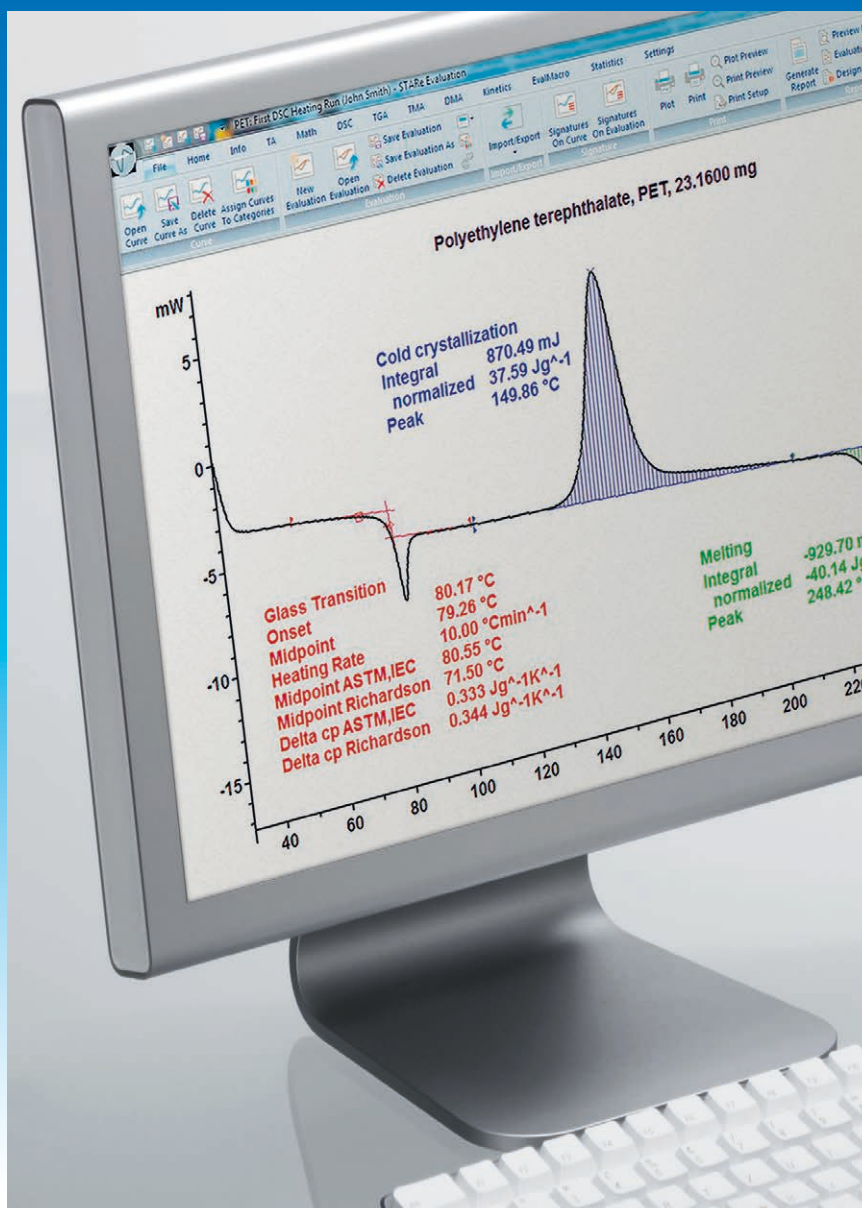


Thermal Analysis Excellence



STAR[®] Excellence Software

Innovative Technology

Versatile Modularity

Swiss Quality

STAR[®] Software

The Standard in Thermal Analysis

METTLER TOLEDO

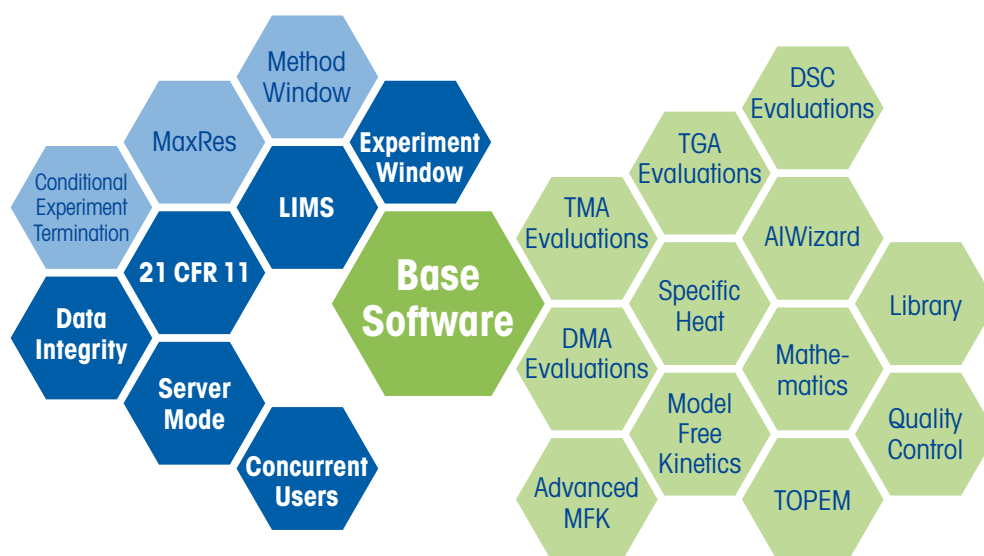
Maximum Flexibility

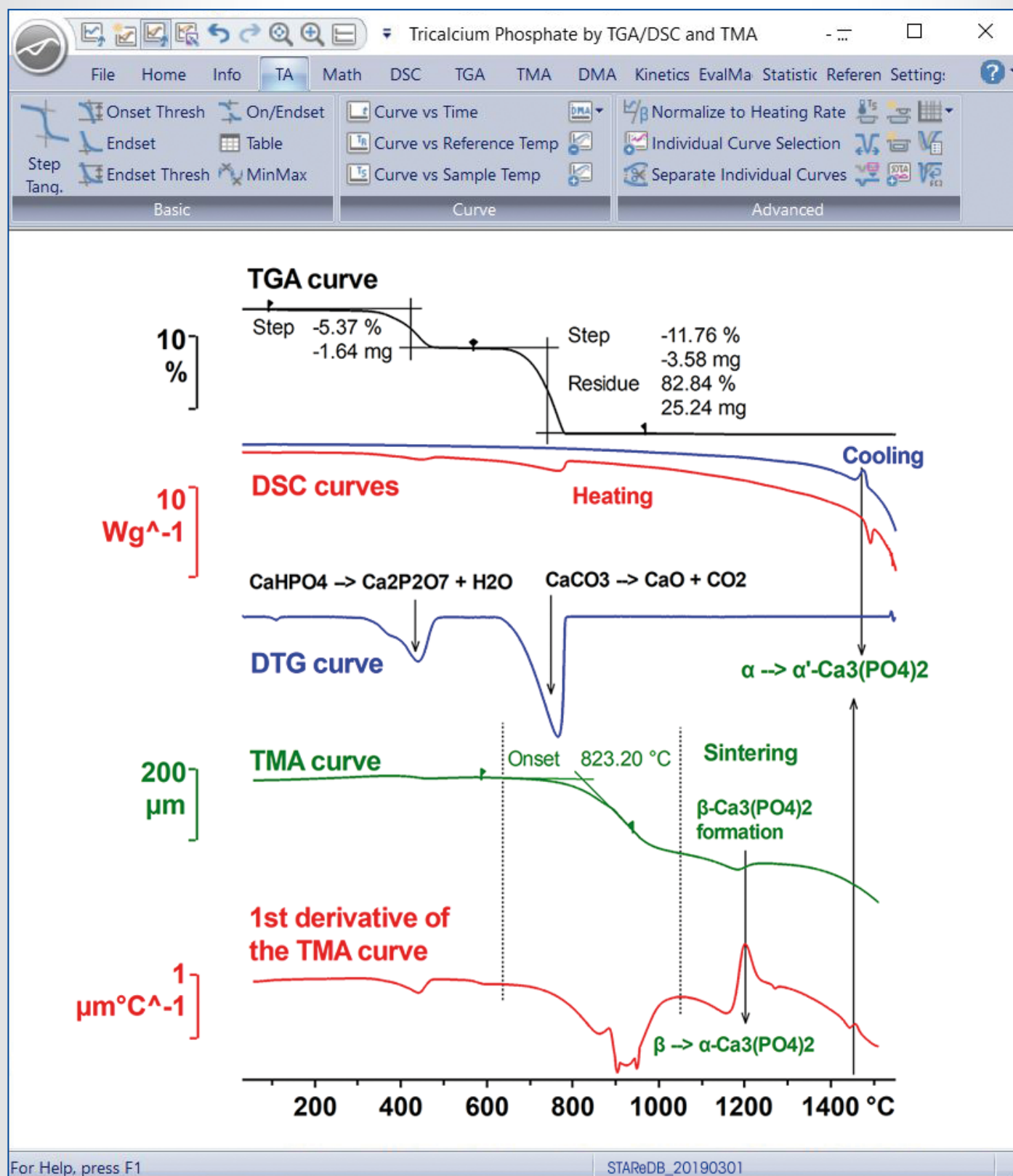
High Quality Results with Less Effort

Thermal analysis is a well-established analytical method that is widely used in many different fields. It provides laboratories with valuable results and new information in quality assurance and control, process and product development, and research. Many problems can be solved by using a combination of different thermal analysis techniques.

Features and benefits of the STAR^e Excellence METTLER TOLEDO software:

- **Unlimited evaluation possibilities** – provides enormous flexibility
- **Reliable automation** – high sample throughput with automatic evaluation dramatically improves efficiency
- **Unique integrated database solution** – guarantees the highest level of data security
- **Solid compliance** – supports 21 CFR Part 11 user level management and electronic signatures
- **Modular concept** – tailor-made solutions for current and future needs
- **Easy and intuitive OneClick™ operation** – saves time in training and in daily use
- **Time-saving FlexCal™ calibration** – for more accurate measurement results
- **State-of-the-art LIMS integration** – guarantees seamless processes from external tasks to measurement evaluation and result assessment
- **AIWizard™** – autonomously identifies and evaluates all types of thermal effects





STAR[®] is the most complete and comprehensive thermal analysis software on the market and provides unrivalled flexibility and unlimited evaluation possibilities.

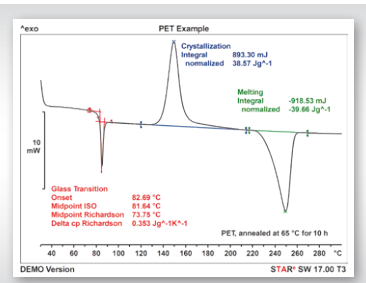
► www.mt.com/ta-software

Unparalleled Evaluation Possibilities

The Right Solution for Every Measurement

STAR^e is the benchmark for flexible evaluation. A complete software package and expert evaluation possibilities are the basis for the correct interpretation of measurement results. The STAR^e evaluation software combines application-specific evaluation tools optimized for thermal analysis users with the flexibility of a superior layout program whose functionality sets no limits to individual creativity.

