

Thermal Analysis Excellence



STAR® System

Innovative Technology

Versatile Modularity

Swiss Quality

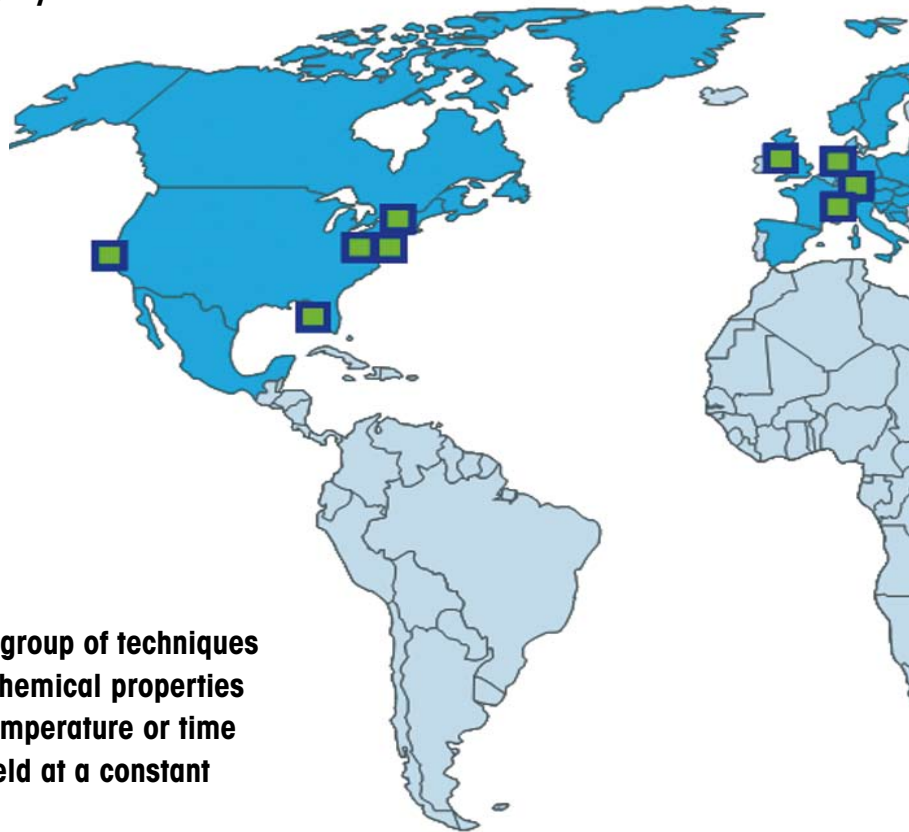
The Future
of Thermal Analysis

METTLER TOLEDO

Intelligent Innovations for Modern Materials Analysis

METTLER TOLEDO is a global manufacturer and marketer of precision instruments for use in laboratory, industrial and food retailing applications. Our products and services are available worldwide in over one hundred countries. With more than 10,000 employees, most of them in sales, service and development, we guarantee customers unique products and support of the very highest quality.

Thermal analysis has played an important role in METTLER TOLEDO since the early 1960s. Since the beginning, we have offered customers innovative thermal analysis solutions, products and services. Our dedicated worldwide team of highly qualified sales and service engineers are ready to assist you.



Thermal analysis comprises a group of techniques that measure the physical or chemical properties of a sample as a function of temperature or time while it is heated, cooled or held at a constant temperature.



