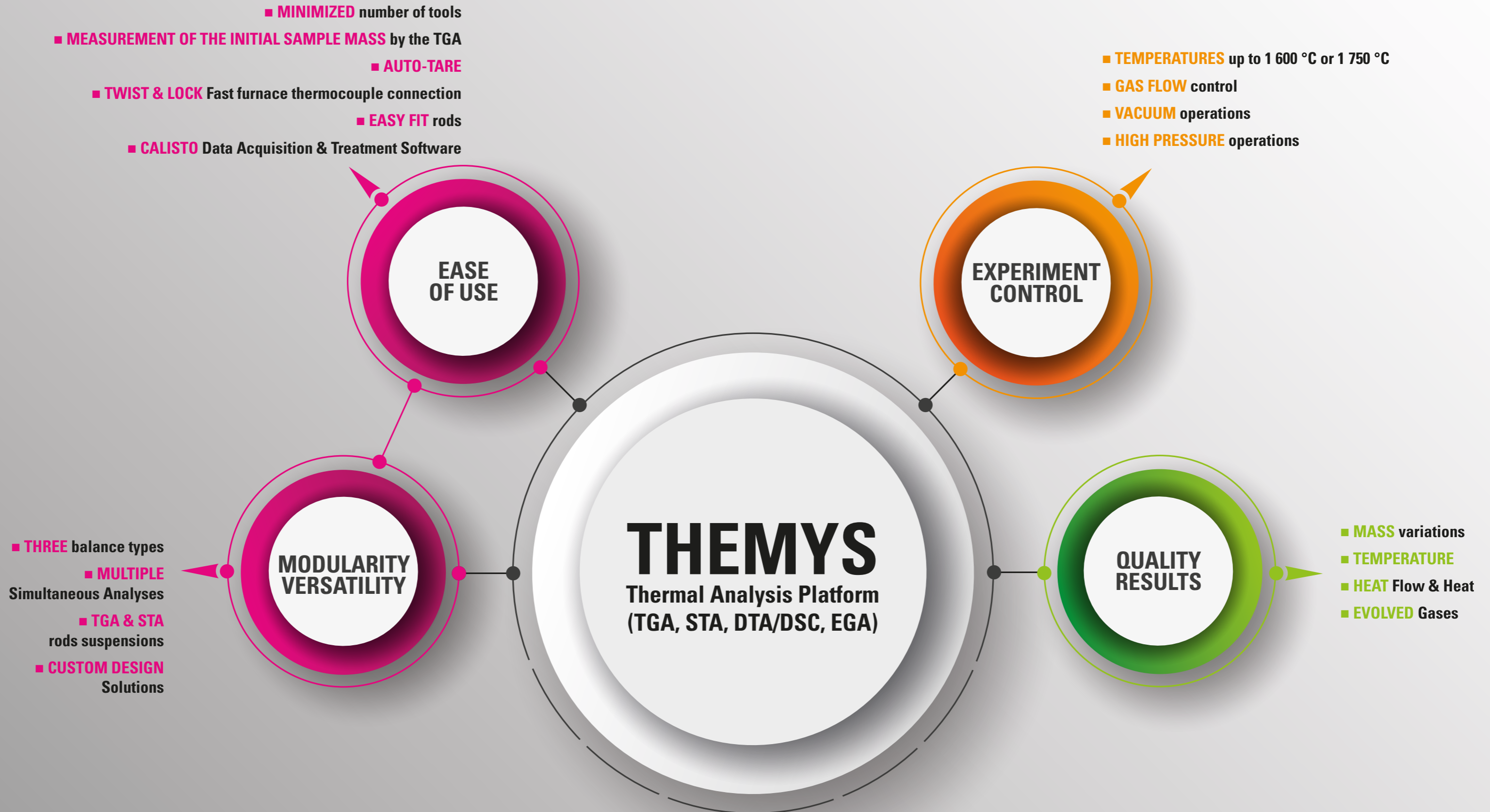


# THEMYS

Thermal Analysis Platform  
TGA, HP-TGA, STA, DTA/DSC, EGA  
by Setaram



A trademark of KEP Technologies group



## BALANCES

Because the core of a thermogravimetric analyzer is its balance, SETARAM Instrumentation designs balances **exclusively for thermal analysis applications**.

Three models of balance are offered with THEMYS to cover the whole range of applications. They are all based on the hang-down design, providing the highest level of stability and the best limit of detection.

The **HIGH SENSITIVITY** balance is designed for the accurate study of very small mass variations. Its 35 g loading capacity still allows one to characterize heavy samples. It has the best noise level, the best limit of detection and the best isothermal drift. This balance is typically the ideal choice for long term corrosion kinetics.

The **HIGH CAPACITY** balance has a +/- 3 000 mg mass variation range, which makes it perfect for experiments that lead to the full decomposition of large samples, as with heterogeneous materials.

The **HIGH VERSATILITY** balance is equipped with the AUTO-TARE system. It is the perfect choice to take full advantage of the THEMYS platform modularity, when frequent changes of samples types, crucibles, or other experimental conditions are required. The **HIGH VERSATILITY** balance also benefits from an excellent signal drift under temperature scanning conditions and from within +/- 200 mg and +/- 2 000 mg mass variation ranges.