Autonomous analysis by AIWizard™

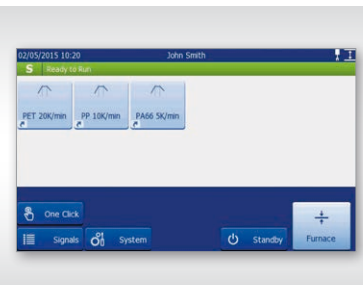


A revolutionary new Artificial Intelligence (AI) option for thermal analysis is provided. The AIWizard automatically identifies and evaluates all thermal effects measured by DSC. Comprised of a trained neural network that utilizes thousands of evaluation examples, the system is able to determine all thermal effects.

As shown in the example above, all thermal effects are recognized i.e. glass transition, crystallization and melting.

► www.mt.com/ta-aiwizard

Simple operation



STAR^e functionality is readily accessible from the software's intuitive ribbon interface. Features such as OneClick™, multiple curve handling and available options like Quality Control or the Reference Library simplify routine work.

Modular concept



The flexible STAR^e software consists of the base software and a large number of application-specific options to satisfy your current and future requirements.



The reference library option permits any type of sample data – be it past measurements or information acquired from the literature – to be organized, stored and easily retrieved from a centralized database.

► www.mt.com/ta-libraries

Simple, Intuitive Operation

Straightforward, Efficient and Secure

STAR® software is the ideal platform for any type of thermal analysis investigation – from simple experiments and automatic result evaluations for quality control to complex scientific applications used in research and academia.

Five programs – one database

Installation Window



The Installation Window allows you to set up instruments, create users and enter data concerning reference materials or other information relevant to the database.

Module Control Window



The Module Control Window represents the measuring modules or balances that are connected. The window allows you to create simple methods and experiments for routine operation.

Method Window



The Method Window is only required if you want to graphically create complex methods (e.g. when using **TOPEM™**).

Experiment Window



From the Experiment Window you choose the method, enter the data specific for the experiment and start the measurement.

