TA Instruments

The **WORLD'S FINEST** line of
THERMOGRAVIMETRIC ANALYZERS

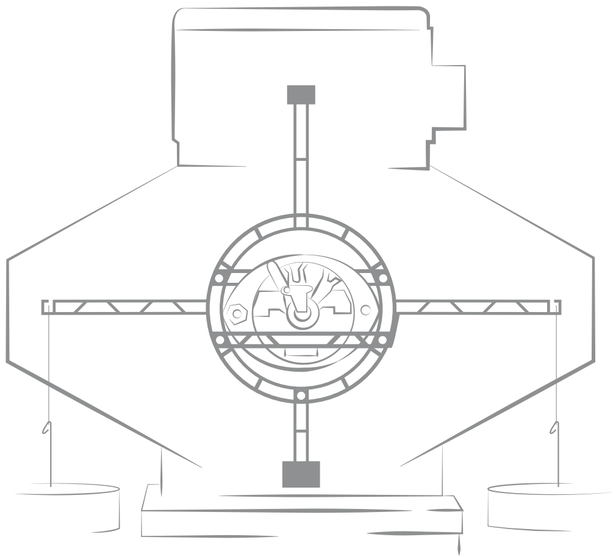
TGA SYSTEMS that **deliver** the

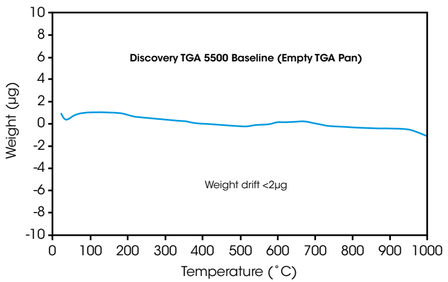
Most Accuracy

Highest Sensitivity

Greatest Reliability

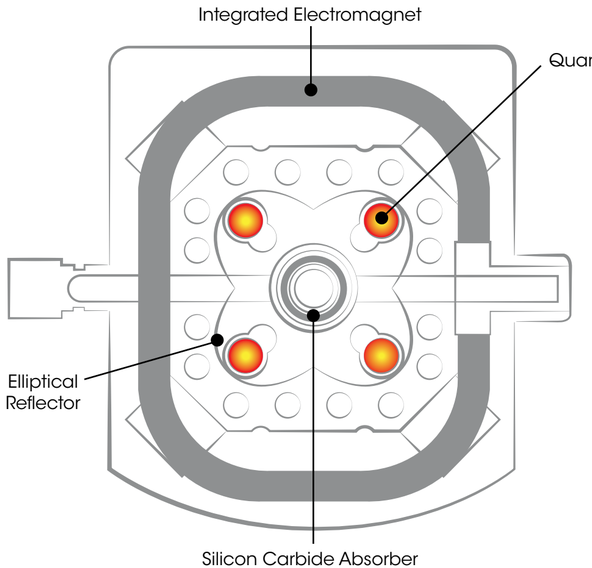
HIGH SENSITIVITY and STABLE WEIGHT MEASUREMENTS

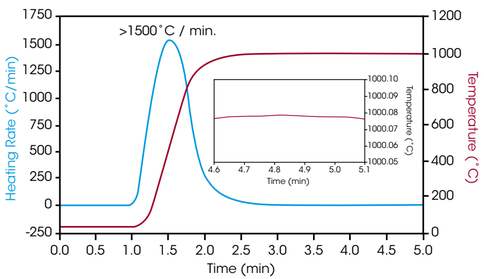




PLUS...

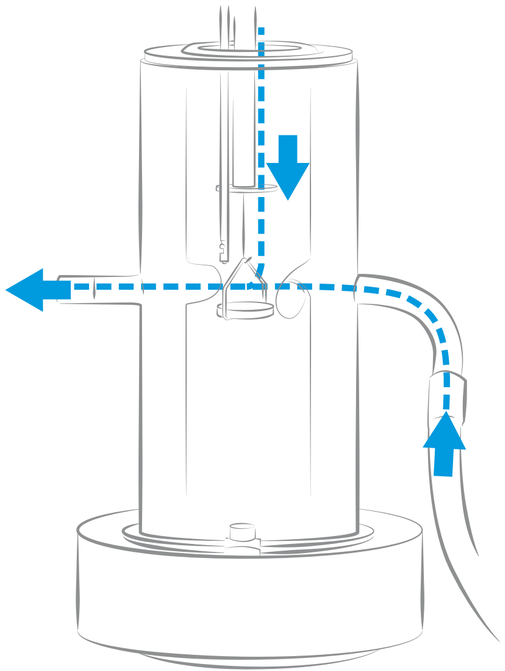
FASTEST and MOST ACCURATE TEMPERATURE CONTROL

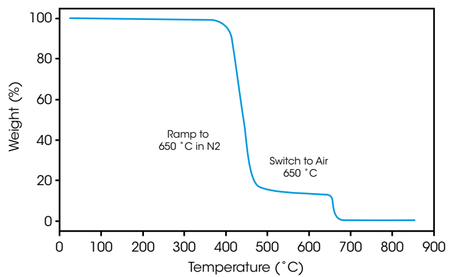




PLUS...