40s
Substitution balance



60s
Modular TA1 concept



70s
Multi-thermocouple DSC sensor for TGA



80s
Microprocessor-controlled thermal analysis systems



1993
DSC Automation



Dr. Erhard Mettler



Dr. Hans-Georg Wiedemann

History

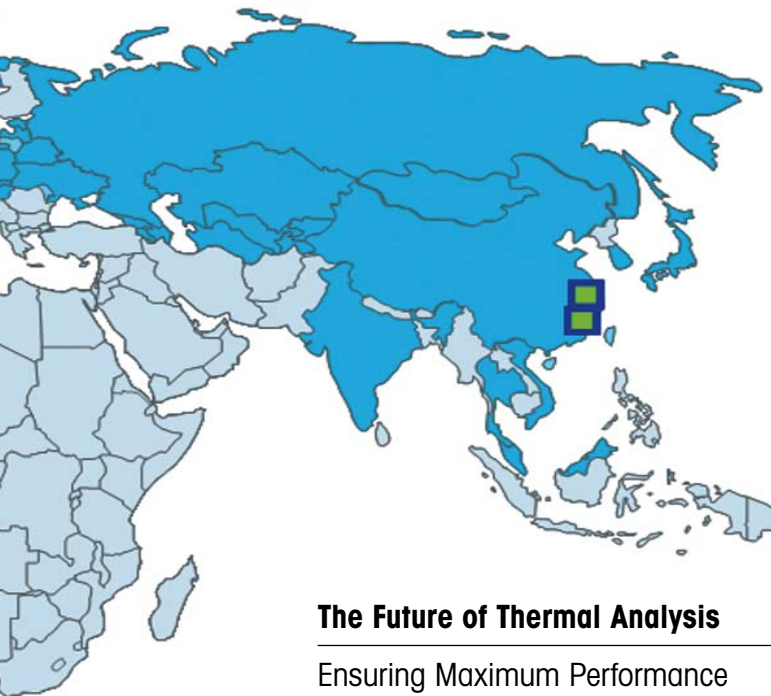
In 1945, Dr. Erhard Mettler, a Swiss engineer, founded a precision mechanics company, which ultimately became the now renowned METTLER TOLEDO company. He laid the foundation for the successful balance business and invented the substitution principle with a single-pan balance. In 1973, the company introduced the first electronic balance with electromagnetic force compensation.

Dr. Mettler also strongly promoted thermal analysis. In the early 1960s, Dr. Hans-Georg Wiedemann, an East German scientist, convinced him to combine the advanced weighing technology with a furnace in order to measure weight changes as a function of temperature. This led to the introduction, in 1964, of the first commercially available TGA/DTA system, the TA1.

Technology and innovation as a driving force

The very first commercial thermal analysis system, the TA1, was a sweeping success. Its modular construction allowed it to be used in many different fields of application.

Attention to detail and commitment has shaped METTLER TOLEDO thermal analysis right through to the present day and has led to products and services that are unique in the market place.



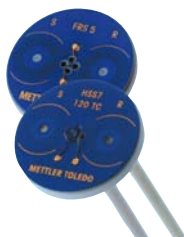
The Future of Thermal Analysis

Ensuring Maximum Performance

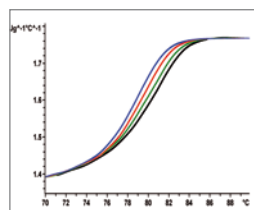
METTLER TOLEDO thermal analysis Excellence instruments allow you to characterize sample materials over a very wide temperature range. Control all the instruments from a single, powerful, easy-to-use software platform. Each instrument configuration has the highest level of performance so you can have complete confidence in your results.



2002
DMA with high frequencies



2004
MultiSTAR® DSC sensors



2005
TOPEM® TMDSC software option



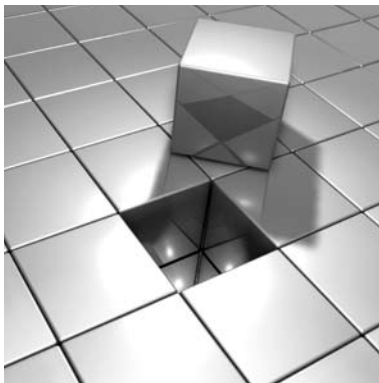
Materials Characterization

Tailored Exactly to Your Needs

The METTLER TOLEDO thermal analysis Excellence line offers tailor-made solutions for academic and industrial problems. The unrivalled performance and innovative technology of the Thermal Analysis Excellence Line will propel you to the forefront of your field and guarantee you the highest level of Swiss quality, accuracy and efficiency.