Evaluation Window



The Evaluation Window included in the base software provides you with extensive evaluation possibilities.



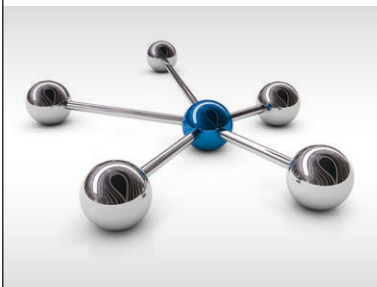
The base software includes a large number of routine evaluations which can be applied to curves from all the different measurement techniques.

Database Management

Unbeatable Data Security

The integrated relational database helps you easily maintain a clear overview even with very large amounts of data. Data is stored within the secure database by sample name, date and time. The base software allows other data filter parameters to be assigned, thus simplifying data searches.

Server option



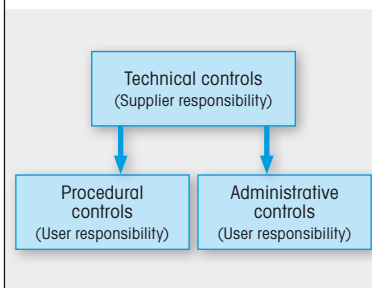
The heart of the server system is the centralized database where all data is stored with the highest level of security, while allowing easy data sharing among users. In addition, the **STAR**[®] software provides powerful administrative tools for finance, calibration and service purposes – ideal for managing multiple instruments located in different laboratories.

Data integrity



The **STAR**[®] Data Integrity software option enables different users to be assigned specific roles and access rights, restricting them to areas of the system that allow them to perform their job functions.

21 CFR Part 11 compliance



This option provides the technical controls to support 21 CFR Part 11 compliance. This includes:

1. Access control (password)
2. User level management (user roles or profiles)
3. Electronic records (file integrity)
4. Electronic signature (status of electronic records)
5. Audit trail (change and system history)

► www.mt.com/ta-cfr



Secure data: All records are stored and linked in a secure, protected data archive, shielding raw data from unintentional deletion or modification.

► www.mt.com/ta-dataintegrity

Seamless Processes Over the Entire Workflow

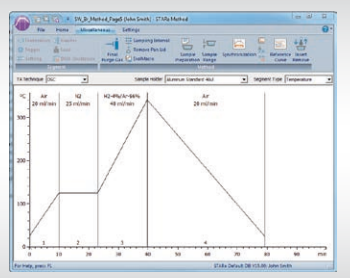
STAR[®] thermal analysis systems enable seamless workflows that automate analytical processes – from sample management and measurement to result interpretation and validation.

LIMS Integration



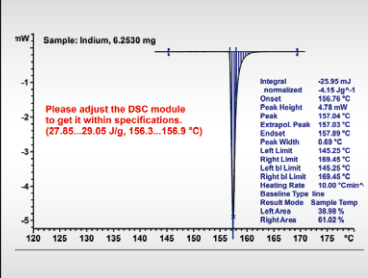
STAR[®] integrates with LIMS to simplify laboratory workflows. Methods can be launched with OneClick™ and automated for repeated measurements. In addition, control functions supervise the status of the system and facilitate serviceability and maintenance.

Graphical method development

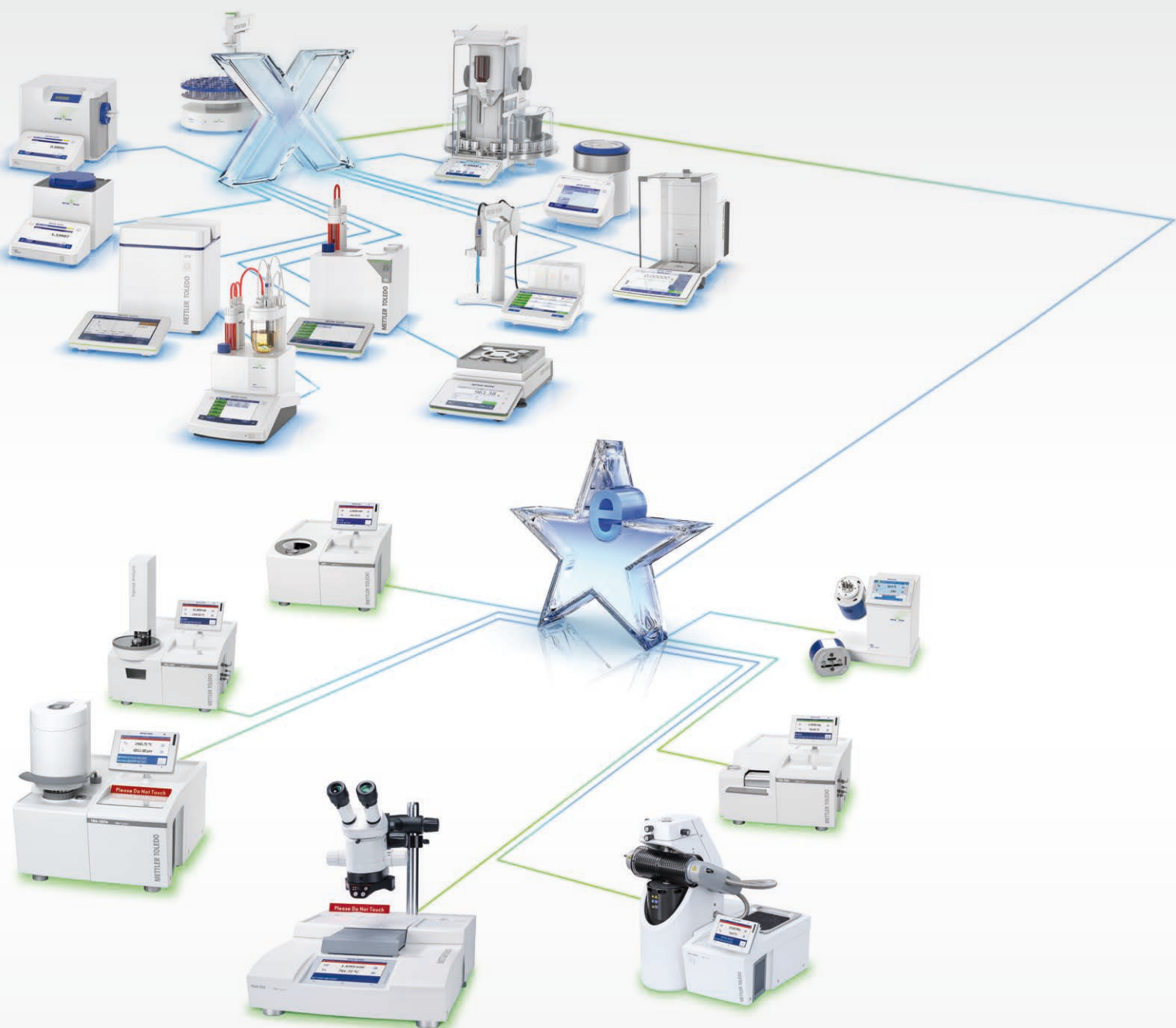


Almost any type of temperature profile can be programmed and graphically modified in the Method Window. This includes a number of complex operations such as loops, conditional termination, lid handling or automatic baseline correction.