SCHEMATICS OF THE THEMYS BALANCE,  
FURNACE AND TEMPERATURE CONTROL



## FURNACE

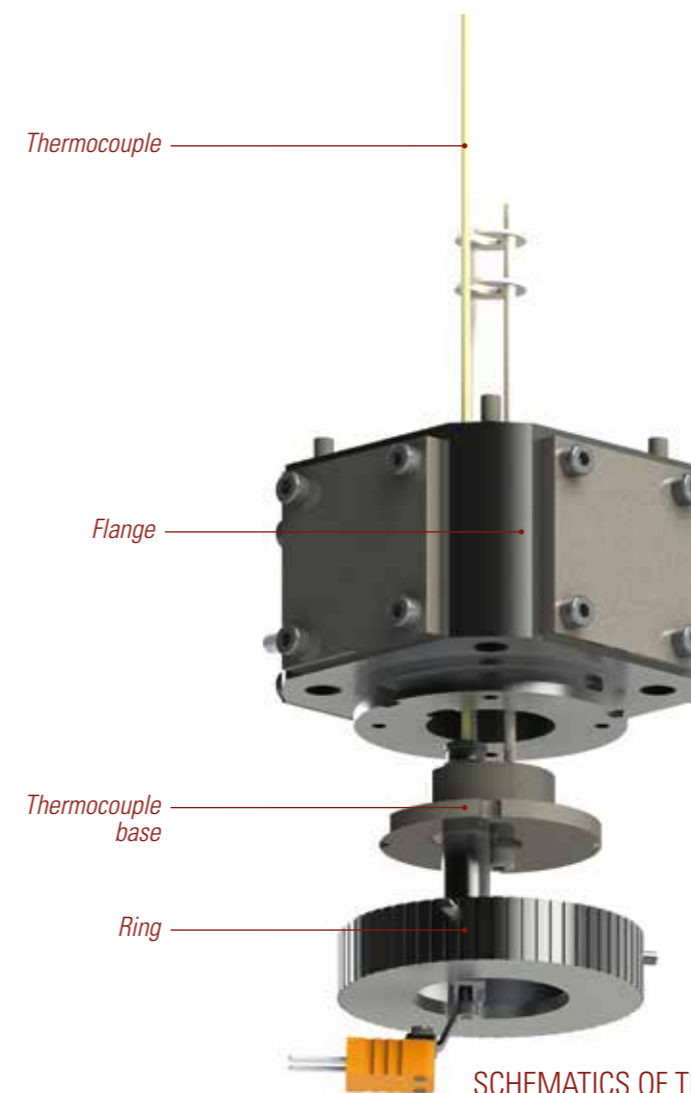
Heat transfer specialists know that a high temperature **furnace with small dimensions means large temperature gradients**. This is why THEMYS is designed around a single, robust and high performance graphite furnace protected by an 18 mm internal diameter alumina tube. This ensures **a large homogeneous temperature zone** required by changing experiments: small or large samples, small TGA crucibles or large tricouple DTA rods, etc. This also avoids tedious furnace exchange when experiment conditions change.

This furnace principle is consistent with the traditional SETARAM effort for providing systems with the **lowest operational costs in the market**.

## TEMPERATURE CONTROL

A choice of high sensitivity thermocouples to cover changing temperature range needs is provided with an easier than ever **TWIST AND LOCK** system. It is fast, does not require tools, and the thermocouple's temperature range is detected automatically.

For challenging samples and atmospheric conditions, sleeved thermocouples (alumina) are available to enhance corrosion resistance.



SCHEMATICS OF THE **TWIST AND LOCK** SYSTEM



See THEMYS (TGA, HP-TGA, STA, DTA/DSC, EGA) application notes

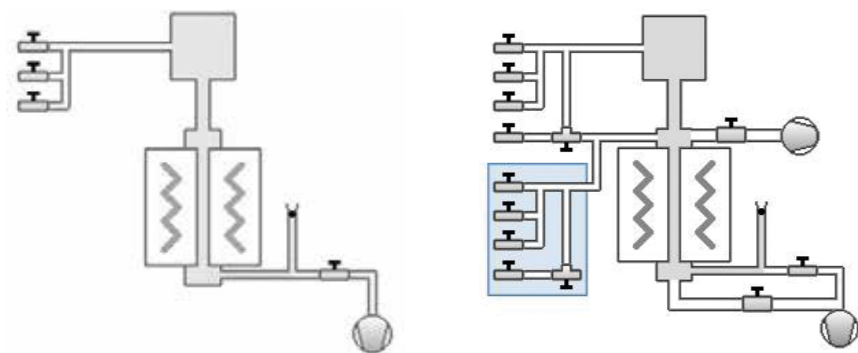
## ATMOSPHERE CONTROL

As most TGA or STA applications are linked with solid-gas reactions, THEMYS provides accurate control of the furnace atmosphere, with different options including mass flow controllers, gas switching and blending devices, vacuum pumps and gauges.

