

Thermal Analysis Excellence



TGA 2

STAR[®] System

Innovative Technology

Versatile Modularity

Swiss Quality



Thermogravimetry For Routine Analysis

METTLER TOLEDO

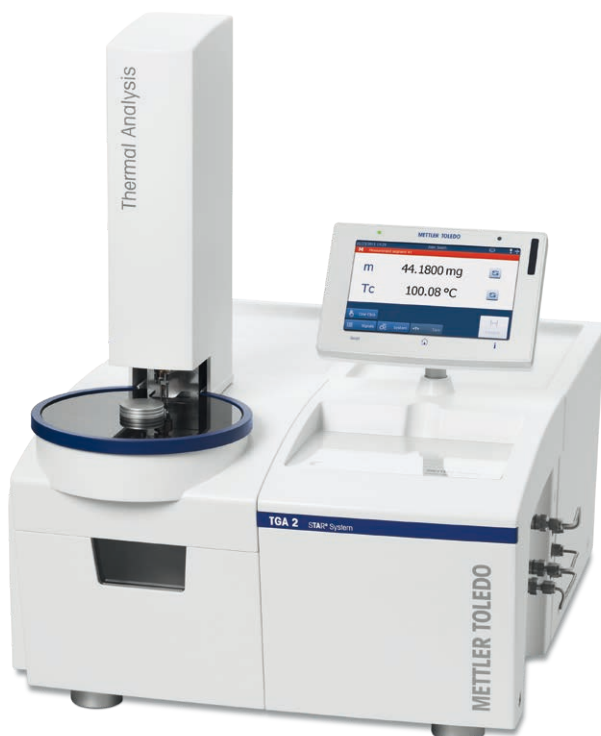
Fast and Accurate TGA Results

METTLER TOLEDO Balance Inside

Thermogravimetry (TGA) is a technique that measures the change in weight of a sample as it is heated, cooled or held at constant temperature. Its main use is to characterize materials with regard to their composition. Application areas include plastics, elastomers, thermosets, mineral compounds and ceramics, as well as in a wide range of analyses in the chemical and pharmaceutical industries.

Features and benefits of the METTLER TOLEDO TGA 2:

- **METTLER TOLEDO ultra-micro balance** – rely on the market leader in balance technology
- **Very low minimum weight on 5-gram-balances** – measure samples accurately and precisely
- **High resolution** – sub-microgram resolution over the entire weighing range
- **Robust, factory endurance-tested sample robot** – operates efficiently and reliably around the clock
- **Start the experiment with just OneClick™** – fast and simple routine operation
- **Built-in gas flow control** – analyze samples in a defined atmosphere
- **Automatic buoyancy compensation** – for faster accurate results
- **Modular concept protects your investment** – fits to your current and future needs
- **Comprehensive services** – professional support for your day-to-day work





TGA equipped with a top-of-the-line METTLER TOLEDO ultra-micro balance with unique built-in calibration weights ensures unbeatable accuracy.

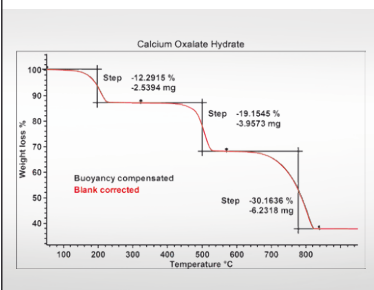
► www.mt.com/ta-acc

Outstanding Technology

Sound Investment for the Future

Ever since its inception in 1964, METTLER TOLEDO's TGA technology has continued to evolve, spawning innovation in industries and new materials. Trying to fit the needs of every customer, there are countless options and built in features to make the TGA 2 a world-class instrument.

Automatic buoyancy correction



The TGA has the capability to automatically correct for influences on a measurement that are not related to the sample such as buoyancy. This reduces the experimental time needed to produce accurate results by eliminating the need to run a blank measurement. The automatic correction can be switched off by the user.

Optimal atmosphere



Built-in mass flow controllers allow for precisely defining the furnace atmosphere. This allows accurate and repeatable investigation of material properties under a variety of atmospheres (including vacuum) and switching of reactive gas during an experiment. The gastight furnace with defined conditions is essential to obtain unambiguous information and quality results.

Furnace options



Choice of different furnace sizes allow for a wide range of possible applications. The small furnace has the highest temperature accuracy, due to its small volume. The large furnace allows measurement of samples in crucibles up to 900 μ L.



With two different furnace sizes available, a wide range of crucible sizes can be used to fit your needs. Crucibles up to 900 μL can accommodate large samples when small weight loss events take place.

► www.mt.com/ta-crucibles

Reliable Automation

24 Hours a Day, Like a Swiss Watch

Automatic and efficient, our sample robot is a sophisticated automation option allowing for reliable operation 24 hours a day though the whole year. Together with the STAR[®] software, the power of the automation is increased by our unique FlexCal™ calibration concept always selecting the correct adjustment parameters, and the possibility to automatically evaluate results.

Features and benefits of the sample robot:

- **34 sample positions** – dramatically increases efficiency
- **Simple and rugged design** – guarantees reliable results
- **Unique lid piercing capability** – no change in sample weight during the wait cycle
- **Automatic crucible lid removal system** – reduces unwanted loss of sample mass
- **Universal gripper** – can handle all types of METTLER TOLEDO crucibles

Fully automatic weigh-in



Samples can be weighed-in semi or fully automatically using the internal TGA balance in combination with the sample robot. Simply place the empty crucibles for automatic weighing, and then insert a sample in each crucible. The robot will take care of the rest.

No weight change before measurement



The sample robot can remove the protective crucible lid from the crucible or pierce the lid of hermetically sealed aluminum crucibles immediately before measurement. This unique feature helps to prevent any mass change between weigh-in and the measurement.

Extensive 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 μ L. All of the different types can be used with the sample robot. Available crucible materials can be found here:

► www.mt.com/ta-crucibles



All TGA 2 models can be automated. The sample robot can process up to 34 samples even if every sample requires a different method and a different crucible.