Automatic result assessment (EvalMacro)



The EvalMacro option in STAR[®] speeds up repetitive tasks and eliminates operator bias by allowing the same type of evaluation to be performed fully automatically. In addition, results may be graphically compared and statistically evaluated to ensure they lie within predefined limits.



STAR[®]X[™] permits weighing results to be transferred electronically from any LabX-connected METTLER TOLEDO balance to **STAR[®]** thermal analysis software for seamless and compliant thermal analysis workflows.

► www.mt.com/labx

FlexCal™ for Accurate Results

Minimizes Calibration and Adjustment Time

A well-calibrated instrument provides values that are independent of the heating or cooling rate, crucible type or gas atmosphere in the furnace. The FlexCal option includes a database of methods to store and handle the necessary calibration parameters of individual measuring cells.

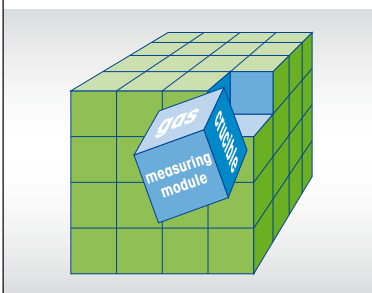
Complete instrument adjustment



Parameters that can be adjusted:

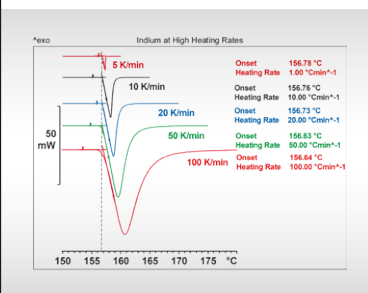
- Temperature
- Measuring cell characteristics (tau lag): After adjustment has been successfully completed, isothermal temperatures and onset temperatures are identical, even at different heating rates.
- Sensors

Unique FlexCal adjustment



Each instrument-specific set of parameters describes primarily the relationship between temperature, heating rate, crucible, gas and sensor type for the standard setup. The module always uses the correct adjustment parameters, even if measurements are performed with different crucibles or if the gas is switched during measurement.

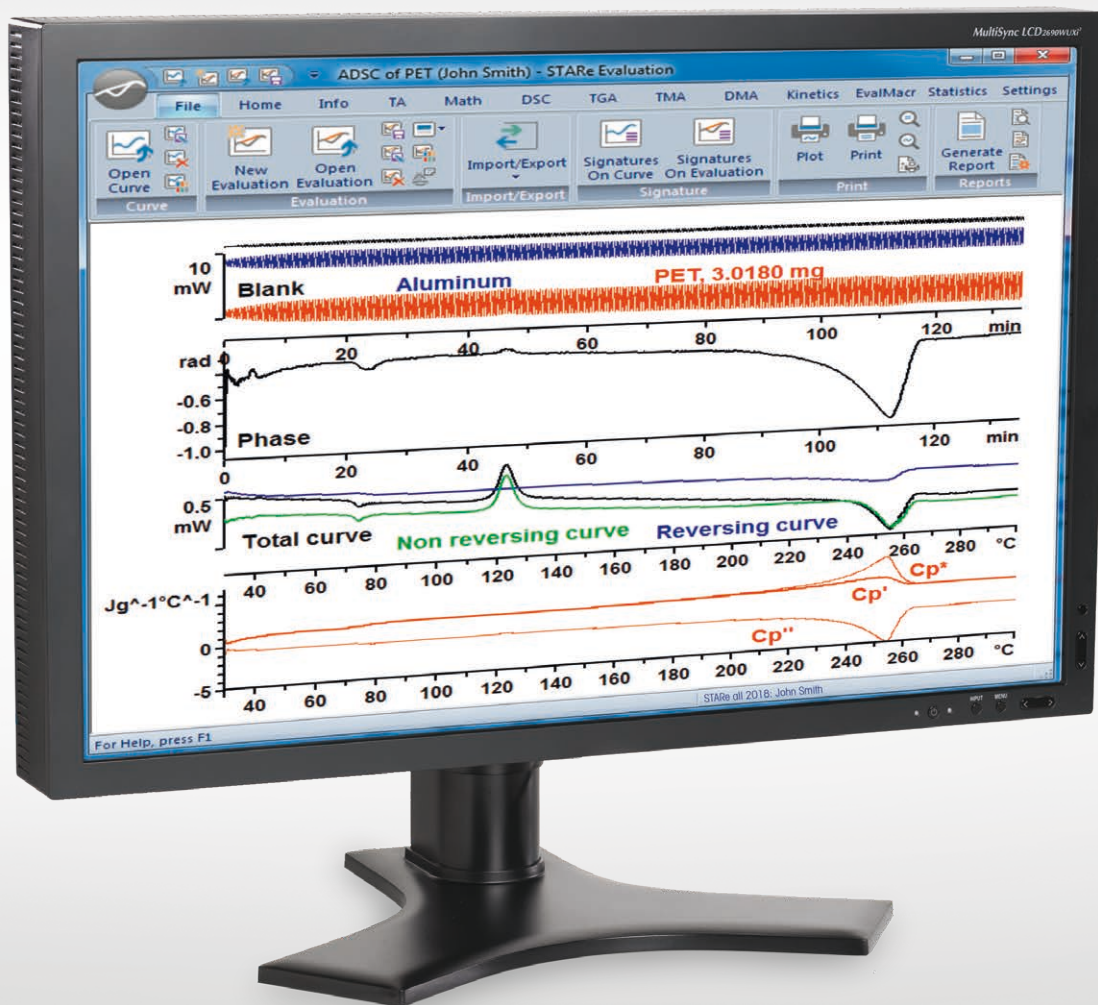
Comprehensive calibration service



We offer:

- Standard Calibration and adjustment in the desired temperature range for one heating rate.
- Expert Calibration and adjustment in the desired temperature range for three heating rates.

► www.mt.com/ta-calibration



Comprehensive evaluation possibilities already included in the base software

The base software includes a large number of routine evaluations that can be applied to curves from all the different measurement techniques.