### GAS FLOW MANAGEMENT

The gas flow management system is designed to be the most flexible and easy to use.

3 options, **PureGas**, **GasBlend** and **MultiGasBlend**, are made available with increasing capacities to generate and control complex atmospheres. They all have in common an intelligent software control system for sequentially changing the gas types, flowrates, or blend ratios during the experiment or sample pretreatment. It also warns the user in the case of incompatible or hazardous gas blend.



SCHEMATIC REPRESENTATION OF THE PUREGAS (LEFT) AND MULTIGASBLEND (RIGHT) OPTIONS

### VACUUM

Primary, Forced Primary or Secondary Vacuum options are available with a selection of adapted vacuum pumps. New pre-programmed procedures for stepwise sample evacuation are available with Calisto software.

### CORROSIVE GASES

Specific accessories are designed for samples under really harsh conditions while protecting the thermal analyzer. Sleeved thermocouples (alumina) and protected DTA rods are available. Custom designed solutions can be developed for specific testing situations.

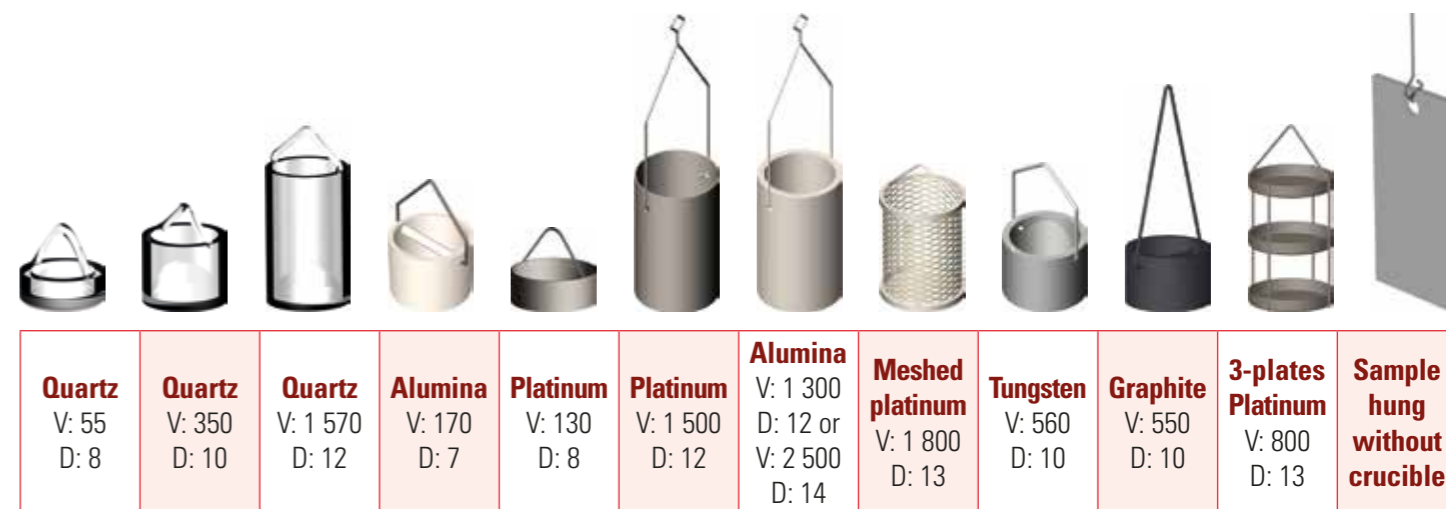
FEATURES		OPTION		
		PureGas	GasBlend	MultiGasBlend
<b>Carrier gas (generally inert)</b>	Connected to the TGA platform	Up to 3	Up to 3	Up to 3
	Flowing in the furnace	1 among the connected ones	1 among the connected ones	1 among the connected ones
<b>Auxiliary gas (generally active)</b>	Connected to the TGA platform	-	1	Up to 5
	Flowing in the furnace	-	1	1 pure OR a blend of up to 3 of the connected ones
<b>Mass flow controllers</b>		1 inside structure	2 inside structure	2 inside and 2 outside structure (external gas panel)
<b>Sequential programming</b>		Yes	Yes	Yes

## TGA ACCESSORIES

The large loading capacity of the balances and the large homogeneous temperature zone of the furnace offer the user to choose the right crucible for the right experiment:

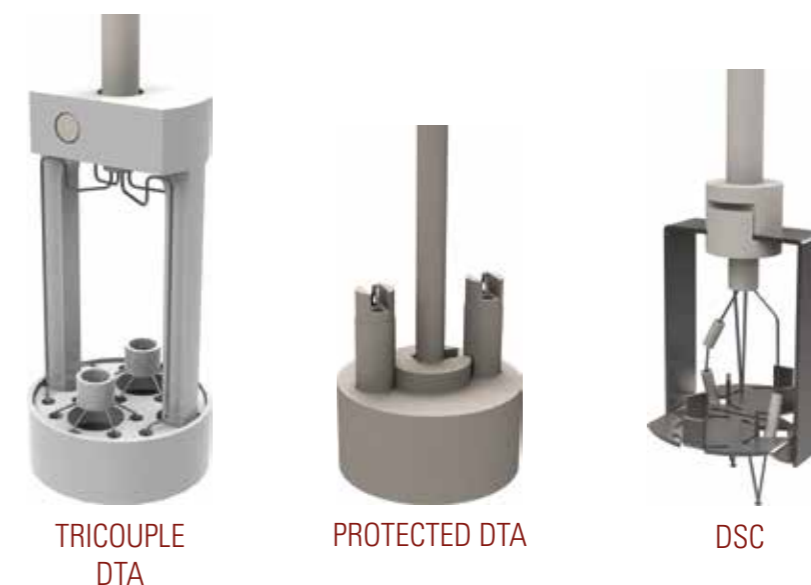
- Choose standard cylindrical crucibles or more dedicated ones, like meshed or three-tray crucibles for better gas sample interactions,
- Choose the volume related to your sample size, ranging from 130  $\mu$ l to 2.5 ml,
- Choose the most inert crucible material for your sample, atmosphere and temperature range: finest quality platinum, tungsten, quartz, alumina, or graphite.

Note that bulk materials can also be held directly on a suspension hook without any crucible, for the best gas sample interactions.



MOST FREQUENTLY USED TGA CRUCIBLES – DIAMETERS (D) IN MM, VOLUMES (V) IN  $\mu$ L

## DTA, DSC, STA (TG-DTA, TG-DSC) ACCESSORIES



### OUR RANGE OF DTA AND DSC SENSORS FEATURE

- Temperature ranges up to 800, 1 000, 1 500, 1 600, 1 750  $^{\circ}$ C,
- The most sensitive thermocouple wires available within each temperature range, including the **type R** thermocouples,
- Tricouple DTA systems for enhanced sensitivity even at the highest temperatures,
- Protected DTA rods for prolonged thermocouple lifetime even when corrosive species are evolved from the samples,
- **Easy Fit** connectors for rod exchange within seconds,
- The finest quality metal (aluminum, platinum, tungsten) or ceramic (alumina, zirconia, yttria, graphite) crucibles, with volumes from 20 to 300  $\mu$ l.

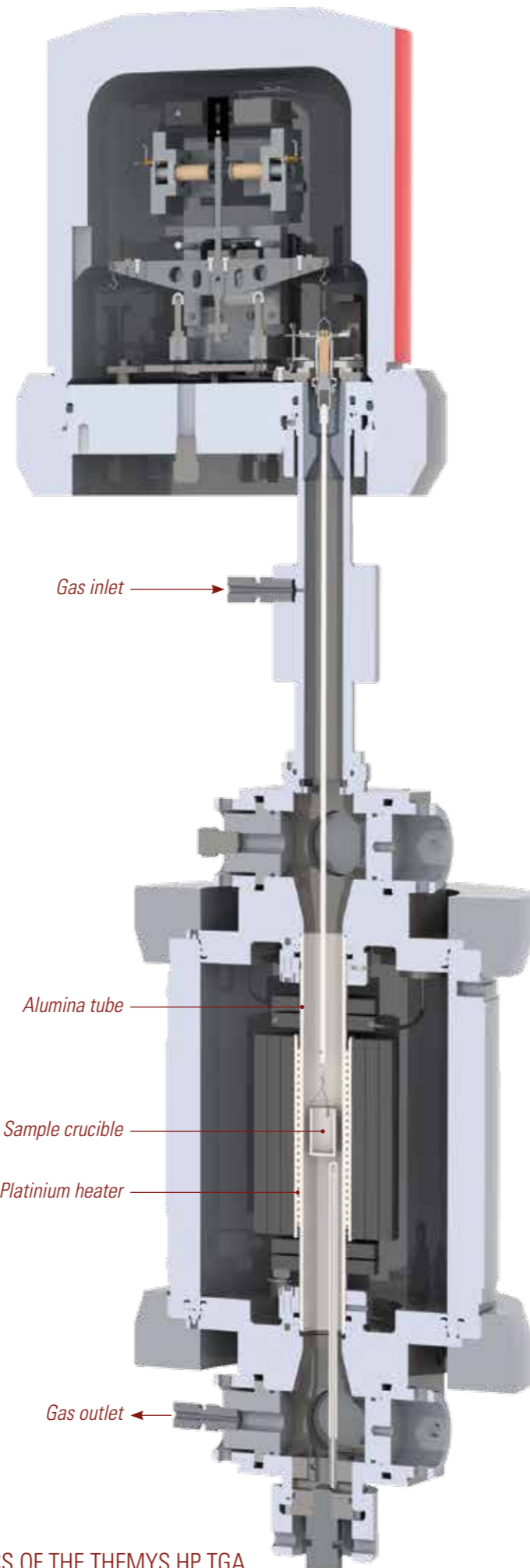
## HIGH PRESSURE TGA

THEMYS HP is a robust, flexible high pressure thermogravimetric analyzer featuring:

- **HIGH PRESSURE** model, a specific pressure-rated balance. It is designed based on the vertical hang-down principle for the best mass signal accuracy and stability.
- An alumina protected furnace with a platinum based heating element for isothermal or temperature scanning operations at heating rates up to 100 °C/min. The same furnace and balance cover a temperature and pressure range **up to 1 200 °C and 150 bar** with the best TGA detection limit. It avoids multiple furnace changes for different samples or test conditions.