► www.mt.com/ta-automation

Hyphenated Techniques Provides More Material Insight

To obtain more information from a single experiment, a TGA 2 can be coupled to a humidity generator, a mass spectrometer, an FTIR spectrometer, a GC/MS-system or a Mirco GC/MS. This enables you to interpret measurement curves with greater certainty.

Features and benefits of the TGA Hyphenated techniques systems:

- **Automated TGA-EGA systems** – save time by acquiring more information from a single run
- **Simultaneous TGA-EGA** – enables quantitative compositional analysis and material identification
- **Reference databases** – help to identify gaseous decomposition products
- **Unique flexibility** – a highly sensitive thermoanalyzer combined with full sorption analysis capability
- **Defined environment** – the effect of moisture and temperature on material properties can be easily investigated

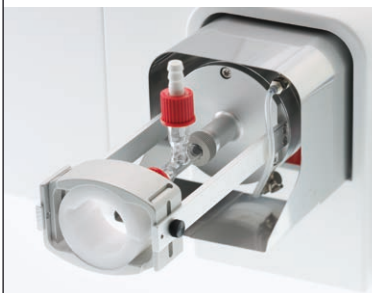
Sorption Interface



The TGA can be converted to a TGA Sorption analyzer in just a few minutes. This allows materials to be analyzed under precisely defined conditions of relative humidity and temperature.

► www.mt.com/ta-moisture

TGA-MS Interface

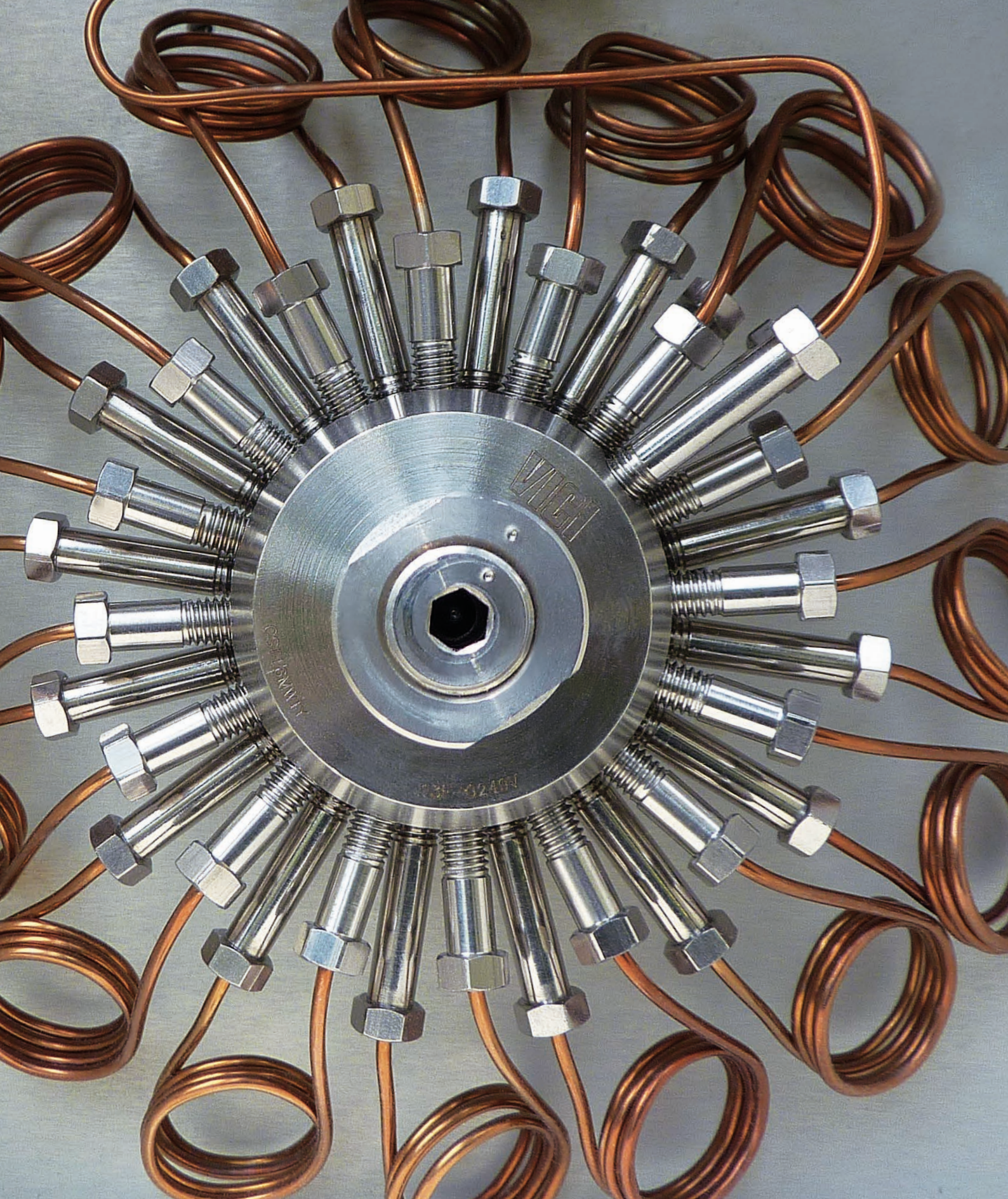


The TGA-MS interface is able to expand the instrument to the extremely sensitive techniques of Mass Spectrometry (MS). Similarly, you can couple a TGA to a Micro GC/MS.

TGA-FTIR Interface



FTIR can be used to characterize or identify a substance or class of molecules. The identification of the evolved gas is simplified by the ability to import the curves into STAR® Software.



The TGA-IST16-GC/MS is an instrument extension for characterization by thermogravimetric analysis. The combined system provides valuable information, whether it is used in quality control or for industrial and academic research.

► www.mt.com/ta-ega

Accessories

For Simple Routine Operation

Save time with our simple and intuitive solutions. Accessories and OneClick™ functionality provide benefits to users by simplifying sample preparation and instrument operation, as well as providing means to calibrate and adjust the TGA 2.