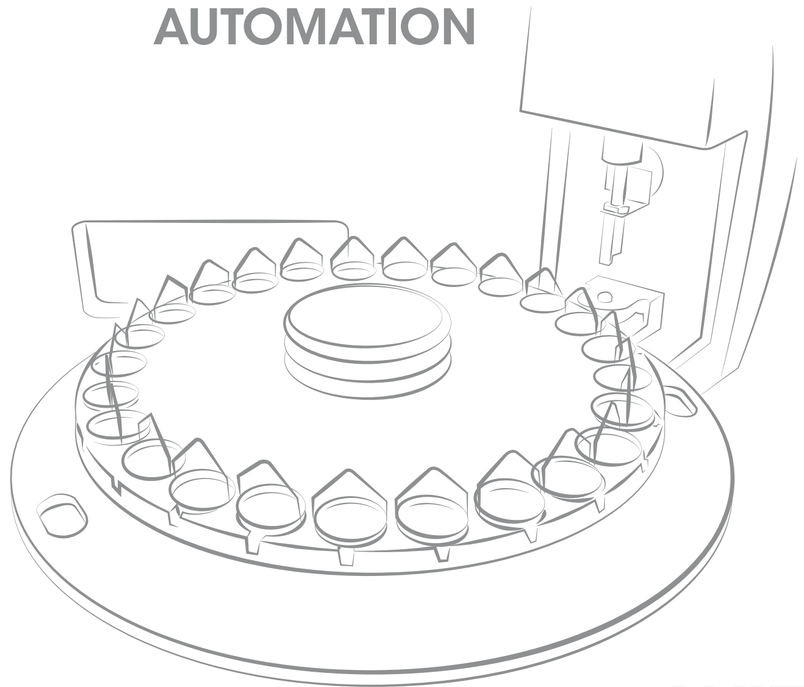
The MOST FLEXIBLE and EFFICIENT ATMOSPHERE CONTROL





PLUS...

RUGGED and RELIABLE AUTOMATION

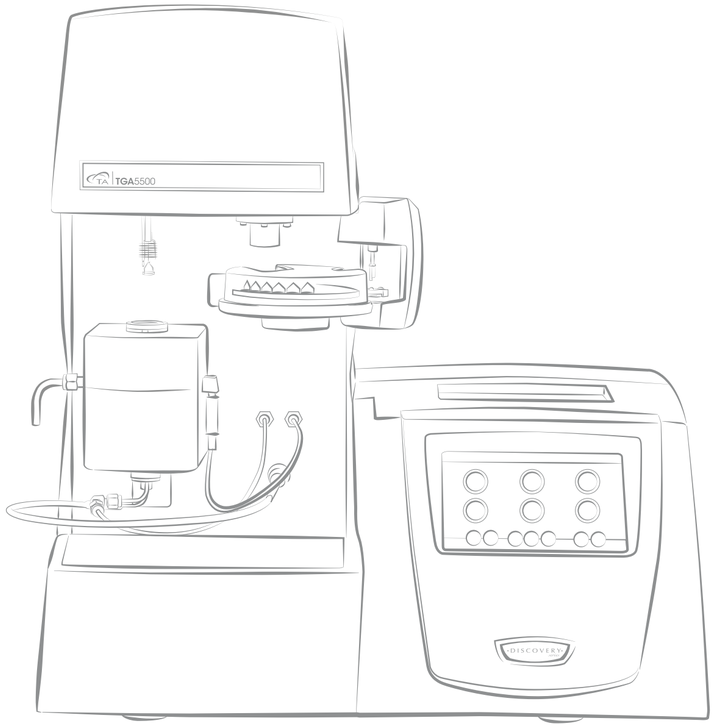


WITH...

The **MOST VERSATILE CONTROL**
and **ANALYSIS SOFTWARE**

EQUALS...

SUPERIOR TGA PERFORMANCE



TA Instruments invites you to experience the world's finest line of Thermogravimetric Analyzers, the Discovery TGA 55, TGA 550, and TGA 5500. Discover the advanced engineering and attention to detail that provides enhancements in every aspect of TGA technology and a new level of user experience. From the most cost-effective and flexible TGA with industry-leading performance, to the most advanced TGA available, there is a Discovery TGA to meet your needs and exceed your expectations.

TGA 55

Premium Performing TGA

The TGA 55 is specifically designed for those that want a rugged, reliable, and cost-effective TGA, and are not willing to compromise on performance. Utilizing TA's proprietary Tru-Mass™ Balance as the core of the measurement, the TGA 55 will outperform competitive research-grade models. Its sensitivity, accuracy and ease-of-use make this TGA an ideal instrument for basic research, academic or industrial labs that need quality results.

TGA 550

Premium performance with advanced options and configuration flexibility

The TGA 550 will not only outperform competitive top-tier systems, but will also give users the flexibility to add advanced features like Hi-Res TGA, MTGA, DTA signal, and our new 25-position autosampler. The performance, flexibility, and ease-of-use make this an excellent TGA for research and multi-user laboratories where a wide variety of TGA experiments are conducted and future expansion of analytical work is anticipated.