THEMYS HP is typically applied to the study of pyrolysis, combustion, gasification conditions met in many coal, biomass or waste to energy processes. It is also designed for high temperature and pressure corrosion studies, and more particularly with alloys used in the above mentioned processes.

THEMYS HP is the ideal tool for sorption and desorption analysis in the fields of gas capture and storage, gas sensing materials characterization, or more generally sorbent materials characterization.



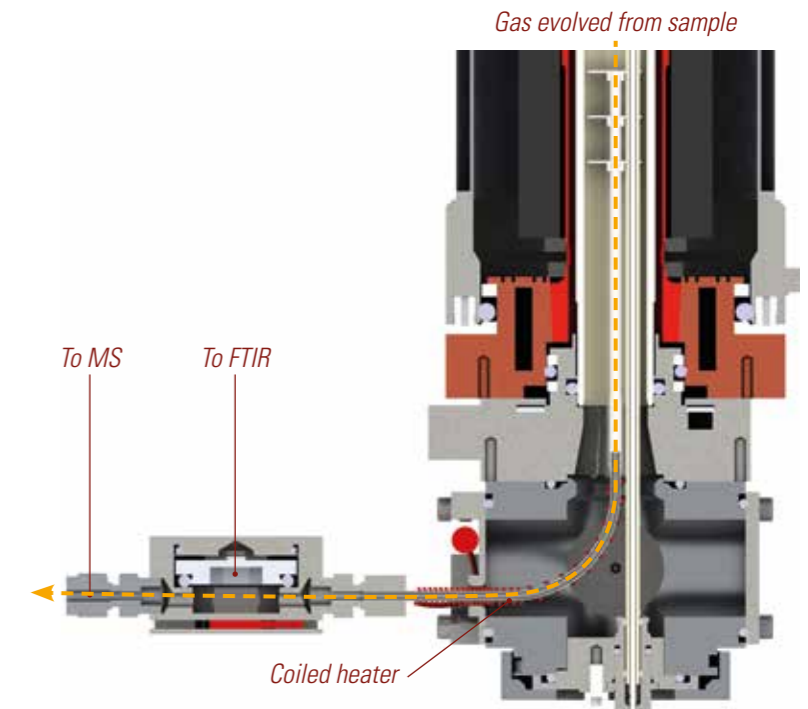
SCHEMATICS OF THE THEMYS HP TGA

## EVOLVED GAS ANALYSIS

Evolved Gas Analysis (EGA) enhances the thermogravimetric analyzers capacity for the investigation of the sample's composition or thermal decomposition chemistry, thanks to the identification of the evolved species by a gas analyzer.

The THEMYS gas sampling system was designed to feature:

- Coupling to the main gas analysis techniques: Mass spectrometry (MS), FTIR spectrometry, gas chromatography (GC) and combinations of these : TG-MS, TG-FTIR, TG-MS-FTIR, TG-GC/MS,
- Transfer lines and parts made to ensure accurate temperature control up to 300 °C, avoiding cold condensation points,
- Advanced sampling/gas injection strategies for GC/MS analyses with the unique Auto-Injector system,
- Quantitative EGA after calibration using the titration TGA option,
- Gas Analyzers data integration in the Calisto thermal analysis software.