Features and benefits:

- **Modular concept** – tailor-made solutions for current and future needs
- **High performance instruments** – accurate analysis of a wide variety of samples
- **Reliable automation** – high sample throughput with result assessment dramatically improves efficiency
- **High-level competence and support** – training courses and applications literature fosters knowledge sharing and growth
- **Service** – prompt response and maintenance contracts guarantee maximum system uptime



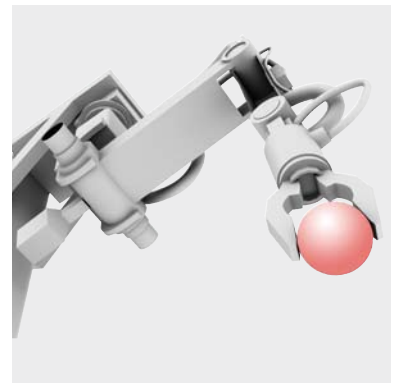
Modularity

Face your new measurement requirements with flexibility: protect your investment through the modularity and upgradeability of our innovative instrument solutions.



Performance

Put your trust in METTLER TOLEDO's world-leading sensor technology: whether DSC, TGA, TMA or DMA, we guarantee amazing sensitivity and highly accurate measurement results.



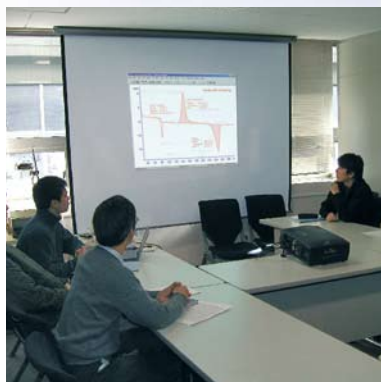
Automation

Have total confidence in our robust and reliable automation solutions. Unattended measurements, automatic evaluation of results and report generation make life easy.



Competence

Benefit from our 40 years of experience: attend one of our valuable training courses and rely on our professional advice so that you can take advantage of the possibilities offered by our amazing solutions.



Service

Trust our local service teams: we respond and attend to your needs quickly and competently and guarantee consistent performance and maximum uptime of your equipment.

Research and development

Science

Product development

Process development

Routine analysis

Quality control

Differential Scanning Calorimetry

Unsurpassed DSC Performance

The DSC utilizes an innovative sensor with a patented star-shaped arrangement of 120 thermocouples that guarantees unmatched sensitivity and resolution.



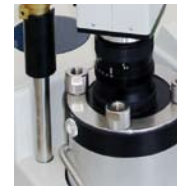
Multi-thermocouple sensors



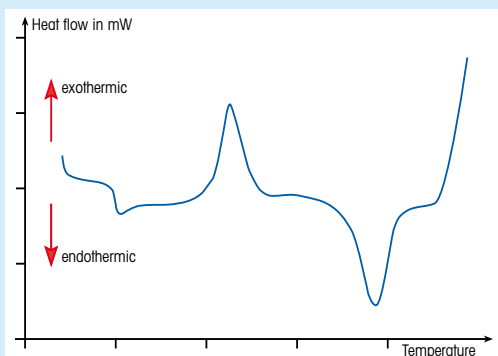
Extremely reliable automation



Flexible photocalorimetry



Versatile chemiluminescence and microscopy



Differential Scanning Calorimetry (DSC) allows you to determine the energy absorbed or released by a sample as it is heated, cooled or held at constant temperature.

Thermogravimetric Analysis

Trust the Leading Supplier of Balances

The TGA is equipped with a top-of-the-line **METTLER TOLEDO** ultra-micro balance with unique built-in calibration ring weights for unparalleled accuracy.



Highly accurate
METTLER TOLEDO
ultra-micro balance



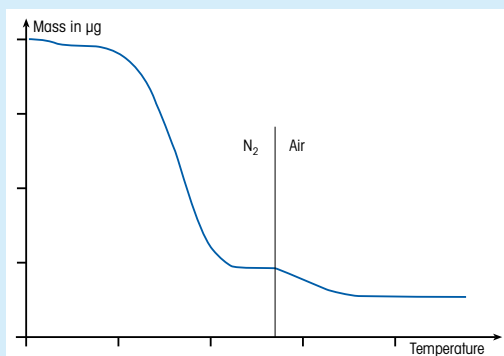
Extremely reliable
automation



Innovative
MultiSTAR®
DSC sensors



Hyphenated
techniques:
MS, FTIR and
sorption



Thermogravimetric Analysis (TGA) measures the mass of a sample as it is heated, cooled or held at constant temperature in a defined atmosphere.