Mathematical evaluation features included in the base software

- First derivative
- Cut to frame – cutting segments
- Take apart
- Envelope curves
- Subtract lines

Search features

- Archive search – quickly find data from backups
- Compare function – search similar curves for simple identification

Comprehensive evaluation functionality included in the base software

- ADSC – FFT, steady state ADSC and ADSC to separate overlapping effects (c_p and kinetic parts)
- Onset and endset, with and without threshold values
- Peak integration
- Step, with horizontal or tangential baselines
- Table: many different possibilities to present curves in tabular form
- Min/Max: determination of the minimum and the maximum within a region
- Normalization to sample size: conversion to W/g or % presentation
- Curve displayed against time, reference or sample temperature
- DSC purity
- Automatic evaluations and validations

Extremely Wide Application Range For All Kind of Materials

Thermal analysis is firmly established as a method for the characterization of physical and chemical properties of materials in many different fields.

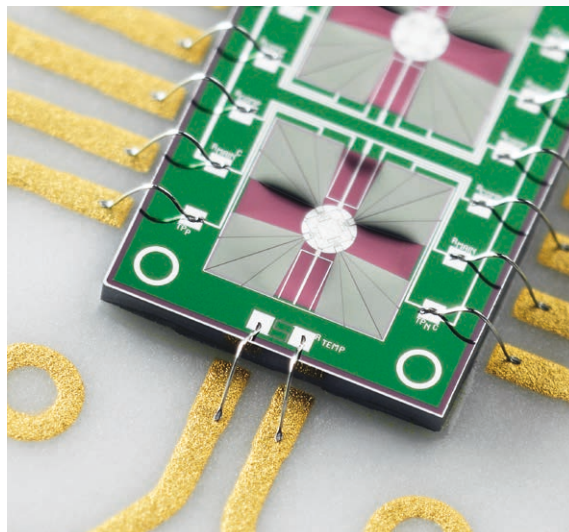
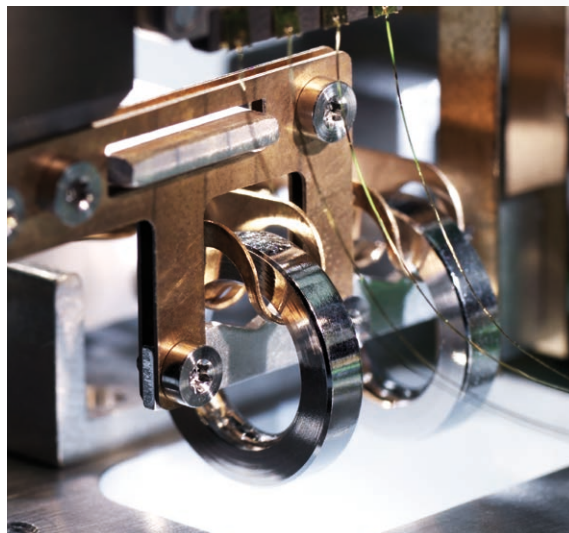
Thermal analysis includes a number of different measurement techniques. Compared with other analytical methods, they offer the following advantages:

- Easy sample preparation
- Measurement of liquids, gels, powder, compact solids, fibers, thin layers, etc.
- Very small samples
- Easy operation
- Short measurement times

Overview of possible fields of application

Materials characterization by:	DSC	FDSC*	TGA	TMA	DMA
Physical properties					
Melting / crystallization	•	•		•	•
Enthalpy of crystallization	•	•			
Solid fat index	•				
Purity determination	•				
Vaporization, drying	•		•		
Sorption and desorption			•		
Glass transition	•	•		•	•
Specific heat capacity	•	•			
Expansion coefficient, shrinkage behavior				•	
Polymorphism, crystalline transitions	•	•		•	
Liquid-crystalline transitions	•	•			
Viscoelastic behavior, elastic modulus				•	•
Chemical changes					
Decomposition, pyrolysis	•	•	•	•	
Oxidation, stability	•		•	•	
Curing, vulcanization, gelation	•				•
Dehydration	•		•		
Denaturation	•				
Swelling and foaming				•	
Reaction process, reaction enthalpy and kinetics	•	•	•		

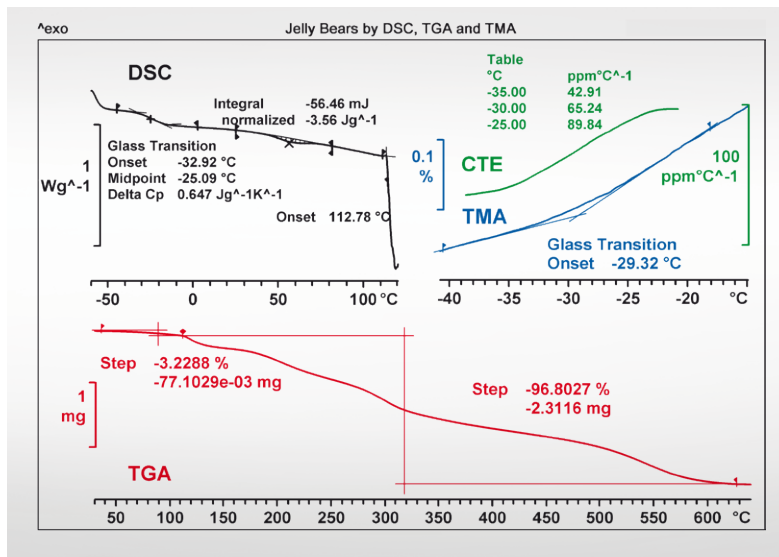
*FDSC: Flash DSC



Thermal analysis (TA) is the method of choice for comprehensive characterization of materials. Quality control, R&D and failure analysis, are areas to which TA techniques make a significant contribution.