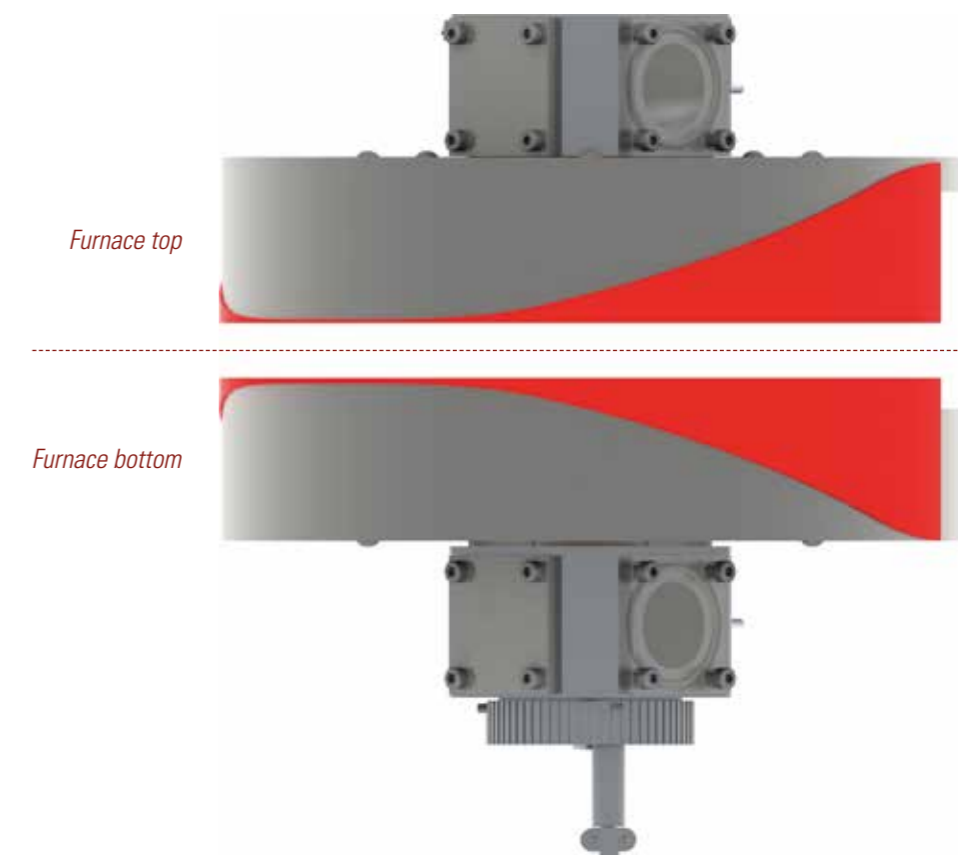


HEATED COUPLING PART FOR EVOLVED GAS ANALYSIS

## EXTRA COUPLING

The THEMYS furnace allows for in-situ analyses with two 4-port parts placed at its top and bottom. Up to 8 extra sensors can be connected (some of the ports may already be occupied with options like vacuum, gas flow or standard EGA coupling).

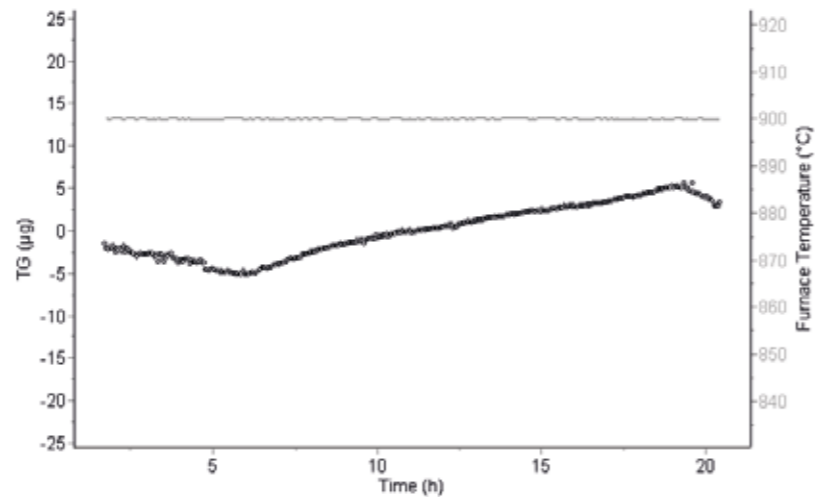
Extra humidity, oxygen or other measurements can be achieved. Discuss your specific needs with our engineers.



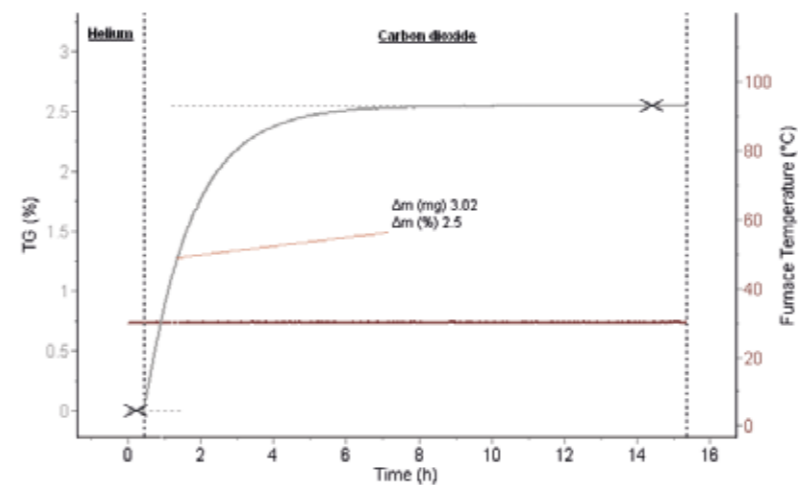
TOP AND BOTTOM FLANGES WITH AVAILABLE PORTS

## ISOTHERMAL STABILITY

A stable signal under isothermal conditions is required for many gas-solid experiments like oxidation, reduction, adsorption etc. The High Sensitivity balance exhibits ground breaking stability as shown with this experiment at 900°C, leading to +/- 5 µg variation over a period of 20 hours, i.e. a 0.5 µg/h average and a maximum value less than 2 µg/h.