CalPac™



An optional set with certified E2 weights can be used for external weight calibration.

OneClick



OneClick technology allows for quick initiation of routine measurements. At the touch of a button, start experiments with predefined methods directly from the instrument's color touchscreen display. This accelerates the processing of routine measurements significantly.

Efficient sample preparation

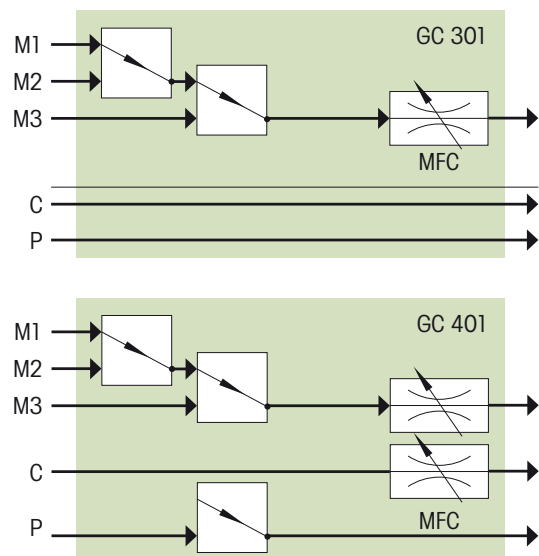


The crucible box and toolbox help you keep everything tidy, making sample preparation easier and faster.

Option Matrix: A TGA 2 for every need and configuration can be found in the below table.

	Balances				EGA (MS, FTIR, GC/MS, Micro-GC/MS)	Sorption	GC 301	GC 401
	XP1	XP1U	XP5	XP5U				
TGA 2 (SF 1100 °C)	•	•	•	•	•		standard	optional
TGA 2 (LF 1100 °C)	•	•	•	•	•	•	standard	optional
Peripheral control					recommended	recommended		
Sample Robot	no additional options required							

• = Selectable



Defined furnace atmosphere, programmable gas flow and gas switching.

The furnace chamber can be purged with a defined gas flow. The software-controlled mass flow gas controller measure and regulates the gas flow between 0 and 200 mL/min and can automatically switch up to 3 gases. Regulate and switch gases such as air, nitrogen, oxygen, argon, CO₂ and inert hydrogen (96% Ar, 4% H₂).

	Small Furnace	Large Furnace
Max Temperature	1100 °C	1100 °C
Max Crucible Size	100 µL	900 µL

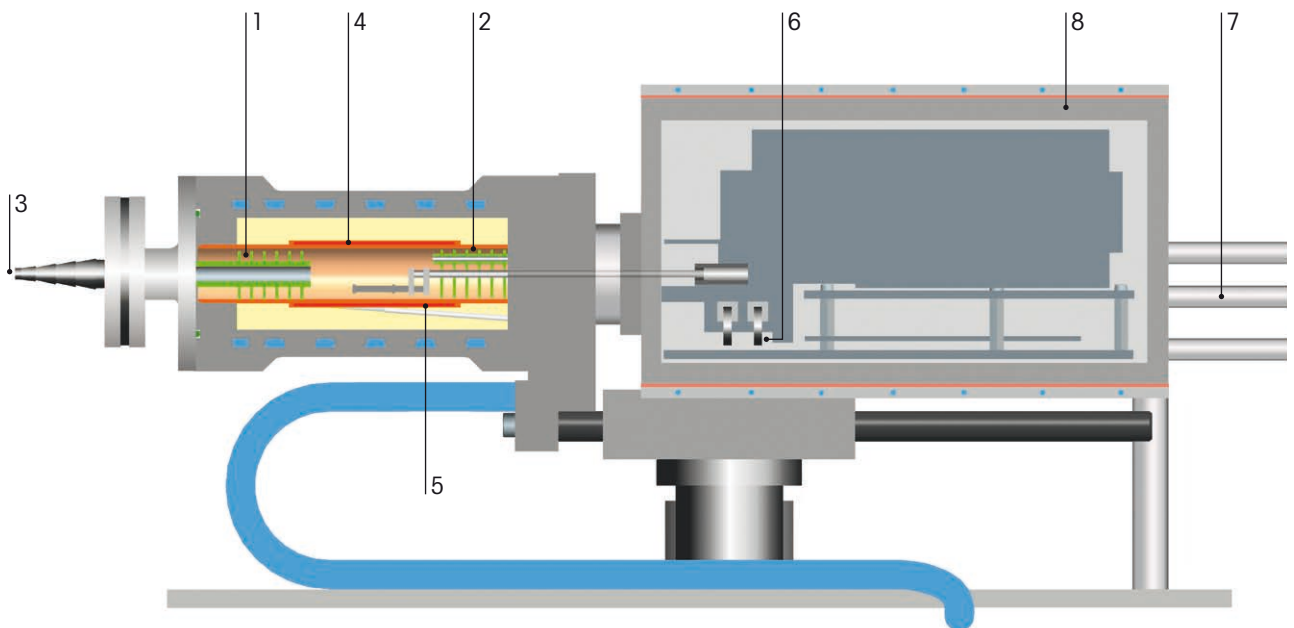
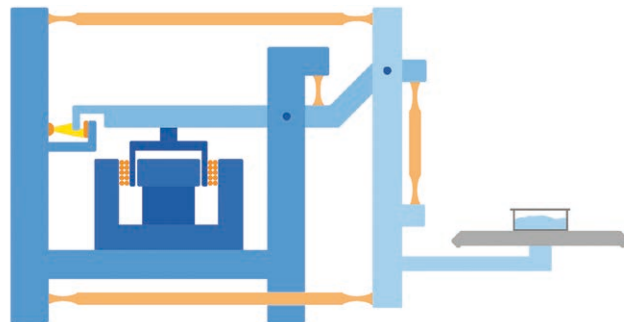
Build the TGA that fits your requirements. Different furnace sizes and balances are available for every possible application.