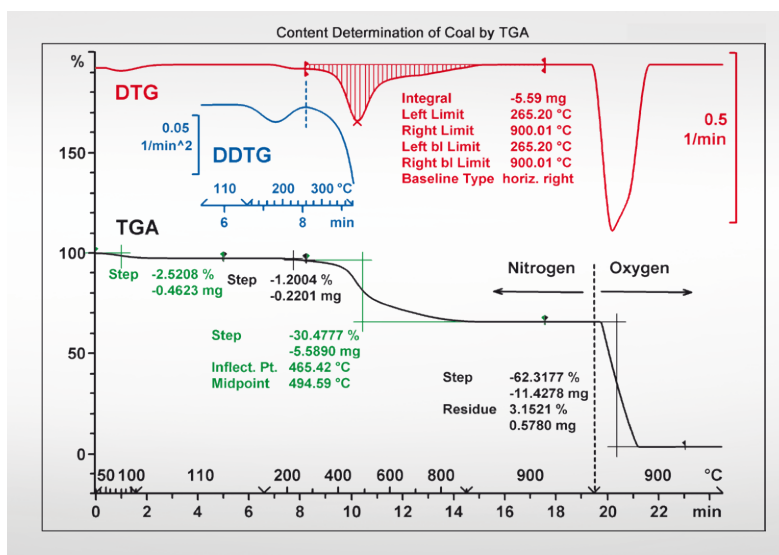
► www.mt.com/ta-techniques

Curve display of different techniques



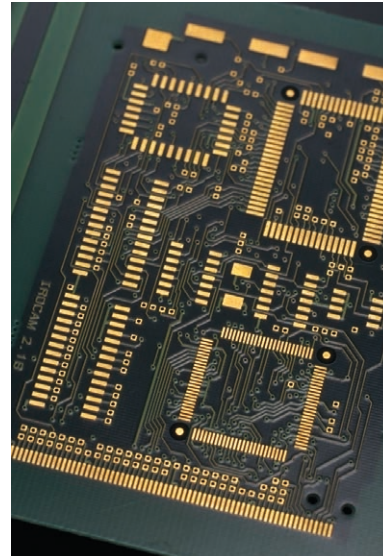
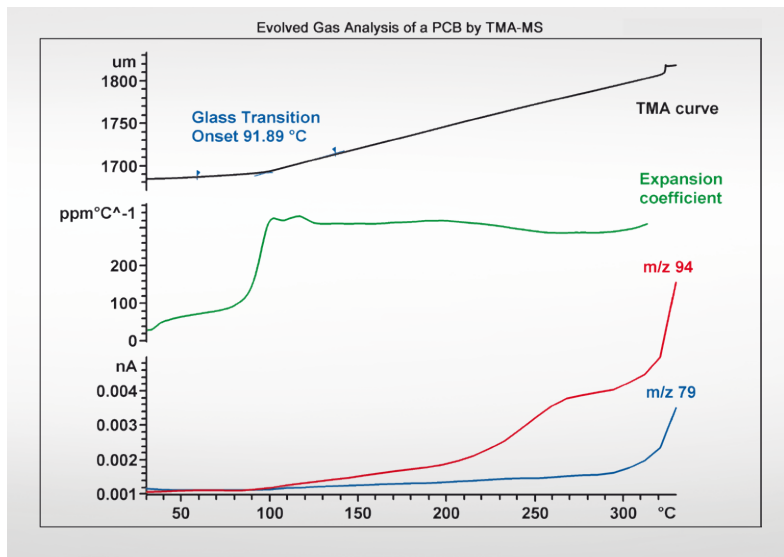
Materials are often characterized by several different thermal analysis techniques. The **STAR**® software can simultaneously display the resulting curves in one diagram. The example shows DSC, TGA and TMA curves from the measurement of a popular rubbery-textured type of candy. The DSC curve shows the glass transition and the vaporization peak of water. The TMA curve displays the glass transition and the expansion coefficient. The onset of thermal decomposition at higher temperature is apparent in the TGA curve.

Content determination by TGA



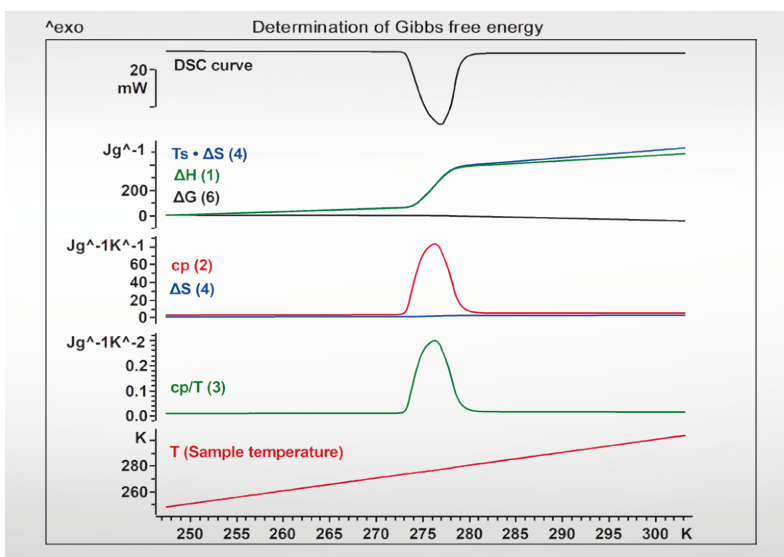
Content analysis is one of the standard applications of TGA. The example shows the results from a coal sample analyzed according to ASTM E1131 for moisture content and for the content of volatile compounds and carbon. The sample was first heated to 900 °C in an inert atmosphere. This allows the moisture and volatile compounds to be determined. The atmosphere was then switched from nitrogen to oxygen. The carbon undergoes combustion, resulting in a further weight loss. The limits set for the individual weight loss steps are based on the first (DTG) and second (DDTG) derivatives of the weight loss curve.

Analysis of decomposition gases



In thermal analysis, it is often important to determine the nature of the gases evolved when a material decomposes. This can be done by coupling the TGA or TMA to a gas analyzer such as an FTIR spectrometer or a mass spectrometer (MS). In this example, the thermal decomposition of a printed circuit board was studied using a TMA coupled online with a MS. The TMA curve shows the glass transition and the onset of delamination above 300 °C. The m/z 79 and m/z 94 fragment ion curves indicate the elimination of bromides and methyl bromides from a brominated flame retardant.

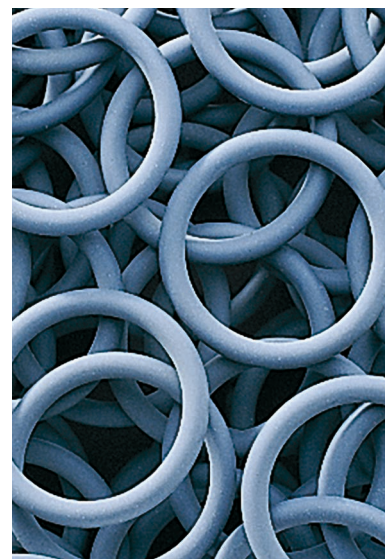
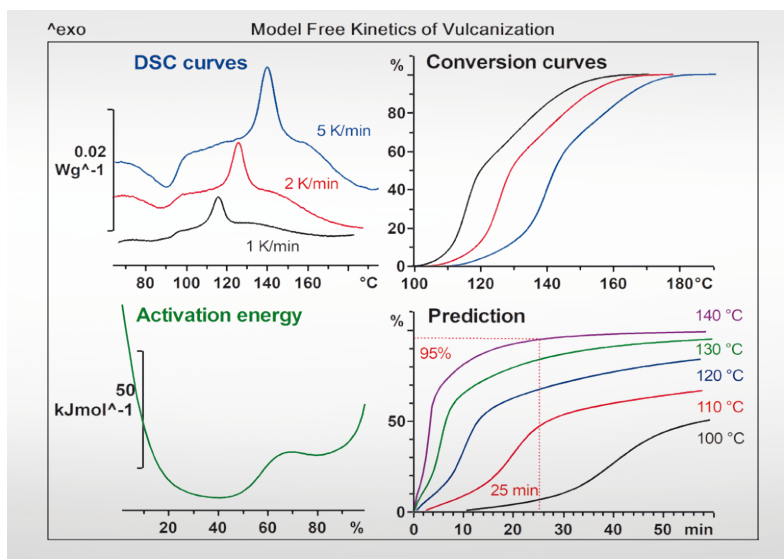
Curve calculations