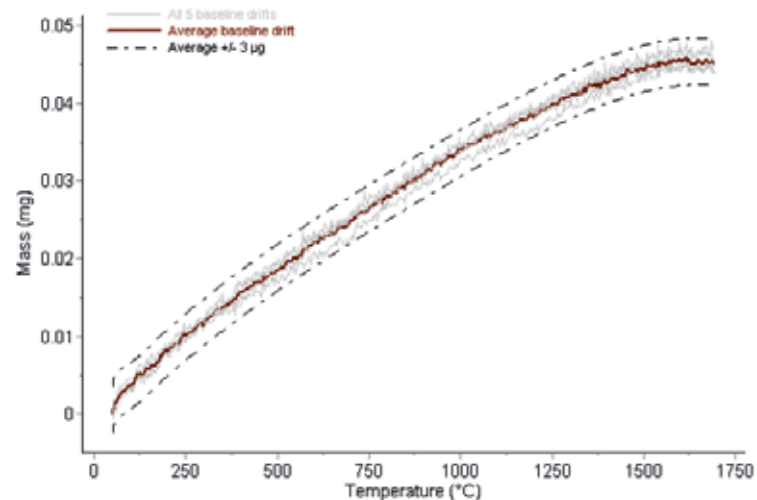


## GAS SORPTION



Testing gas sorption properties is essential for porous materials characterization. The vacuum and gas flow management options of THEMYS were designed for that purpose. This example shows the adsorption of carbon dioxide on a ZIF-8 sample at 30 °C. It required a series of heating under vacuum, cooling and gas change at a test temperature that was all programmed and then operated automatically. Sorption capacity and kinetics data can be derived from such a chart.

## BASELINE DRIFT AND REPEATABILITY



A low TGA baseline drift under temperature scanning conditions is highly desirable for most experiments, leading to large sample mass variations that do not require baseline subtraction.

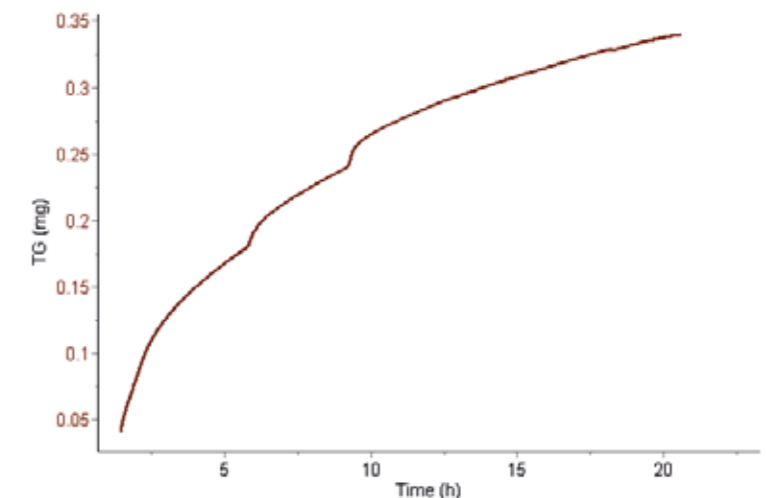
High baseline drift precision is required for the small sample mass variation experiments when baseline subtraction is necessary.

The opposite chart proves the excellence of THEMYS High Versatility balance in that respect. Data is based on six repeated experiments from 50 °C up to 1 700 °C, at a rate of 10 °C/min. Helium flow of 20 mL/min.

## HIGH TEMPERATURE CORROSION

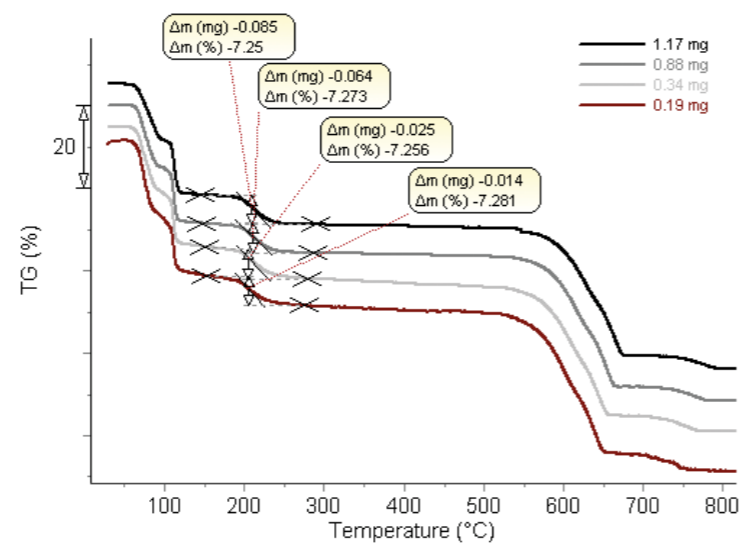
High temperature, corrosion resistant superalloys like the tested INCONEL 600 sample need to be characterized in terms of their oxidation kinetics. These characterizations typically require the TGA instrument to provide good gas-solid interface, high mass signal stability over long periods of time, and efficient control of the sample atmosphere. At 900 °C the total mass gain of the sample was no more than 298.5 µg, i.e. 0.395 mg.cm<sup>2</sup>. This demonstrates the ability of the TGA instrument to measure small effects over time, thanks to the combination of its high sensitivity and stability.