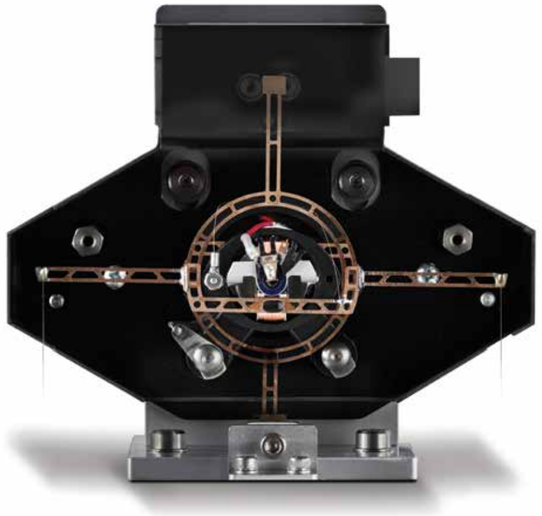
TGA 5500

Ultimate performance with every option to meet the requirements of the most demanding applications

The TGA 5500 is designed for the researcher that requires the highest level of performance and features in one package. Built to maximize temperature control and minimize signal drift, the TGA 5500 has less drift than any competitive TGA – even those using post-test data manipulation! The TA patented IR furnace* delivers the fastest heating and cooling rates available. The all-new 25 position autosampler takes productivity to the highest level while also featuring the pan punch mechanism for automated sequencing of materials where the sample environment must be controlled prior to testing.

* U.S. Patent no. 7,416,328 and 7,566,167

No one makes a MORE SENSITIVE and ACCURATE THERMOBALANCE



At the core of every new Discovery TGA is the proprietary Tru-Mass™ Balance. The Tru-Mass Balance system is Thermally isolated for high Sensitivity in every laboratory environment, delivers the highest Resolution to separate components of the most challenging TGA samples, and has Ultra low drift (Tru-Mass) for weight accuracy. Unlike competitive designs, the Discovery TGA delivers optimum performance without requiring baseline subtractions and other post-test manipulation required by competitors. The result is an innovative TGA with unrivaled performance in weight drift and sensitivity.

Balance Features and Benefits:

- Ultra-low drift balance design ensures accurate detection of even the smallest weight changes
- High capacity (1 g) Tru-Mass balance with auto-ranging capability to ensure the best sensitivity no matter the size of the sample
- Free-hanging sample eliminates the heat sink prevalent in top-loading designs, for the most efficient heat transfer and gas flow around the sample
- Thermally isolated balance with low drift and high sensitivity to deliver the most accurate real-time data

The propriety Tru-Mass™ balance delivers pure real-time weight data.

Low DRIFT
High CAPACITY
Most ACCURATE DATA

WIDEST RANGE of HEATING & COOLING RATES

EVERY furnace on EVERY system is designed and manufactured by TA specifically for high performance TGA measurements. From the economical high-performing wire wound and EGA furnaces to the patented IR furnace* with the industry-leading heating rates, there is a TGA furnace to meet your needs.

IR Furnace

The TGA 5500 is the only system offering patented infrared heating technology.

- Ambient to 1200°C
- Linear controlled heating rates of 0.1 to 500°C/min
- Ballistic heating rates >1500°C/min for the highest efficiency available
- Fastest cooling for improved sample throughput
- Low volume, vacuum tight, and quartz lined with heated outlet option for best evolved gas results
- Quartz liner makes furnace easy to clean
- Integrated electromagnet for automated verification and calibration using Curie point standards

Wire Wound (Pt/Rh) Furnace

Standard furnace for the TGA 55 and TGA 550.

- Ambient to 1000°C
- Linear controlled heating rates of 0.1 to 100°C/min
- Ballistic heating rates >600°C/min
- Low mass furnace allows fast cooling for quick and efficient turn-around between runs

EGA Furnace

Optional Evolved Gas Analysis (EGA) furnace for the TGA 55 and TGA 550.

- Ambient to 1000°C
- Linear controlled heating rates of 0.1 to 50°C/min
- Low volume, vacuum tight, and quartz lined for good evolved gas results
- Quartz liner makes furnace easy to clean

All TA furnaces are built to be rugged and reliable and are covered by the industry's ONLY 5-YEAR WARRANTY

* U.S. Patent no. 7,416,328 & 7,566,167

BEST SAMPLE–ATMOSPHERE INTERACTION

Discovery TGA's are designed with superior atmosphere control to meet the most demanding applications. Whether maintaining an inert atmosphere, switching to an oxidative purge, or maintaining a high vacuum, the Discovery TGA is up to the task.

Atmosphere Control Features and Benefits:

- Innovative Gas-Delivery Manifold (GDM) design eliminates potential leak points from tubing and hardware connections ensuring the most consistent, repeatable atmosphere
- Integrated software-controlled gas switching for experiments requiring dynamic or reactive atmospheres
- An optional Blending Gas Delivery Module with in-line mixing of binary gases and advance atmosphere control where the concentration ratio of the gases may be held constant, incremented or ramped
- Horizontal gas purge for optimal sample-atmosphere interaction
- Vacuum tight to ensure inert, oxygen-free atmospheres
- Sealed pan option to maintain the atmosphere of the sample until the experiment starts

The Discovery TGA features a 25-position autosampler designed to be the most rugged and reliable system ever developed.

