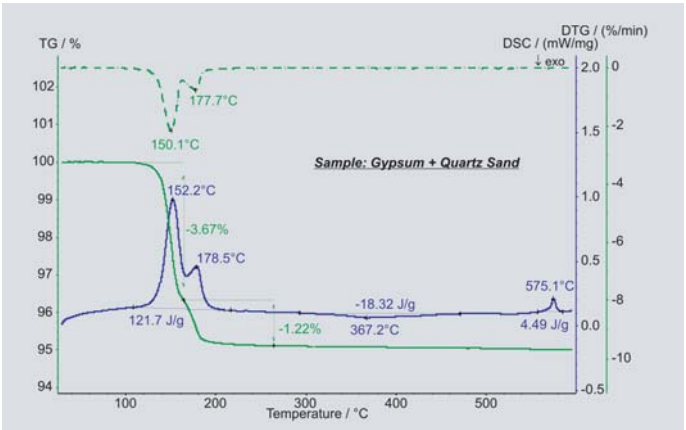
Reduction of manganese dioxide

Manganese dioxide (MnO_2) is often used in chemistry as an oxidizer but is also used, for example, as a cathode material in batteries. This STA measurement shows mass loss steps at approx. 600°C and 950°C which are due to the reduction of MnO_2 into Mn_2O_3 and finally into Mn_3O_4. The values of 9.20% and 3.07% match the stoichiometrical values exactly, thus reflecting the high accuracy of the balance system. Endothermic DSC peaks with enthalpies of 432 J/g and 180 J/g were detected during the reduction steps. The endothermic DSC peak at 1201°C is due to a reversible structural transformation of Mn_3O_4 which was observed at the peak temperature of 1148°C upon cooling (dashed lines).

Decomposition of iron hydroxide sulfate

Iron hydroxide sulfate $Fe(OH)SO_4$ is a possible base material for the synthesis of iron oxide particles. These can be used, for example, as a pigment or as a magnetic storage medium. So called ferrofluids contain superparamagnetic iron oxide nanoparticles which can serve as a contrast agent for MRI. Below 600°C, the STA-MS measurement exhibits a two-step release of H_2O with mass number 18, and between 600°C and 800°C, a release of SO_2 and O_2 with mass numbers 64 and 32, respectively. The final product is Fe_2O_3 (hematite).





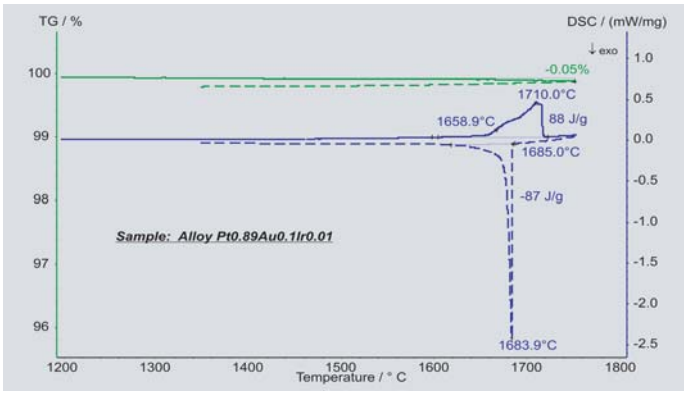
Building materials: gypsum and quartz sand

Gypsum and quartz sand are often used in building materials such as plaster and mortar. The gypsum part of the sample shows a two-step dehydration below 250°C from $CaSO_4 \cdot 2H_2O$ (dihydrate) into $CaSO_4 \cdot 1/2H_2O$ (half-hydrate) and finally into $CaSO_4$ (anhydrite). This requires a total energy of 122 J/g. Quantitative analysis reveals that the gypsum was a pure dihydrate with a mass fraction of 23.4% in the sample. Between approx. 300°C and 450°C, the exothermic formation of β-$CaSO_4$ with a released energy of 18.3 J/g occurred. The endothermic effect at an extrapolated onset temperature of 573°C is due to the structural $\alpha \rightarrow \beta$ transition of quartz (crystalline SiO_2).

STA 449 ***F1*** *Jupiter*® – Applications

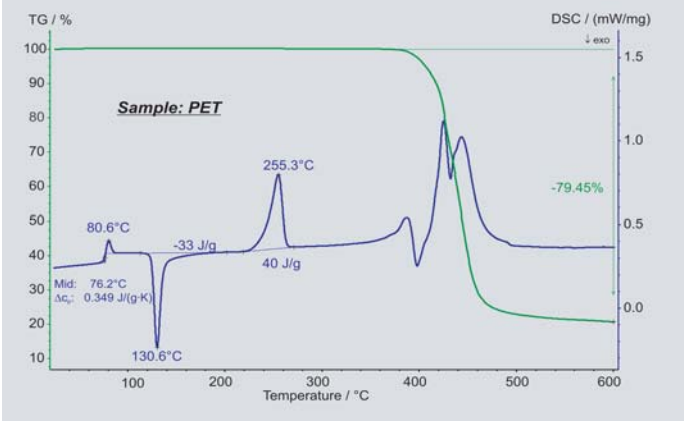
Phase diagrams of alloys

$Pt_{0.89}Au_{0.1}0\ Ir_{0.01}$ is a possible dental alloy generally used for inlays, crowns and bridges. Dental alloys must be shapeable but robust, corrosion-resistant and biocompatible. The measurement shows an endothermic DSC effect with an enthalpy of 88 J/g beginning at an extrapolated onset temperature of 1659°C upon heating (solid lines). This effect is due to melting. Upon cooling (dashed lines), an exothermic DSC peak (peak temperature 1684°C) with an enthalpy of -87 J/g occurred at 1685°C onset temperature due to recrystallization of the alloy. The mass loss of 0.05% observed at highest temperatures may be due to the start of evaporation.