The Sample Robot

Precise and Reliable like a Swiss Watch

All METTLER TOLEDO DSC and TGA instruments can be equipped with the robust sample robot enabling reliable around-the-clock operation.



Simple robust design



Universal gripper



Unique "wasp" crucible lid piercing device



copper



aluminum



alumina



sapphire



gold



platinum

Enormous range of crucibles

We have the right crucible for every application. The crucibles are made of different materials with volumes ranging from 20 to 900 μL . All the different types can be used with the sample robot.

Mechanical Material Properties

Accurate, Straightforward and Fast

The Dynamic Mechanical Analyzer (DMA) with its revolutionary technology offers previously unattained performance and timesaving external sample loading.

The Thermomechanical Analyzer (TMA) incorporates Swiss precision mechanics and features nanometer resolution to measure the very smallest dimensional changes.



Temperature measurement very close to the sample



Temperature measurement very close to the sample



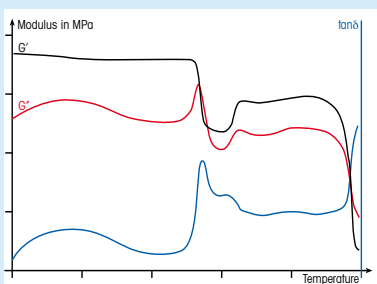
Direct measurement of deformation and force



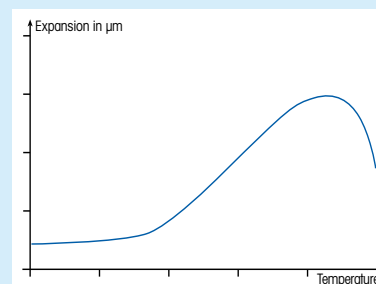
Unique sensor technology



Comprehensive accessory case



The DMA measures the mechanical properties of viscoelastic materials as a function of time, temperature and frequency when they are deformed under a periodic stress.



The TMA measures the dimensional changes of a sample as it is heated or cooled in a defined atmosphere.

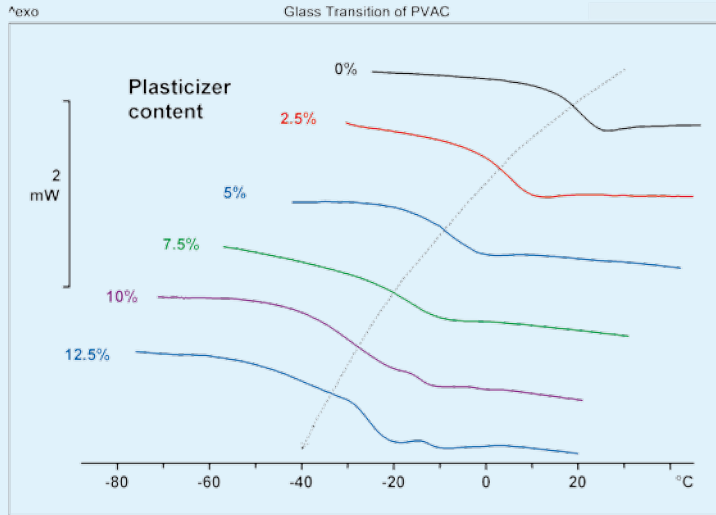
Extremely Wide Application Range

Thermal analysis includes a number of versatile techniques and is firmly established as an analytical method for materials characterization.

Thermal analysis solves problems and answers questions from research and development to quality control.