Balance	Measurement Range (g)	Resolution (µg)
XP1	1	1
XP1U	1	0.1
XP5	5	1
XP5U	5	0.1

Excellent Performance Over the Entire Weighing Range

Outstanding weighing performance. No other TGA can measure up to 50 million resolution points continuously – weight changes of a 5-gram sample are determined to 0.1 µg. A low minimum weight ensures that small samples close to the low end of the weighing range are also weighed accurately.

Modern weighing technology:
The parallel guided balance ensures that the position of the sample does not influence the weight measurement. Built-in automatic buoyancy compensation eliminates the need for time consuming baseline measurements.



- | | | |
|---------------------------|-------------------------------|---------------------------------------|
| 1. Baffles | 4. Furnace heater | 7. Protective and purge gas connector |
| 2. Reactive gas Capillary | 5. Furnace temperature sensor | 8. Thermostated balance chamber |
| 3. Gas outlet | 6. Adjustment ring weights | |



Inserting samples manually is made easy with the well-designed and ergonomic support. The instrument's display also gives a clear picture of the instrument's status for ease of use.

► www.mt.com/ta-tga

Extremely Wide Application Range For All Kinds of Materials

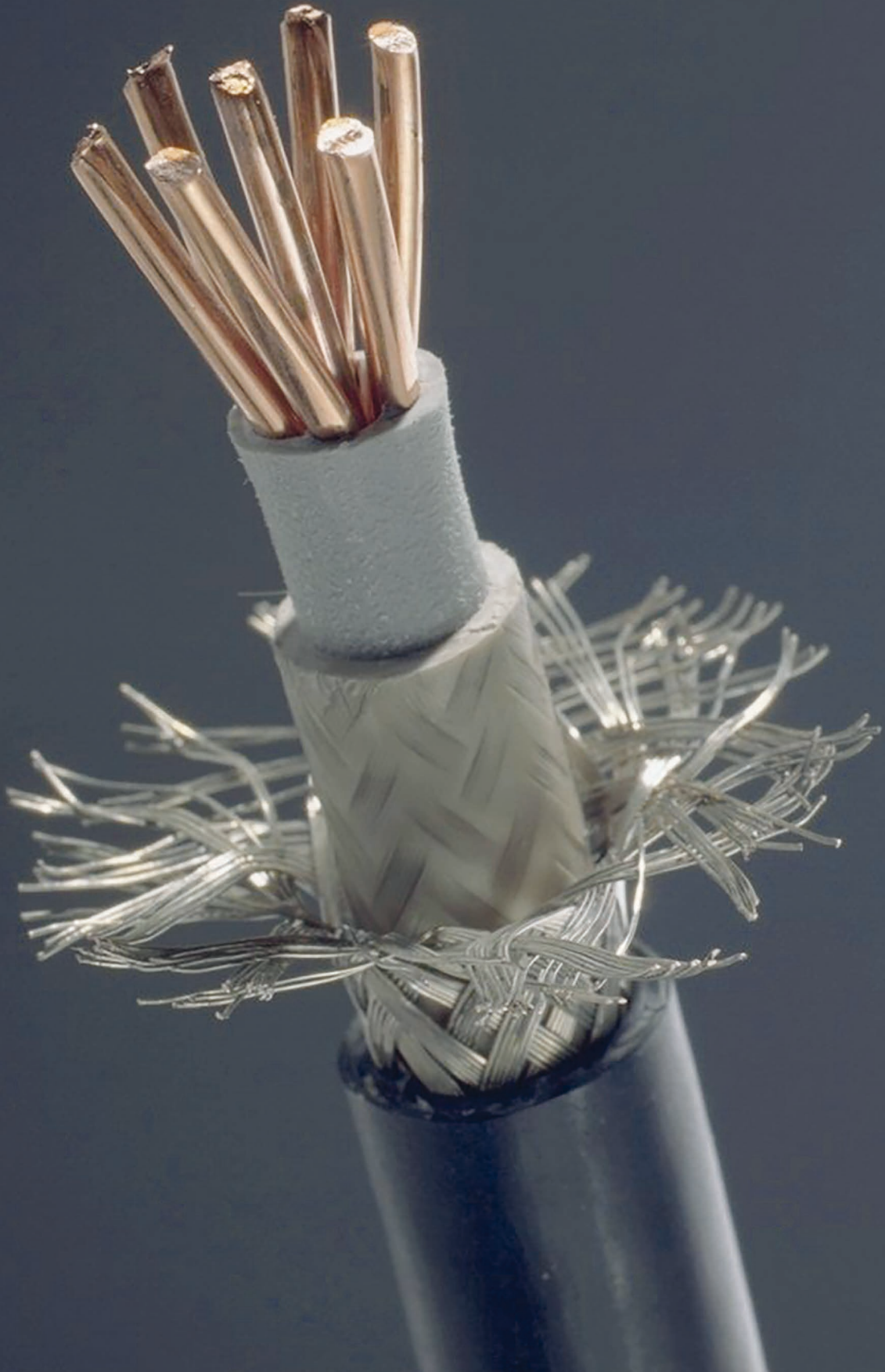
Thermogravimetric analysis measures the change in mass over a wide temperature range (up to 1100 °C). Utilizing the world's best METTLER TOLEDO micro and ultra-micro balances the TGA 2 is an exceptionally versatile tool for the characterization of physical and chemical material properties under precisely controlled atmospheric conditions.

The TGA 2 is a fast, reliable method to gain valuable information for research, development and quality control in numerous fields such as plastics, building materials, minerals, pharmaceuticals and foodstuffs.