Autosampler Features and Benefits:

- Compatible with all pan types and sizes for ultimate flexibility
- Sealed pan* and pan punch option for effective isolation of air-sensitive or volatile samples
- Scheduled and unattended calibrations and verifications give scientists more time for research
- Integrated electromagnet allows for unattended Curie point calibrations[1]
- New TRIOS software makes it easier than ever to manage and run a large and diverse sample queue. The Design view and Running queue allow for quick and efficient autosampler programming

FLEXIBLE DESIGN for ENHANCED PRODUCTIVITY

[1] TGA 5500 only

* U.S. Patent no. 6,840,668

"APP" Style Touch Screen

One Touch Away™

Touch Screen Features and Benefits:

- Ergonomic design for easy viewing and operation
- Packed with functionality to simplify operation and enhance user experience. The touch screen includes:
  - Start/stop runs
  - Real-time signals
  - Active method viewing
  - Autosampler calibration
  - System information
  - Test and instrument status
  - Real-time plot
  - Advance method segments
  - Loading/unloading and taring pans

The app-style touch screen, powerful new TRIOS software, the robust and reliable autosampler with automated calibration and verification routines all work seamlessly to dramatically improve laboratory workflow and productivity.

ITS NEVER BEEN EASIER TO GET GREAT DATA!

Discover powerful TRIOS software that delivers exceptional user experience in a combined package for instrument control, data analysis and reporting for thermal analysis and rheology. New features such as multiple calibration sets, real-time test method editing, and inter-laboratory data and test method sharing provide unmatched flexibility, while one-click analysis and custom reporting raise productivity to new levels.

TRIOS Features:

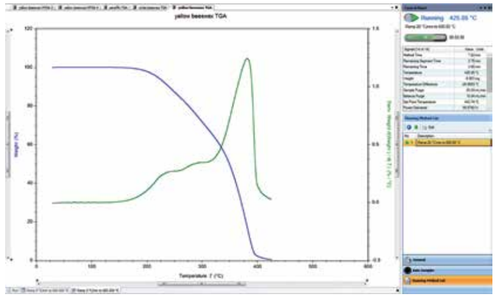
- Control multiple instruments with a single PC and software package
- Overlay and compare results across techniques including DSC, TGA, DMA, SDT and rheometers
- Unlimited licenses and free lifetime software upgrades
- One-click repeated analysis for increased productivity
- Automated custom report generation including: experimental details, data plots and tables, analysis results
- Convenient data export to plain-text, CSV, XML, Excel®, Word®, PowerPoint®, and image formats
- Optional TRIOS Guardian with electronic signatures for audit trail and data integrity

Ease of Use

TRIOS software makes calibration and operation of the entire line of Thermogravimetric Analyzers simple. Users can easily generate multiple calibration data sets under different experimental conditions (e.g. different heating rates or gas selections) and seamlessly switch between them to match the experimental conditions used for sample testing. Real-time signals and the progress of running experiments is readily available with the added capability of modifying a running method on the fly. TRIOS software offers a level of flexibility that is unmatched in the industry.

Complete Data Record

The advanced data collection system automatically saves all relevant signals, active calibrations, and system settings. This comprehensive set of information is invaluable for method development, procedure deployment and data validation.



The Most **VERSATILE CONTROL** and **ANALYSIS SOFTWARE!**

Complete Data Analysis Capabilities

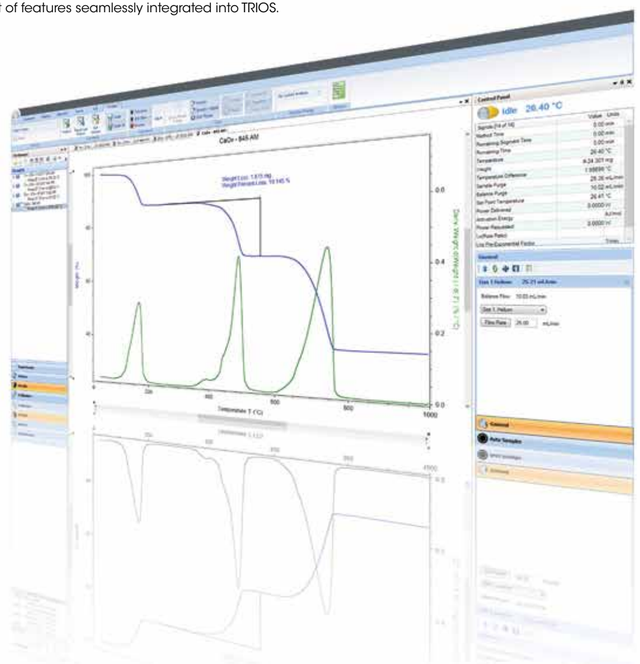
A comprehensive set of relevant tools are available for real-time data analysis, even during experiments. Gain actionable insights into your material behavior through a powerful and versatile set of features seamlessly integrated into TRIOS.

All Standard TGA Analyses:

- Weight change (absolute and as a percentage)
- Residue content
- 1st and 2nd derivatives
- Weight at a specified time or temperature
- Weight loss at a specified time or temperature
- Peak height and area
- Temperature at peak maximum
- Onset and endset analyses
- Step transition analysis
- Easily import and export TGA data with TRIOS

Advanced Analysis Capabilities:

- Activation energy determination with Modulated TGA
- Decomposition kinetics as obtained from constant or dynamic heating rate, and constant reaction rate experiments
- DTA signal for endothermic and exothermic thermal events such as melting, crystallization, cure reactions and decomposition
- Advanced custom analysis with user-defined variables and models



In Hi-Res TGA (only available from TA Instruments), the heating rate is controlled by the decomposition rate of the sample. The Discovery TGA 5500 and 550 designs are ideal for these measurements with rapid response furnaces for precise temperature control, and sensitive thermobalances designed to quickly detect small weight changes.