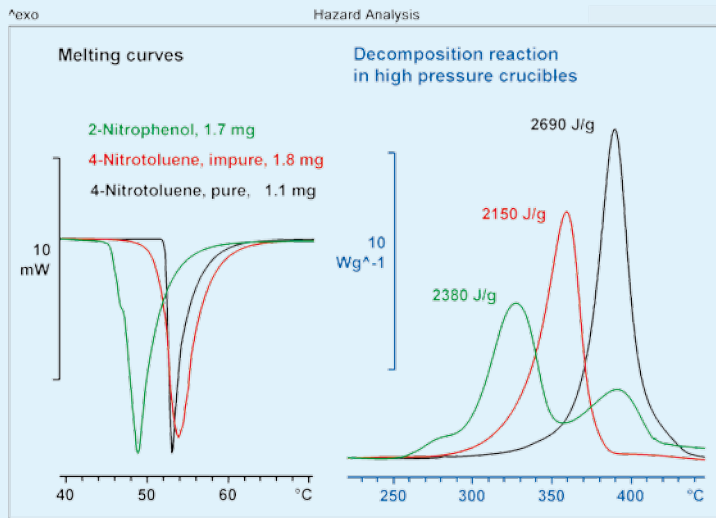
The table illustrates the diversity of thermal analysis applications. A number of applications are described to support this.

	<p>Organic compounds Chemicals Intermediates</p>	<p>Technology Composition Content Purity Content and influence of fillers Effects of moisture Storage stability Safety investigations Process control</p>
	<p>Inorganic compounds Minerals Ceramics Metals</p>	<p>Chemical changes Decomposition Pyrolysis Oxidation Stability Reaction process Reaction enthalpy and Kinetics Curing Vulcanization</p>
	<p>Pharmaceuticals Drugs Formulations Excipients</p>	<p>Phase changes Melting/Crystallization Vaporization Drying Adsorption Polymorphism Crystalline transitions Glass transition Liquid-crystalline transitions</p>
	<p>Petrochemicals Oils Fats Bitumens</p>	<p>Physical properties Specific heat capacity Expansion coefficient and behavior Viscoelastic behavior Elastic modulus</p>
	<p>Plastics Thermoplastics Elastomers Thermosets</p>	
	<p>Foodstuffs Fats Proteins Carbohydrates</p>	
	<p>Materials Composites Adhesives Coatings</p>	



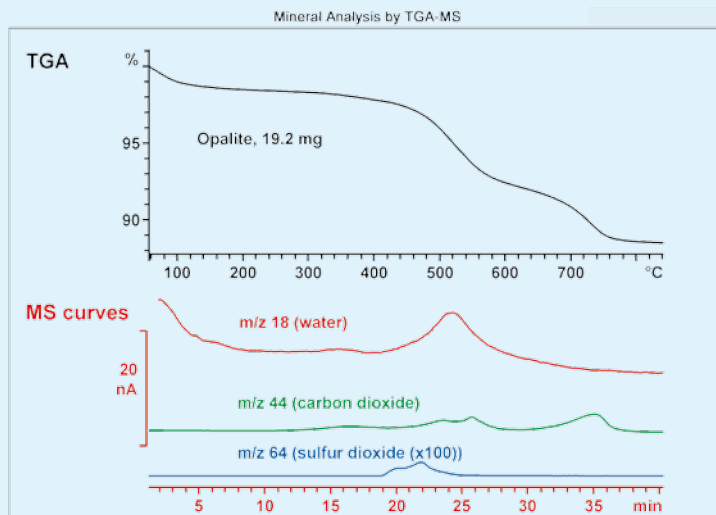
Influence of plasticizers by DSC

Plasticizers modify the mechanical properties of amorphous materials such as polymers. The DSC heating curves of polyvinylacetate (PVAC) show how the glass transition temperature decreases with increasing plasticizer content. Above the glass transition, the material is in a rubbery-elastic state. The results were obtained by measuring several samples containing different concentrations of plasticizer. This approach allows materials to be optimized for their specific use. It also shows the effect that the loss of plasticizer has on the glass transition temperature and on the stability of a material.