Examples of thermal events and processes that can be determined by TGA

- Quantitative content analysis (moisture, fillers, polymer content, materials, etc.)
- Adsorption and desorption of gases
- Kinetics of decomposition processes
- Sublimation, evaporation and vaporization
- Thermal stability
- Oxidation reactions and oxidation stability
- Identification of decomposition products, solvents and solvates
- Sorption and desorption of moisture
- Pseudopolymorphism
- Determination of Curie temperatures

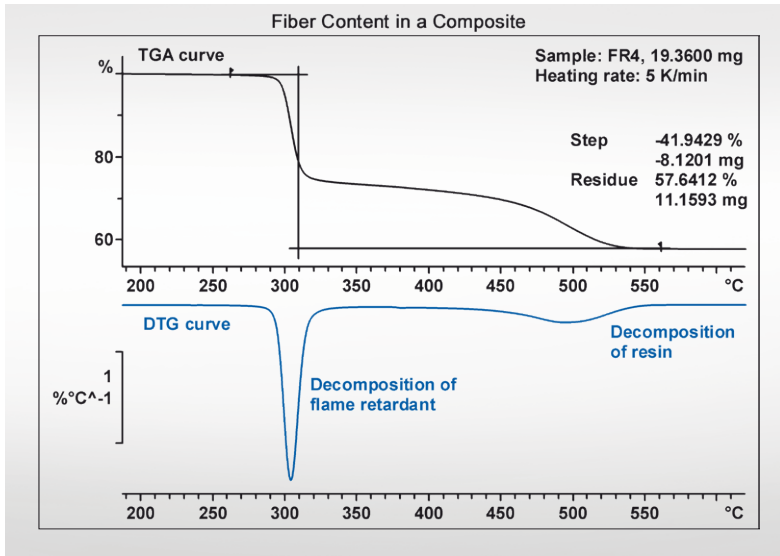




Thermogravimetry provides quantitative information on the composition and thermal stability of many different types of materials. The method is fast and can even be used with very small samples.

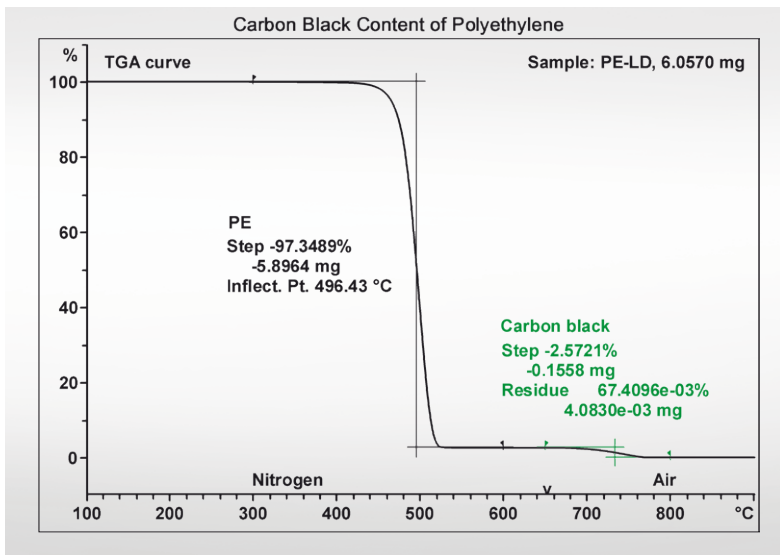
► www.mt.com/ta-applications

Fiber content in composite materials



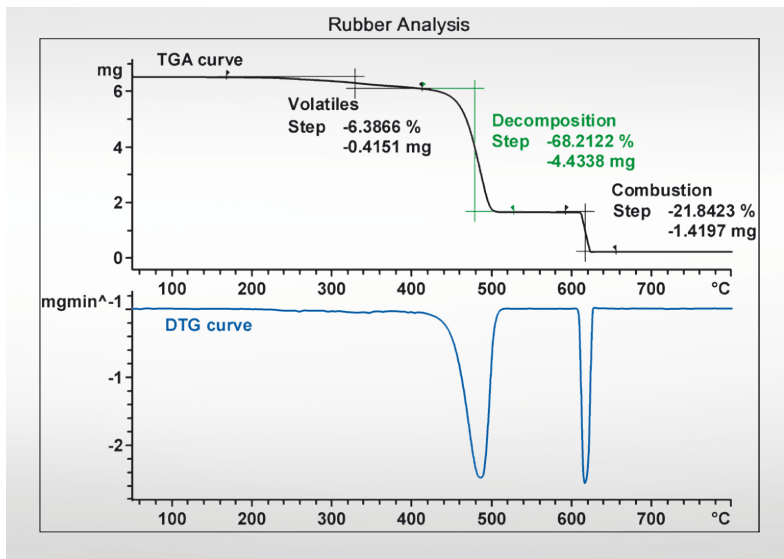
Thermosetting materials are often reinforced with fibers in order to increase their rigidity. The determination of the fiber content is a regular task in quality control. The first derivative of the TGA curve (DTG) is proportional to the rate of decomposition. The weight loss and reaction that occur at about 300 °C are responsible for the material's flame resistance. The rest of the matrix resin burns off at temperatures between 450 and 550 °C, leaving behind the glass fabric. The glass fiber content of this material is 57.6%.

Carbon black content in polyethylene



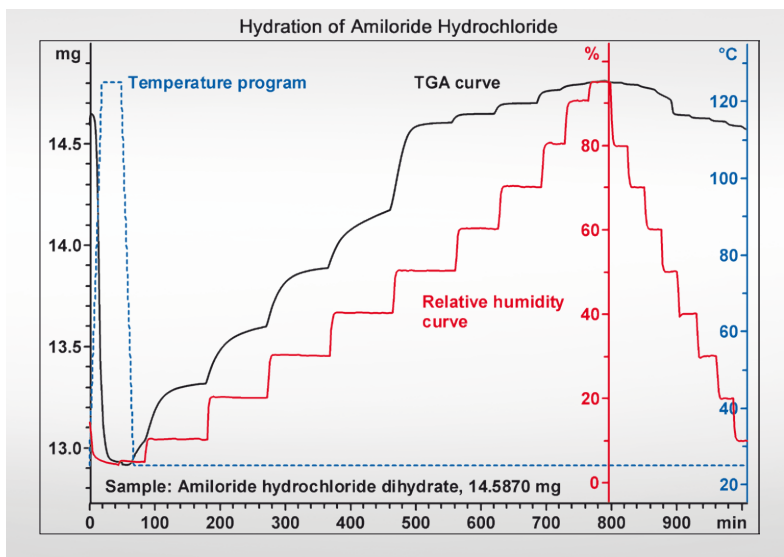
Polyethylene (PE) pyrolyzes in a nitrogen atmosphere between 400 °C and 600 °C. The carbon black used as a filler burns off after the atmosphere is switched to air at 650 °C. The higher the specific surface or "activity" of the carbon black, the faster the oxidation reaction takes place. The sample investigated had a polymer content of 97.3% and a carbon black content of about 2.6%.