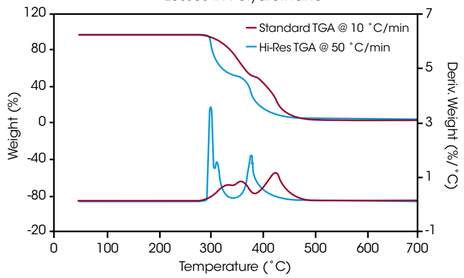
Benefits of Hi-Res TGA include:

- Separation of broad and overlapping weight losses
- Increased productivity with better resolution
- Rapid survey over wide temperature range with excellent resolution
- Simple method set up

DTA Signal

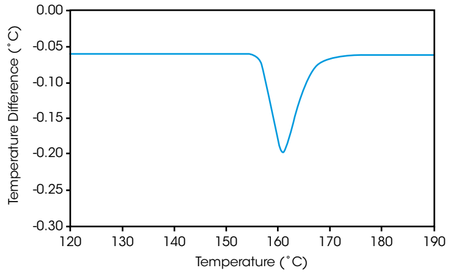
The DTA signal is a qualitative measurement of endothermic and exothermic reactions occurring in the TGA. This signal can also be used for temperature calibration by using melting point standards.

Separation of Overlapping Weight Losses in Polyurethane



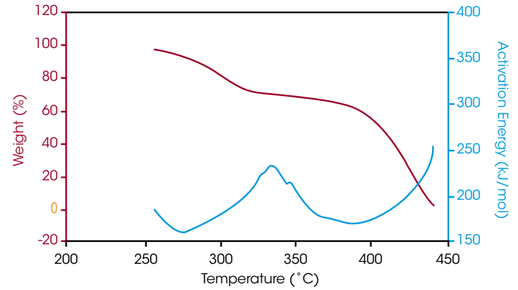
The figure above shows the Hi-Res TGA results for a polyurethane material by standard and Hi-Res TGA. The superior resolution provided by the Hi-Res technique is clearly evident in both the TGA weight loss and the first derivative (DTG) signals. The latter signal is especially useful in defining the onset and the end-set of the individual weight loss segments, as well as indicating subtle events that provide a "fingerprint" of the sample.

Indium



DISCOVER more about your MATERIALS

Activation Energy vs Temperature



TA's patented MTGA* is another TA Instruments innovation that offers advantages for material decomposition studies. Developed from the proprietary heater control technology utilized by Hi-Res TGA and MDSC, MTGA produces model-free kinetic data. Activation energy can be continuously calculated during the test and studied as a function of time, temperature, and conversion.

Benefits of MTGA include:

- Increased productivity for studying kinetics
- Model-free kinetic data
- Can be combined with Hi-Res for better separation of overlapping weight losses
- Direct determination of activation energy

The figure to the left shows the MTGA plot from a kinetic study of the effect of temperature on the decomposition of 60 % ethylene vinyl acetate (EVA) in a single analysis. The plot quantitatively shows the EVA decomposition profile and changes in activation energy as functions of temperature. The data supports a dual-step decomposition mechanism. MTGA can also monitor activation energy as a function of conversion, which can infer the mechanism involved.

* U.S. Patent no. 6.113.261 and 6.336.741

Evolved gas analysis involves the qualitative investigation of the evolved gas products from a TGA experiment. These products are generally the result of decomposition, but can also evolve from desorption, evaporation or chemical reactions. Evolved gas analysis is typically performed by interfacing a mass spectrometer (MS) or Fourier transform infrared spectrometer (FTIR) to the exit port of the TGA furnace. Through the use of a heated transfer line, the evolved gas stream is delivered to the MS or FTIR instrument, and the compositional analysis is performed in real time. TA Instruments offers a 300 amu bench-top, quadrapole mass spectrometer with a heated capillary interface, and TGA module-specific interface kits for the Discovery TGA. A variety of FTIR suppliers provide gas cells and interfaces.

The Discovery TGA is the ideal platform for evolved gas analysis studies. A horizontal purge stream over the sample and a short path to the exit port eliminates dead volume in the furnace, thereby reducing product dilution and optimizing EGA sensitivity. Heated EGA adapters are designed to interface directly with the MS or FTIR transfer line to ensure continuous heating of the offgas stream through the furnace wall, dramatically reducing offgas condensation and improving EGA sensitivity.

TA Instruments TRIOS software supports the importation of MS (trend analysis) and FTIR data (Gram-Schmidt and Chemigram reconstructions), allowing TGA and EGA data to be displayed on a common axis of temperature and/or time.