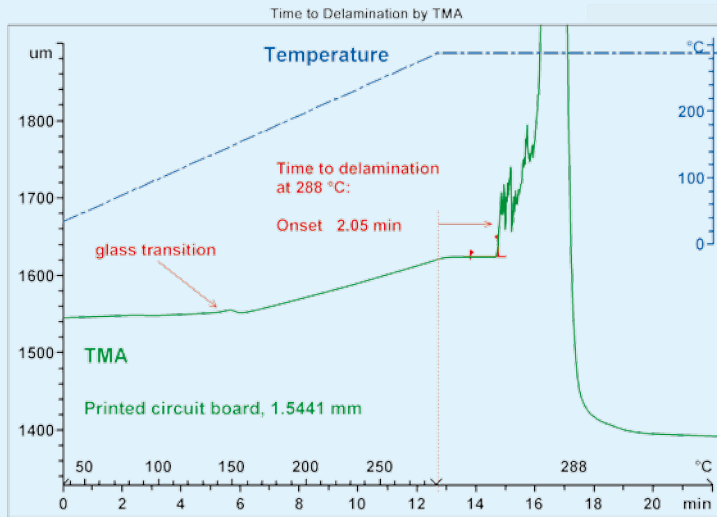
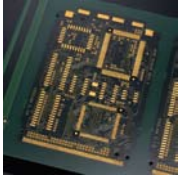
Safety investigations by DSC

The potential hazards associated with chemical reactions can be routinely investigated with the aid of DSC experiments. The melting peaks serve to identify substances and determine their purity. Besides this, decomposition peaks frequently occur. Exothermic peaks with enthalpies above 200 J/g indicate a certain degree of risk. Enthalpies greater than 500 J/g point to the potential danger of an explosion. The DSC measurements are performed with small amounts of material in special 30- μ L high-pressure crucibles to prevent vaporization. The example shows the results obtained from heating three nitro-compounds from 25 to 450 °C at 10 K/min.



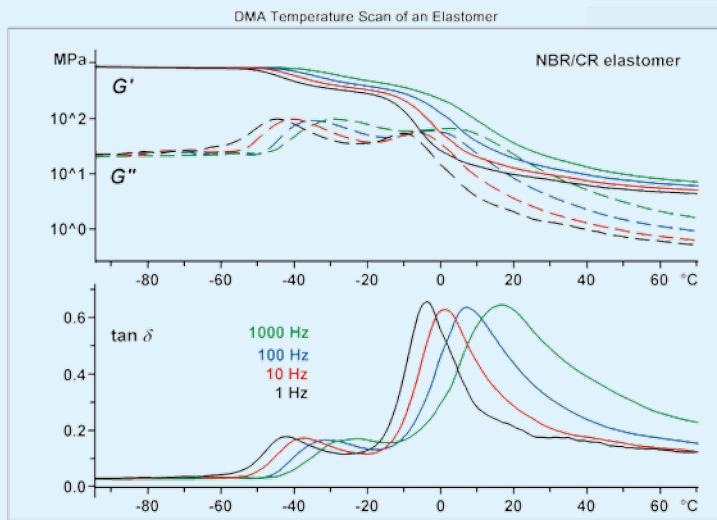
Mineral analysis by TGA-MS

Opalite is a mineral that consists mainly of clay, different carbonates and a little pyrite. On heating, the sample first loses adsorbed moisture, then water of crystallization at about 350 °C and finally water from the crystal lattice of the clay at about 500 °C. This is shown by the steps in the TGA curve and the peaks in the m/z 18 MS ion curve. The sulfur dioxide from the pyrite is hardly visible in the TGA curve but can be clearly seen in the m/z 64 curve. The carbonates lose carbon dioxide as shown in the m/z 44 curve. The MS curves were measured using a Pfeiffer Vacuum ThermoStar™ mass spectrometer coupled online with the TGA.