Composition of SBR



In rubber analysis, the sample is first heated to 600 °C under inert conditions. The volatile components (plasticizers, often oils) vaporize and pyrolysis of the polymer begins shortly afterward at about 400 °C. At 600 °C, the atmosphere is then switched from inert to oxidative, resulting in the combustion of the carbon black additive. Inorganic components remain behind as a residue. The SBR sample analyzed in the example contained 6.4% plasticizer, 68.2% polymer and 21.8% carbon black. The residue (mainly zinc oxide) was 3.6%.

Dynamic sorption curve

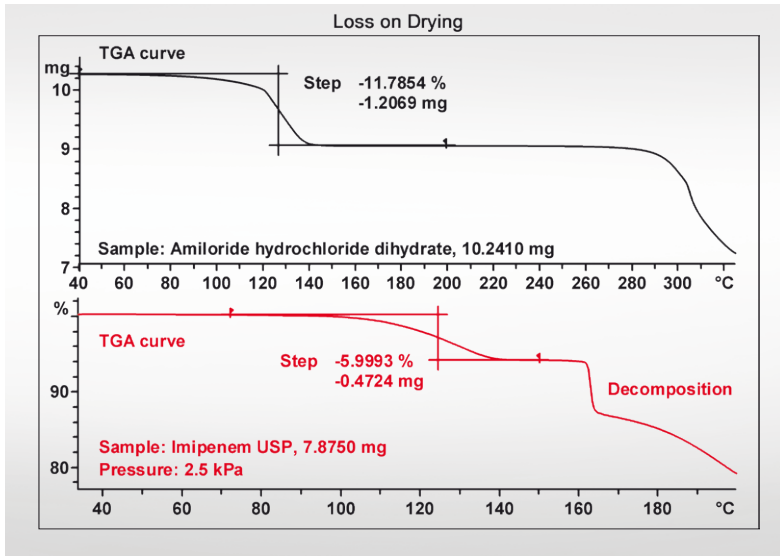


The TGA curve shows the uptake and release of moisture by a sample of amiloride hydrochloride dihydrate as a function of relative humidity (RH). The stages of the analysis include:

- Temperature program with a preconditioning segment (dehydration) at 125 °C (dotted line)
- Increase of RH in steps of 10% with equilibration (red curve)
- Resulting weight changes for each 10% change in RH (black curve)

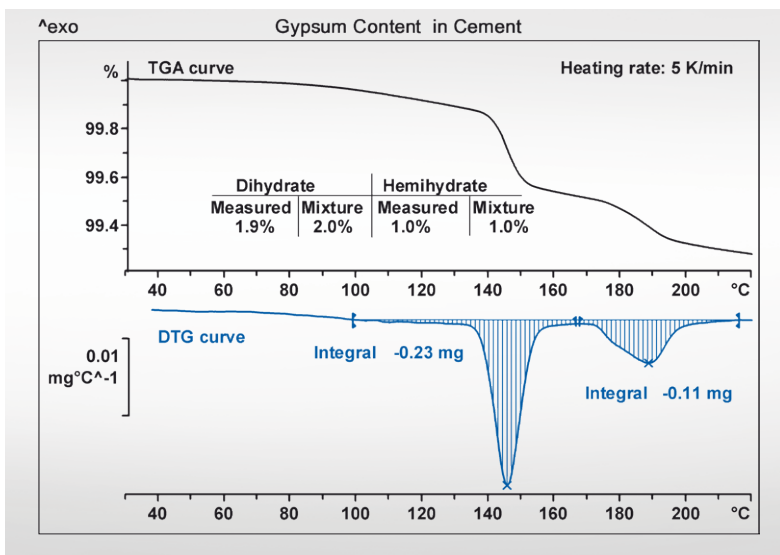
At a RH of about 85%, the substance has regained its original water of crystallization. Further increase of RH results in the uptake of free surface water. This is liberated when the RH is reduced.

Weight loss on drying



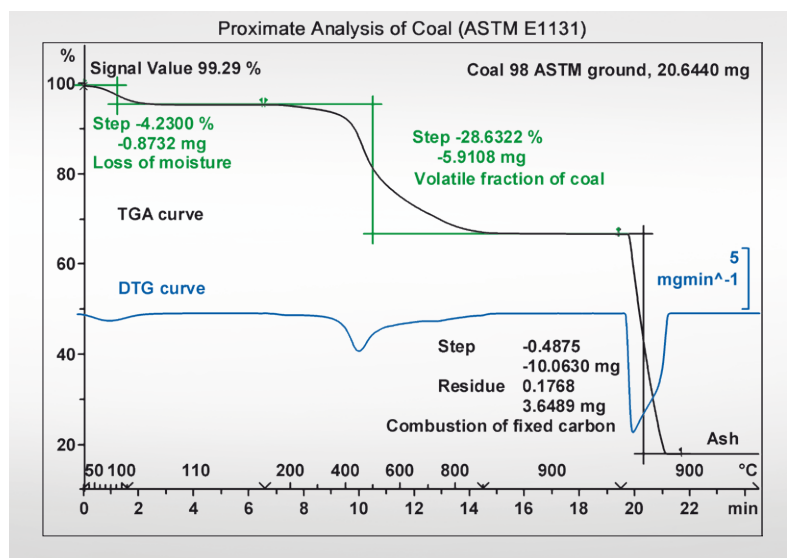
The simplest way to get an overview of the drying behavior of a pharmaceutical substance is to use a standard method, such as the USP "Loss on Drying". The examples show the weight loss curves of amiloride dihydrate (above) and imipenem (below). Imipenem was measured in vacuum at 2.5 kPa. The measurement of the two samples according to the standard method resulted in weight losses of 11.8% and 6% due to the release of water. The weight losses of both substances are within the tolerances permitted in the monographs. Measurements such as these are typically used in control and release analysis.