The example showing the determination of free enthalpy ($\Delta G = \Delta H - T \cdot \Delta S$) demonstrates that the STAR^e software can be used to perform calculations on thermal analysis curves.

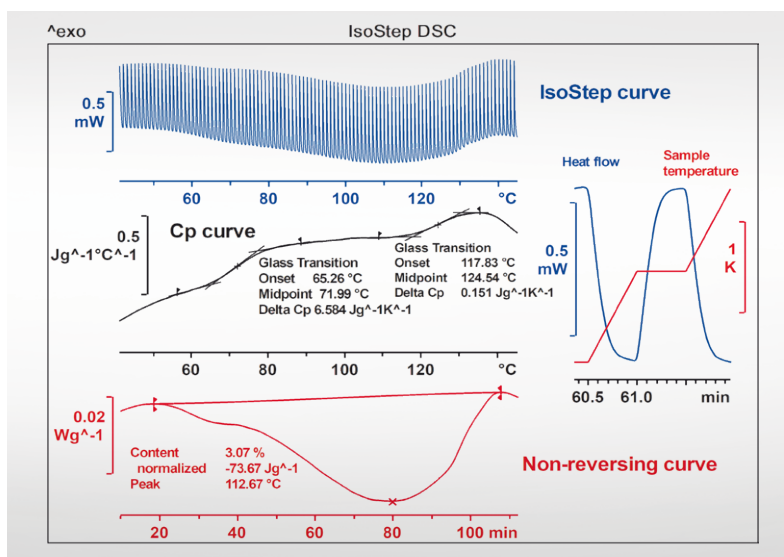
- | | | |
|----------------------------------|---|---|
| 1. Enthalpy curve (ΔH) | 3. c_p / T | 5. $T \cdot \Delta S$ |
| 2. Heat capacity curve (c_p) | 4. $\Delta S = \int_{T_1}^{T_2} \frac{c_p}{T} dT$ | 6. $\Delta G = \Delta H - T \cdot \Delta S$ |

Kinetics of chemical reactions



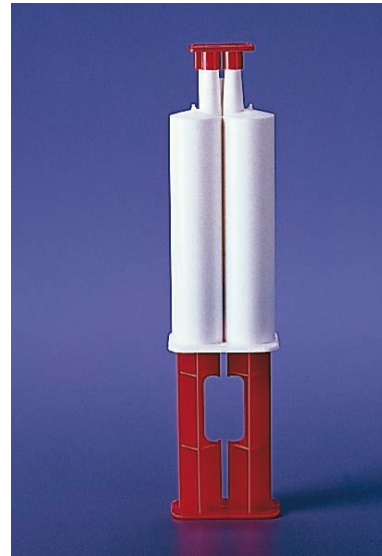
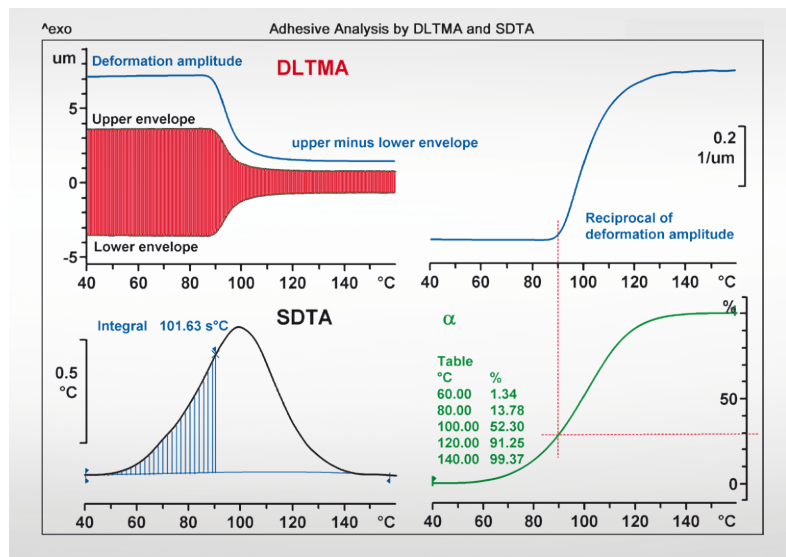
The STAR[®] software can be used to predict and model chemical reactions in different ways. The example shows the vulcanization reaction of an NBR elastomer analyzed by model free kinetics. The method requires three separate DSC measurements to be performed at different heating rates. The software then uses the resulting conversion curves to calculate the activation energy for the reaction as a function of reaction conversion. This allows the conversion to be predicted as a function of time at different isothermal temperatures.

IsoStep[™] temperature-modulated DSC



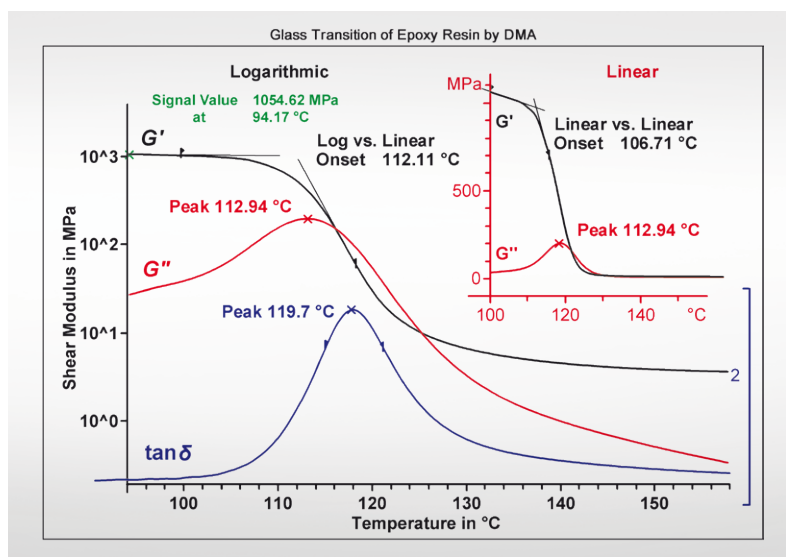
In the IsoStep technique, the temperature program consists of a series of alternating isothermal and heating segments. Typically, each segment lasts one minute (see inserted diagram, right). The heat capacity is determined from the dynamic segments, and the non-reversing heat flow from the isothermal segments. In the example, the specific heat capacity curve exhibits two glass transitions while the non-reversing heat flow curve shows the evaporation of moisture. This type of separation of different phenomena is only possible with temperature-modulated DSC techniques.