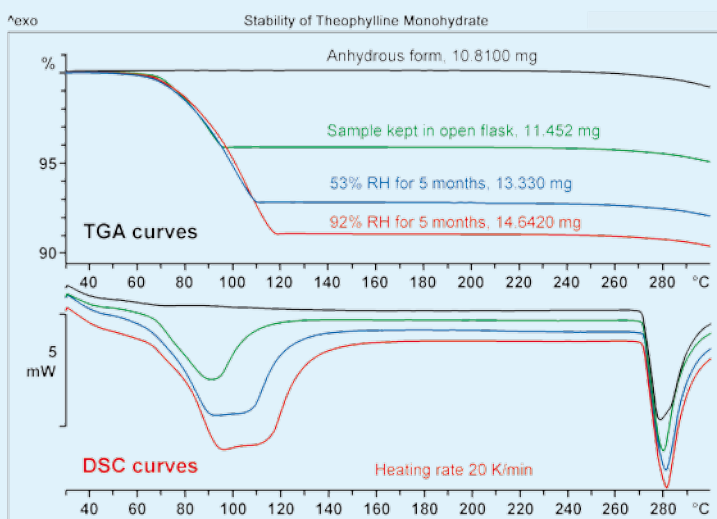
Delamination of printed circuit boards

The IPC-TM-650 standard No. 2.4.24.1 describes a TMA test method to determine the time taken for a printed circuit board to irreversibly delaminate at a particular temperature. The glass transition and the expansion coefficient of the laminate material can also be determined while the sample is heated to 288 °C as defined in the standard. The TMA curve shows that the thickness of the printed circuit board suddenly increases 2.05 min after reaching the end temperature. The board, which is made of glass fibers and epoxy matrix, showed no signs of delamination at the usual test temperature of 260 °C.



DMA of incompatible elastomer blends

The polymers of blends of different elastomers are often incompatible. The material then exhibits two glass transitions. The DMA curves show the dynamic-mechanical behavior of an NBR/CR elastomer (each 24%) with 33% filler and 9% plasticizer at four different frequencies. The glass transition of CR is observed at about -40 °C and that of NBR at about 0 °C. The transition exhibits characteristic frequency dependence. This is illustrated in the storage and loss moduli (G' and G'') and $\tan \delta$ curves of the shear measurement.



Hydrate stability of an active pharmaceutical ingredient

Hydrate stability is important for correctly setting the content of pharmaceutical ingredients in production. Theophylline monohydrate is only stable at a relative humidity (RH) above 92%. Other conditions lead to a reduction in the content of water of crystallization. The TGA curves show the loss of water of crystallization from samples of theophylline monohydrate stored under different conditions. Only the sample stored at 92% RH exhibits the content of water of crystallization expected from stoichiometry. The DSC curves show the endothermic elimination of water and the melting of the anhydrous substance at 270 °C.

World-Class Service and Support

Exceptional Reliability and Experience



Services of the highest quality

Skilled local sales and service engineers are ready to help you. Trained in Switzerland, they bring the know-how and expertise necessary to advise you on the services we offer and to optimize them for your particular needs.

Put your trust in a reliable partner with an excellent worldwide reputation.

Key service activities	Benefit
Equipment Qualification (EQ)	Full traceability and documentation streamlines the audit process.
Training Programs	Tailored training programs are designed to increase your knowledge of thermal analysis so that you get more from your capital investment.
Preventive Maintenance	Ensures maximum system uptime.
Repair	Quickly puts your instrument back into operation.
Calibration and Adjustment	Maintains system performance at the highest possible level.



The power of ServiceXXL

ServiceXXL is the most comprehensive range of services offered on a global level to help you maintain your thermal analysis systems. It is based on the knowledge and experience of our dedicated team of factory-trained engineers which allows them to provide fast on-site diagnosis and repair.

Leader in Laboratory Solutions

METTLER TOLEDO manufactures a wide array of balances and solutions for routine applications, research and development, and quality control. This is supported by innovative accessories, competent assistance and extensive applications know-how.



Microbalances, analytical and precision balances

Innovation, reliability and quality have made METTLER TOLEDO famous for its balances. These qualities still determine balance standards today. A comprehensive range of accessories is available to solve every weighing task.



Titration

The Excellence family of titrators provides highly automated state-of-the-art solutions for a wide range of routine to complex titrations and Karl Fischer moisture content determination.



pH meters and electrodes

METTLER TOLEDO offers a wide range of bench and portable meters and electrodes for the determination of pH, conductivity, dissolved oxygen and ion concentrations. There is a solution for every application, whether in the field, in production or in the laboratory.



Density and refractometry

The benchtop, portable and combined instruments determine density and refractive index quickly, simply and with great accuracy – and even simultaneously, depending on the instrument type.



Materials characterization

Besides innovative instrument systems for thermal analysis (DSC, TGA, TMA, DMA and TOA), we offer a number of different instruments for the determination of thermal values such as melting, boiling, dropping and cloud point temperatures.

www.mt.com

For more information

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