EGA Features and Benefits:

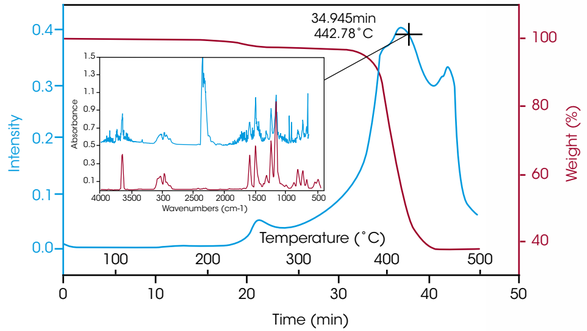
- Identification of decomposition products
- Additional information for the interpretation of the reactions during TGA scans
- Exact control of the furnace atmosphere before and during experiments

Design Features and Benefits of the Discovery TGA for EGA Analysis:

- Horizontal purge stream over the sample for optimal sensitivity
- Low volume furnace to eliminate dead volume, reducing dilution
- Heated EGA adaptor to eliminate cold spots and condensation
- Powerful TRIOS software allows importation of MS or FTIR data for improved data interpretation

TGA-FTIR: Phenolic Resin Decomposition

This figure contains the TGA-FTIR results for the thermal decomposition of a phenolic resin adhesive. A Gram-Schmidt reconstruction of the time-resolved FTIR spectra is compared to the weight loss signal as a function of time and temperature. The inset image contains the FTIR spectrum of the offgas composition at 34.95 minutes, near the point of the maximum rate of decomposition. The FTIR spectrum corresponding to this temperature indicates that the offgas products are primarily composed of phenols, including bisphenol A, which is included as a comparison spectrum. This level of chemical specificity is useful in comparing similar products, quality control, and fingerprint analysis.

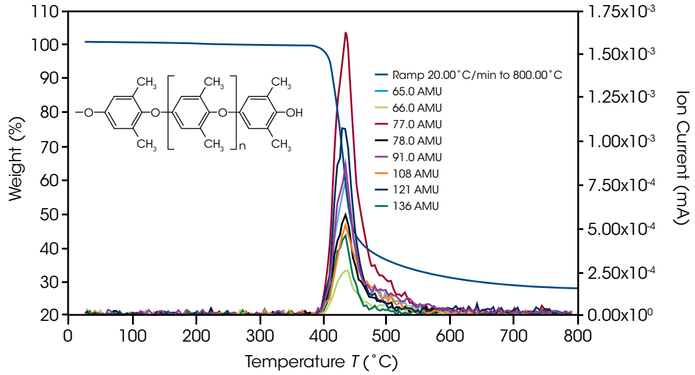


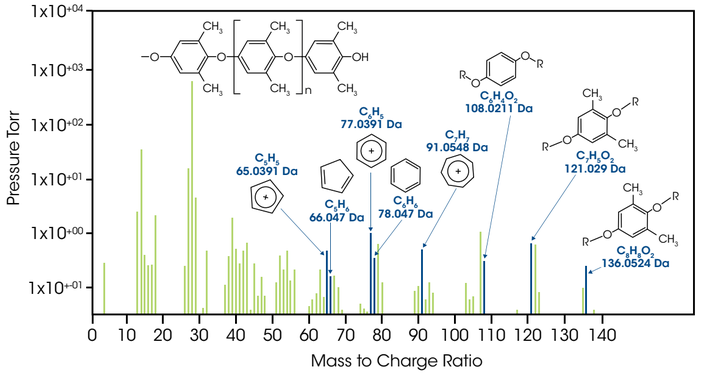
Discovery Mass Spectrometer (DMS)

The Discovery MS is a benchtop quadrupole mass spectrometer, designed and optimized for evolved gas analysis. It features industry-standard technology configured for the efficient transfer, and rapid detection of offgas from the TGA furnace. Parts per billion (ppb) sensitivity is ensured with our state-of-the-art quadrupole detection system, including a closed ion source, a triple mass filter and a dual (Faraday and Secondary Electron Multiplier) detector system. This analyzer configuration is selected to optimize sensitivity and long-term stability performance.

Control of the experimental parameters and analysis of the mass spectral data is achieved through a user-friendly, recipe-driven software interface. Data collection can be triggered directly from the TGA software, and the resulting MS data can be combined with the corresponding TGA results for direct overlaying and comparison.

Parameter	Performance
Mass range (amu)	1-300
Mass Resolution	>0.5 amu
Sensitivity	< 100 ppb (gas-dependent)
Ionization Source	Electron Ionization
Detector System	Dual (Faraday and Second Electron Multiplier)
Sample Pressure	1 atm (nominal)
Data Collection Modes	Bargraph and Peak Jump
Scanning Speed	
Bargraph Mode	>50 amu/s
Peak Jump Mode	>64 channels/s
Transfer line Temperature	300°C (fixed)
Transfer line	1.8 meters, flexible
Filaments	Dual, customer changeable
Capillary	Stainless Steel, changeable
Capillary size	I.D. = 0.22 mm
Inputs	Data collection controlled by TGA Trigger