Plastics

Plastic bottles, textile fibers and films (for example packaging for food) are well known applications of the polymer PET (polyethylene terephthalate). The STA measurement under nitrogen exhibits a step in the DSC signal below 100°C which is due to the glass transition. A corresponding increase in specific heat of 0.35 J/(g·K) was detected. The endothermic DSC peak at 81°C is due to relaxation, the exothermic peak at 131°C is due to crystallization and the endothermic peak at 255°C is due to melting. At temperatures above 360°C, the pyrolytic decomposition of the sample occurred with an entire mass loss of 79.5%.



STA 449 ***F1*** *Jupiter*® – Servicing Our Customers' Special Needs

Accessories

A wide range of crucibles (aluminum, silver, gold, copper, platinum, alumina, zirconia, graphite, stainless steel, etc.) is available for nearly all possible applications and materials.

For working in critical atmospheres, a "CO version" of the STA 449 ***F1*** *Jupiter*® can be supplied. This version is optimized for measurements under corrosive or reducing atmospheres. Gas flow control systems are prepared in a separate box and special sensors with protected thermocouple wires are available.

For measurements on difficult samples or radioactive substances, the STA 449 ***F1*** *Jupiter*® can be prepared for installation in a glove box or hot cell. Electronics are removed from the measurement part and all cables and fittings are prepared for connection to an existing feedthrough.

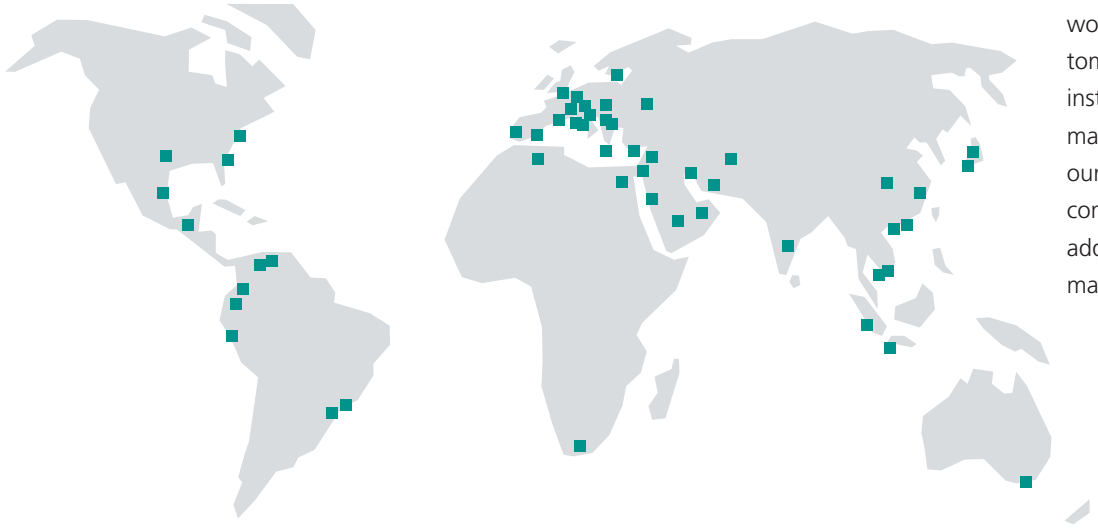
If you have any other special application or test condition, ask us! Our engineers are prepared to develop special versions of instrumentation or software with your requirements in mind.

Global Customer Support & Service Network

State-of-the-art technology combined with optimal customer support are NETZSCH trademarks. Our training department provides a complete range of programs tailored to the needs of our customers in research, education and industry.

A wide range of different seminars, users' meetings and individual training programs is available to assist you in achieving optimum performance and benefit from your thermal analysis system.

NETZSCH is the fastest growing company in the field of thermal analysis and thermophysical properties testing in the world. This can be attributed not only to our superior technology and quality, but also to our unmatched pre- and after-sales service network. NETZSCH-certified staff at 45 service centers across the world provide fast and reliable customer support including qualified installation, calibration services, and maintenance contracts. In addition, our applications laboratories offer contract testing and support to address the most specific of thermal analyses.



Jupiter®

Advantages in STA Testing

The new STA 449 ***F1*** *Jupiter*® is the ideal tool for day-to-day work in your laboratory. The system is generally employed for:

- Top-level research
- Material development
- Quality assurance
- Failure analysis

The key features of the STA 449 ***F1*** *Jupiter*® are:

- Maximum flexibility
- Top quality
- Optimum performance
- Wide range of accessories
- Low cost of ownership

The STA 449 ***F1*** *Jupiter*® is part of the NETZSCH high-temperature series of instruments. Together with the DIL 402 PC/C (dilatometer), the TMA 202/402 (thermomechanical analyzer), the DMA 242 C (dynamic mechanical analyzer), the DSC 404 *Pegasus*® (differential scanning calorimeter), the DEA 230/231 series (dielectric analyzers) for cure monitoring, and other DSC and TGA systems, a full-scale thermal analysis of your materials and parts can be carried out.

NETZSCH offers a full range of low- and high-temperature thermal analysis instruments for temperatures between -260 and 2800°C, including all conventional thermal analysis systems.

For thermophysical properties testing (measurement of the thermal diffusivity/conductivity), NETZSCH offers a broad range of heat flow meters (HFM), guarded hot-plate systems (GHP), flash devices (LFA) and other thermal conductivity testers (TCT systems).

Technical specifications subject to change

Leading Thermal Analysis.

NGB · STA 449 F1 · E · 1000 · 0708 · MMM

NETZSCH

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