Curing of an adhesive by DLTMA



During a curing reaction, the liquid adhesive changes into a hard layer that fixes the parts together. If a liquid adhesive is applied to the underside of a razor blade, the curing process can be followed in a 3-point bending experiment using DLTMA (Dynamic Load TMA). The curing of the adhesive causes the sample to become stiffer. This leads to a decrease in the deformation amplitude in the DLTMA curve. In the SDTA curve, the curing process produces an exothermic peak. Comparison of the DLTMA and SDTA curves indicates that above 30% cure the mechanical properties of the adhesive change rapidly with increasing degree of cure.

DMA curve presentation



DMA experiments yield the complex modulus (M : Modulus, more specifically E : Young's modulus and G : Shear modulus), which is made up of the storage and loss moduli (M' and M''). The loss factor ($\tan \delta$) is also often calculated, which corresponds to the ratio of M'' to M' . The value of the glass transition temperature can be determined as the onset temperature of the step-like decrease in M' , the peak temperature of M'' , or the loss factor. It is important to note that the onset temperature of the storage modulus depends on the presentation of the curve: if M' is displayed linearly, the onset temperature is lower than when M' is displayed logarithmically.

Modular System for Cost-Effective Tailor-Made Solutions

The flexible STAR[®] software consists of the base software and a large number of application-specific options to satisfy both current and future requirements.

Software options

AIWizard™	Autonomous identification and evaluation of thermal analysis effects. AI-enabled methods run experiments and analyze results instantaneously
DSC Evaluations	Glass transition, content, conversion and enthalpy
Specific Heat	Specific heat (c_p) and specific heat with sapphire (DIN method)
TOPEM™ (Multi-frequency TMDSC)	Determination of the frequency-dependent heat capacity and separation of overlapping effects
TGA Evaluations	Content and conversion
MaxRes	Event-controlled optimization of the heating rate, based on patents of Prof. Dr. F. Paulik
TMA Evaluations	Glass transition, expansion and conversion as well as Young's modulus determination
DMA Evaluations	The time-temperature superposition principle allows the simulation of material properties outside the measurement range (mHz and GHz range, master curves)
Mathematics	Integral and integration, multiply/divide curves or add/subtract curves, subtract line or subtract poly-line, polynomial fit
Model Free Kinetics	Activation energy curve, simulation, conversion plot and isoconversion plot, based on dynamic curves
Advanced Model Free Kinetics	Activation energy curve, simulation, conversion plot and isoconversion plot, based on any curves
Quality Control	Reference curve and trend tracking with statistical evaluation
Reference Library	Reference Library with possibility to expand and rearrange data; search for similar results
21 CFR Part 11	Provides the technical controls (including electronic signatures and audit trails) for 21 CFR Part 11 compliance
Data integrity	Enables password access-control, assigns user-rights, and ensures file integrity with electronic records



With the latest **STAR**® software you can control all METTLER TOLEDO thermal analysis modules that have been introduced since the 1980s. Such a system protects your investment and saves education time.

► www.mt.com/ta-software

World-Class Service and Support Provide Results You Can Trust

METTLER TOLEDO's portfolio of services is designed to ensure the continuous performance and reliability of your thermal analysis systems. Factory-trained in Switzerland, our worldwide teams bring the professional expertise and know-how needed to provide you with the highest level of after-sales support, as well as the experience necessary to optimize services for your own particular needs.

Large library of overview and how-to videos



Increase your productivity by learning from our video libraries and more than 600 applications.

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Bi-annual application magazine



Every year, thermal analysis generates a large number of scientific results and discoveries. Interesting examples from different application fields and industries are published in our UserCom magazine.

► www.mt.com/ta-usercoms

Thermal Analysis eNewsletter

Sign up to receive quarterly news on the latest trends in thermal analysis, including applications, webinars, courses and how-to-videos.

► www.mt.com/ta-knowledge

Videos for Thermal Analysis

Some procedures and operations have to be seen in order to perform them properly. Videos make technology understandable. Our new technical videos explain complex issues concerning thermal analysis instrumentation and the STARe software – whether it's sample preparation, installation, creating experiments or evaluating measurement results.

The following videos are currently available:

Instruments

Software and TA in General



Get a quick overview of the METTLER TOLEDO Thermal Analysis offering

DSC



Stay informed about today's state-of-the-art DSC technology

TGA/DSC



TGAs based on real ultra-micro balances from the leader

TMA



Stay informed about the versatile TMA technology

DMA



Latest information on the exciting DMA technology



Intuitive STARe thermal analysis software for all users



Stay up-to-date with the revolutionary Flash DSC capabilities



Rugged and reliable TGA automation with lid piercing options



Rugged and reliable DSC automation with lid piercing options

A large library of product videos as well as more technical "how to" videos is provided.

► www.mt.com/ta-videos

Software Options and Their Requirements

Software options	Requires
Experiment Window	–
Server Mode	– (≥ 1 Concurrent User recommended)
Concurrent User	Server Mode
Data Integrity (User Rights)	–
21 CFR 11	–
LIMS	Experiment Window

Method options

Method Window	–
Conditional Experiment Termination	Method Window
MaxRes	Method Window

Evaluation options

AIWizard™	–
Reference Library	–
Mathematics	–
Quality Control	–
DSC Evaluations	–
Specific Heat	–
TOPEM™	Method Window and Experiment Window
TGA Evaluations	–
TMA Evaluations	–
DMA Evaluations (TMA Evaluations included)	–
Model Free Kinetics	DSC, TGA or TMA Evaluations
Advanced Model Free Kinetics	DSC, TGA or TMA Evaluations

Software update packages

Interesting software packages you will find at: ► www.mt.com/ta-swupdates

www.mt.com/ta

For more Information

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Local contact: www.mt.com/contacts

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