Gypsum content in cement



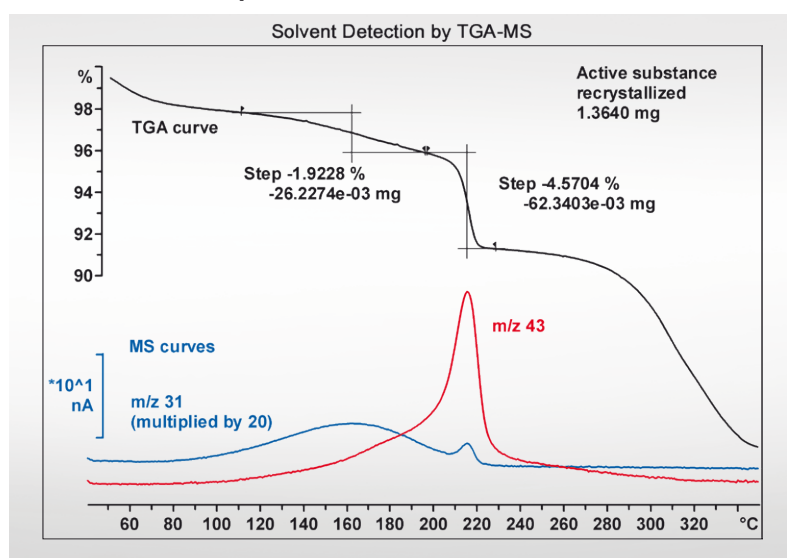
Gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, is used to control the hardening of cement and is present as the dihydrate and hemihydrate. The two compounds can be analyzed in cement by measuring samples in crucibles sealed with lids with 50 μm holes. The TGA curve shows two weight loss steps corresponding to the dehydration of the gypsum and the hemihydrate. The weight losses are more easily determined by integrating the peaks in the first derivative (DTG) curve. The dihydrate and hemihydrate contents determined in this way agree well with the manufacturer's specifications.

Fast coal analysis



Thermogravimetric analysis provides a quick and convenient way to evaluate the quality of coal and coke in about 20 minutes. The moisture content, volatile substances, bound (fixed) carbon, and ash are all reliably quantified by this method. The higher the ratio of combustible to non-combustible components, the more valuable the coal. In contrast to classical standard methods, the smaller sample sizes and higher heating rates used by the TGA result in significantly faster results. The evaluation shows the analysis of an ASTM standard coal. The measurement is performed in nitrogen up to the first isothermal segment at 900 °C, and then automatically switched to oxygen for the final segment.

Residual solvents in pharmaceutical substances



Many pharmaceutical substances are recrystallized from solvents. As a result, residues of solvents often remain in the product. Combined techniques such as TGA-MS are ideal to detect and identify such undesired residues. In the example, methanol and acetone were used to recrystallize the active substance. The presence of these two substances is confirmed by the peaks in the m/z 43 and m/z 31 fragment ion curves. The results indicate that the weight loss step at 200 °C is almost entirely due to the elimination of acetone.

Simple, Intuitive Operation

Straightforward, Efficient and Secure

STAR[®] software has been expanded to include new features that help you prepare your TGA 2 instrument for specific experiments, develop methods for advanced analyses and perform flexible result evaluations. Complex measurement programs are set up within minutes and the vast range of available tools permit curves to be evaluated accurately and efficiently.

Routine window



The Routine Window allows you to create simple methods directly in the upper part of the Module Control Window.

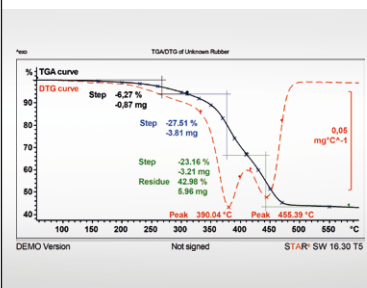
Reference library



The reference library option in STAR[®] thermal analysis software permits TA data and complementary EGA data (MS, FTIR or GC/MS) to be readily incorporated into a centralized database for rapid and reliable result comparisons.

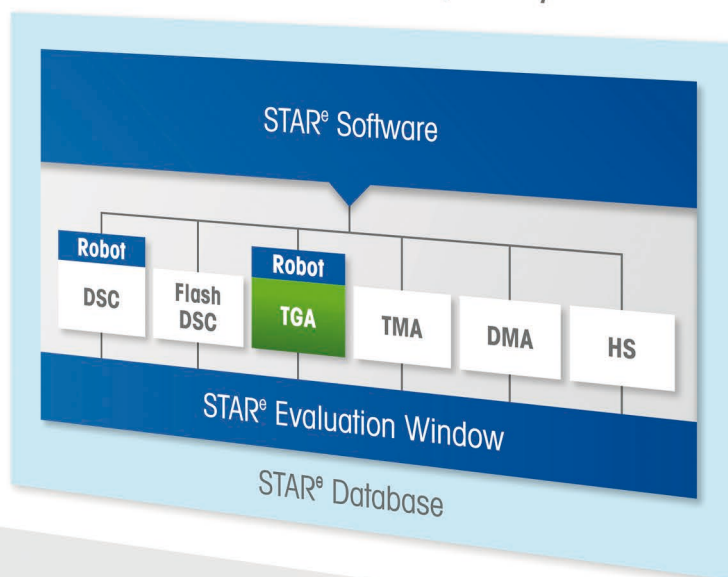
► www.mt.com/ta-libraries

TGA/DTG



The first derivative of the TGA curve, the DTG curve, often improves the evaluation of the step in a TGA curve. In a DTG curve, a TGA step due to a change in mass is displayed as a peak. This makes it easier to determine the limits of the TGA steps (shown as minima between peaks in the DTG curve).

Complete Thermal Analysis System



A complete thermal analysis system consists of the basic six complementary measuring techniques, each bringing fast and accurate results. Additional knowledge can be obtained by means of several hyphenated techniques.