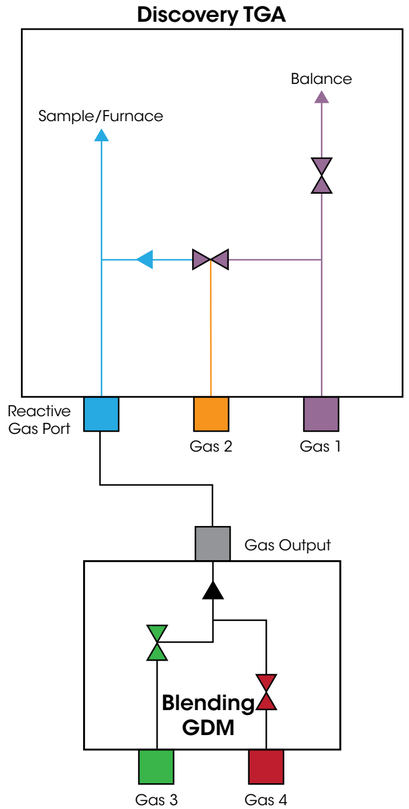


Decomposition of an Engineered Plastic

Poly(phenylene oxide), or PPO, is a high-performance, engineered thermoplastic with desirable specifications for heat resistance and dimensional stability. With a glass transition temperature as high as 215°C, the processing temperature of PPO would need to be high and will result in a cumbersome and costly manufacturing process. In many cases, other polymers such as polystyrene (HIPS) are blended with PPO to both aid in processing and improve the ductility over PPO alone. In this example, neat PPO is heated through decomposition in an inert nitrogen atmosphere with the off-gas collected by the attached MS. The TGA-MS hyphenated technique allows for the detection and identification of the resultant decomposition products. The data is displayed as an overlay of ion current and weight loss with respect to temperature. TGA shows a monotonic weight loss step; however, the mass spectroscopy data presents the detection of several decomposition entities that range in mass to charge ratios of 65 to 136 amu which is the molecular ion of the repeatingunit. Proposed possible decomposition products, based on the structure of the polyether, are also shown.

Blending Gas Delivery Module

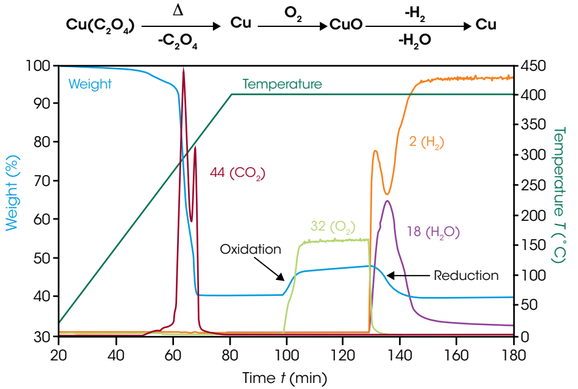
The Blending Gas Delivery Module (Blending GDM) delivers flexibility in gas handling on the Discovery TGA 5500, TGA 550, and SDT 650. The Blending GDM is an external accessory with two gas inlet ports that, when connected to the reactive gas port on the TGA or SDT, give the user a total of four gases to control. The software controlled accessory allows for automated switching between the four gas ports as well as blending of binary mixtures of gases. The added blending capability allows for TGA experiments to be carried out in an atmosphere where the concentration ratio between gases may be fixed, stepped incrementally or ramped at a controlled rate. The Blending GDM is compatible with Nitrogen, Argon, Helium, Air, Oxygen, Carbon Dioxide, Carbon Monoxide and Forming Gas and can be used to study sorption of gasses onto a material, redox reactions, and thermal stability of materials in a controlled atmosphere.



Gas Port	Gases Supported	Blend Options
1 Instrument, also used as balance purge	N_2, He, Ar	3 or 4
2 Instrument	N_2, O_2, Air, He, Ar	3 or 4
3 Blending GDM	N_2, O2, Air, He, Ar, Forming Gas, CO, CO_2	1, 2 or 4
4 Blending GDM	N_2, O_2, Air, He, Ar, Forming Gas, CO, CO_2	1, 2 or 3

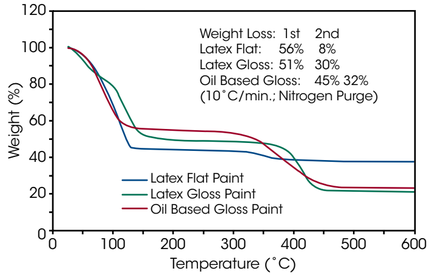
Redox Reaction of Copper Oxalate

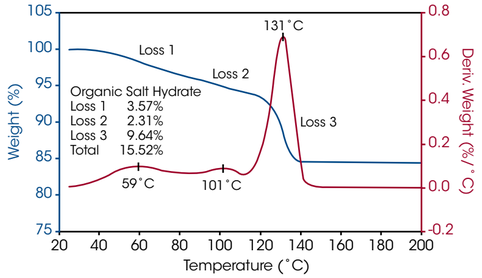
Copper oxalate (CuC_2O_4) is a salt that decomposes to elemental copper upon heating in an inert atmosphere. It is often used to measure the inertness of the TGA atmosphere, as the high surface area copper is readily oxidized at high temperatures. In this example an oxidation-reduction (redox) reaction experiment was accomplished using the Blending GDM and the Discovery TGA. After decomposition of the oxalate during the initial temperature ramp, oxygen was introduced into the TGA sample chamber resulting in the formation of copper (II) oxide. Subsequent reduction of the copper oxide was achieved through the introduction of small amounts of hydrogen gas. Forming gas was safely used as the hydrogen source in the TGA.



Compositional Analysis

TGA is used to determine sample composition by measuring the weight of each component as it volatilizes or decomposes under controlled conditions of temperature, time, and atmosphere. This figure shows quantitative differences in type, amount, and decomposition mechanism of the main polymers in three paint samples. More detailed examination of the profiles below 150°C may reveal further information on the amount and possible nature of the carrier solvent (aqueous or oil) used in each paint.



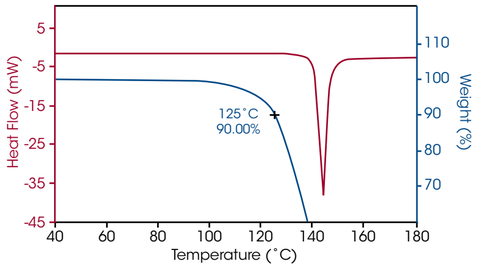


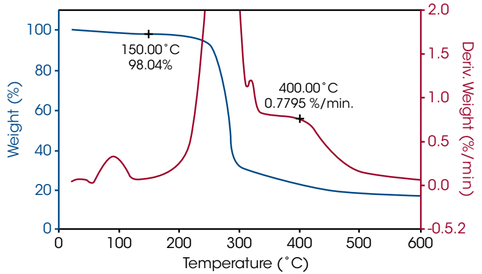
Volatiles Analysis

TGA determinations of absorbed, bound, or occluded moisture, and organic volatiles are important analyses for product performance and environmental acceptance. Analysis of an organic salt hydrate in nitrogen atmosphere shows a bound-water content of 9.6%, and two lower temperature weight losses of 3.6% and 2.3% respectively. These losses are likely due to adsorbed moisture at the salt surface or held to it by weak attractive forces.

Verification of Thermal Events

TGA is very useful in conjunction with other thermal analysis techniques such as DSC and is often critical to understanding the true nature of thermal events. In this data, a pharmaceutical material undergoes an endothermic transition above 125°C which was previously thought to be melting. TGA analysis demonstrates considerable weight loss below 125°C, which suggests that the endotherm is actually decomposition. DSC analysis at multiple rates exposes rate-dependence of this transition which confirms decomposition.





Moisture Content & Thermal Stability of a Pharmaceutical Material

TGA is a useful technique for determining the absolute and relative thermal stability of pharmaceutical compounds, as well as the moisture content. In this example, an active pharmaceutical ingredient (API) is analyzed by TGA at a heating rate of 10°C/min. The data show a small (~2%) weight loss below 150°C, which is typical for adsorbed water. The material is relatively stable up to 200°C, after which a large, multi-step weight loss is indicative of thermal decomposition.

Choose the BEST TGA for YOUR NEEDS

Instrument Features	TGA 55	TGA 550	TGA 5500
Low Mass IR Furnace	—	—	●
Hi-Res TGA™	—	O	●
Modulated TGA™	—	O	●
Auto-Stepwise TGA	●	●	●
DTA Signal	—	O	●
Auto-loader	●	●	—
25-Position Autosampler	—	O	●
Sealed Pan Punch	—	O	●
Color App-Style Touch Screen	●	●	●
Long-Life Wire Wound (Pt/Rh) Furnace	●	●	—
EGA Furnace Capable	O	O	●
Dual Input Gas-Delivery Manifold	●	●	●
Integrated Electromagnet	—	—	●
Temperature Calibration Curie Point (ASTM E1582)	●	●	●
Temperature Calibration Melting Point Standards	—	O	●
Blending Gas Delivery Module	—	O	O
Heated EGA Furnace Adapter	—	—	O
TGA/MS Operation	O	O	O
TGA/FTIR Operation	O	O	O

● Included O Optional — Not Available

Instrument Specifications	TGA 55	TGA 550	TGA 5500
Temperature Range	Ambient to 1000°C	Ambient to 1000°C	Ambient to 1200°C
Temperature Accuracy	±1°C	±1°C	±1°C
Temperature Precision	±0.1°C	±0.1°C	±0.1°C
Heating Rate (Linear)	0.1 to 100 °C/min	0.1 to 100°C/min	0.1 to 500°C/min
Heating Rate (Ballistic)	>600°C/min	>600°C/min	>1600°C/min
Furnace Cooling (Forced air/N2)	1000°C to 50°C in <12 min	1000°C to 50°C in <12 min	1200°C to 35°C in <10 min
Sample Weight Capacity	1000 mg	1000 mg	1000 mg
Dynamic Weighing Range	1000 mg	1000 mg	1000 mg
Weighing Precision	±0.01 %	±0.01 %	±0.01 %
Resolution	0.1 µg	0.1 µg	<0.1 µg
Weight Baseline Drift[1] (Ambient to 1000 °C)	<25 µg	<25 µg	<10 µg
Vacuum	50 µTorr (EGA furnace)	50 µTorr (EGA furnace)	50 µTorr

[1] Without baseline subtraction

Pan specifications

Material	Size	Temperature Range	Notes
Platinum	50 µL 100 µL	Ambient to 1000°C	Robust, high performance, reusable pans
Ceramic	100 µL 250 µL	Ambient to 1200°C	Reusable pans for higher temperatures
Aluminum	80 µL	Ambient to 600°C	One-time use, can be sealed to prevent volatilization before experiment

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