► 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.

Videos

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Handbooks

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Applications

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Comprehensive training courses



We offer effective classroom training sessions.

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For self-training purposes, you may purchase the tutorial kit consisting of 23 well-chosen application examples and their corresponding test substances.

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Register for an e-training course

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Bi-annual application magazine



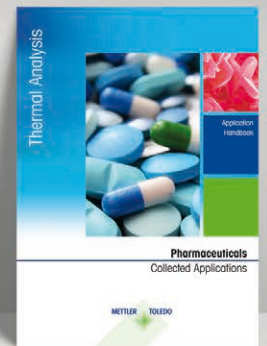
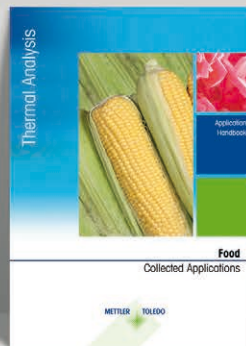
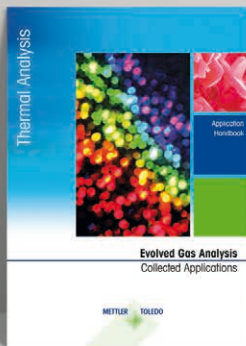
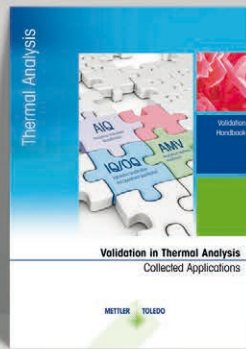
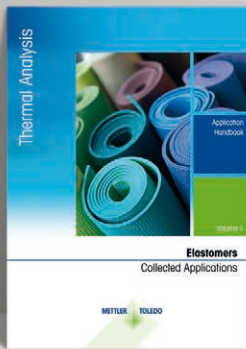
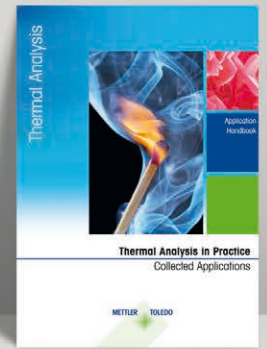
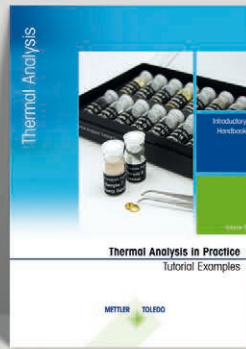
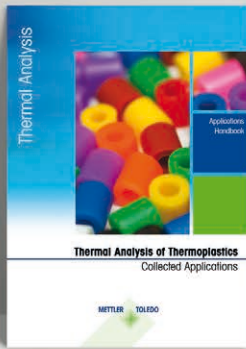
Every year, thermal analysis generates a large number of scientific results and discoveries. Interesting examples from different application fields and industries are published in our UserCom magazine.

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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



We offer application handbooks for thermal analysis. These include an introduction to the main thermal analysis techniques – DSC, TGA, TMA, and DMA – followed by a range of application examples for a wide variety of materials.

► www.mt.com/ta-handbooks

TGA 2 Specifications

Temperature data	Small furnace (SF)	Large furnace (LF)
Temperature range	RT to 1100 °C	RT to 1100 °C
Temperature accuracy ¹⁾	± 1 K	± 1 K
Temperature precision ¹⁾	± 0.4 K	± 0.6 K
Heating rate ²⁾	0.02 to 250 K/min	0.02 to 150 K/min
Cooling time	20 min (1100 to 100 °C)	22 min (1100 to 100 °C)
Cooling time with helium ²⁾	≤ 10 min (1100 to 100 °C)	≤ 11 min (1100 to 100 °C)
Sample volume	≤ 100 µL	≤ 900 µL

Special modes

Automation	optional	
MaxRes		
TGA-MS, TGA-FTIR, TGA-GC/MS, TGA-Micro GC/MS		
Vacuum	> 10 mbar	> 10 mbar
TGA-Sorption	no	optional

Balance data	XP1	XP1U	XP5	XP5U
Measurement range	≤ 1 g	≤ 1 g	≤ 5 g	≤ 5 g
Resolution	1.0 µg	0.1 µg	1.0 µg	0.1 µg
Weighing accuracy	0.005%	0.005%	0.005%	0.005%
Weighing precision	0.0025%	0.0025%	0.0025%	0.0025%
Repeatability	< 0.001 mg	< 0.0008 mg	< 0.002 mg	< 0.0009 mg
Typical Minimum Weight ³⁾	0.19 mg	0.16 mg	0.22 mg	0.17 mg
Typical Minimum Weight USP ^{3,4)}	1.9 mg	1.6 mg	2.2 mg	1.7 mg
Internal ring weights	2			
Blank curve reproducibility	better than ± 10 µg over the whole temperature range			

Dimensions

Width/depth/height	52/63/28 cm (62.5 cm with sample changer)
Weight	40 kg (44 kg with sample changer)
Power supply	230 V, 60 Hz, 6 A or 115 V, 50 Hz, 12 A

Approvals

IEC/EN61010-1:2001, IEC/EN61010-2-010:2003
 CAN/CSA C22.2 No. 61010-1-04
 UL Std No. 61010A-1
 EN61326-1:2006 (class B)
 EN61326-1:2006 (Industrial environments)
 FCC, Part 15, class A
 AS/NZS CISPR 22, AS/NZS 61000.4.3
 Conformity mark: CE

¹⁾ based on Curie reference substances

²⁾ depends on instrument configuration

³⁾ depends on instrument environment and condition

⁴⁾ USP = United States Pharmacopeia

www.mt.com/ta

For more Information

METTLER TOLEDO Group

Analytical Instruments

Local contact: www.mt.com/contacts

Subject to technical changes

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Marketing MatChar / MarCom Analytical



Quality certificate. Development, production and testing according to ISO 9001.



Environmental management system according to ISO 14001.



“European conformity”. The CE conformity mark provides you with the assurance that our products comply with the EU directives.