The bumps on the mass uptake curve at about 6 and 10 hours are linked with the formation of cracks in the oxide layer.

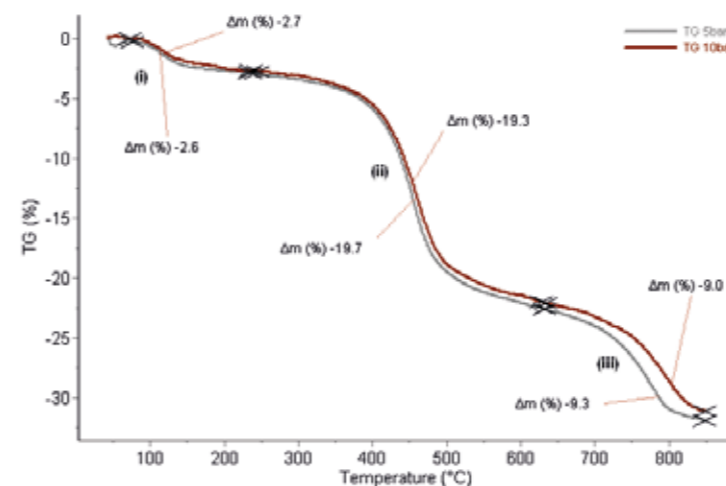


## SMALL MASS LOSSES

This test series, with decreasing initial sample masses, shows the strong performance of the High Sensitivity balance, with an accurate quantification of a 0.014 mg mass loss corresponding to one step in the dehydration of CuSO<sub>4</sub> · 5H<sub>2</sub>O.



## COAL PYROLYSIS



TGA and more particularly THEMYS HP high pressure TGA in that field is ideal for characterizing coal feedstocks and provides coal pyrolysis data that are valuable for the industrial process, like pyrolysis conversion and rate. The chart compares the TGA profile of the same coal from Longkou (Shandong, China) with a drying step and two devolatilization steps (lighter and heavier hydrocarbons).

## APPLICATIONS

Depending on its configuration (TGA, STA) and mode of operation (isothermal, temperature scanning), THEMYS can be applied to the characterization of organic or inorganic materials ranging from polymers, composites, oils, coal, to ceramics, cements, metals, and nanomaterials. It is the perfect tool to understand the thermal behavior of materials that are exposed to temperature increase during their production, service life, or recycling. The objectives of the experiments are the characterization of their composition, of their thermal resistance, of their corrosion resistance properties, of the efficiency of their synthesis routes, of their regeneration / recycling conditions, and the detection of their phase transitions.

High pressure processes like pyrolysis, combustion, gasification are best studied by THEMYS HP, whether it concerns the fuels (biomass, coal...) or the structure of materials (alloys, ceramics...).

THEMYS and THEMYS HP are also meant to characterize the sorption properties of catalysts or porous materials under low, atmospheric or high pressure.

View the application notes in your field, available for download, by visiting [www.setaram.com](http://www.setaram.com)!

A huge database is in the [application library area](#) of our website. We have also included a powerful search engine that will enable you to find the most applicable data.

## SPECIFICATIONS

GENERAL		TGA			HP TGA	STA	
						DTA, TG-DTA	DSC, TG-DSC
<b>Temperature range</b>		RT to 1 750 °C			RT to 1 200 °C	RT to 1 750 °C	RT to 1 600 °C
<b>Programmable heating rate</b>		0.01 to 100 °C/min.			0.01 to 100 °C/min <sup>a</sup>	0.01 to 100 °C/min	
<b>Crucibles volumes</b>		55 to 2 500 µl or L: 20 D: 14 mm without crucible			1 300 µl	30 to 300 µl	80 to 100 µl
<b>Vacuum</b>		Primary (< 1mbar), forced primary (< 5.10-2 mbar), secondary vacuum options					
BALANCE		HIGH SENSITIVITY	HIGH VERSATILITY	HIGH CAPACITY	HIGH PRESSURE		
<b>Measuring range (mg)</b>	Small	+/- 5	+/- 200	+/- 300	+/- 200		
	Large	+/- 50	+/- 2 000, AUTO-TARE	+/- 3 000	+/- 2 000		
<b>Maximum loading capacity</b>		35 g	35 g	100 g	35 g		
<b>TGA baseline drift (temperature scanning)<sup>b, c</sup></b>		30 µg up to 1 000 °C 40 µg up to 1 600 °C	35 µg up to 1 000 °C 50 µg up to 1 700 °C	< 100 µg up to 1 700 °C	- <sup>d</sup>		
<b>TGA baseline drift precision<sup>c</sup></b>		+/- 3 µg	+/- 10 µg	-	+/- 200 µg		
<b>Balance resolution (small range)</b>		0.00059 µg	0.023 µg	0.03 µg	0.023 µg		
DTA/DSC						DTA, TG-DTA	DSC, TG-DSC
<b>Calorimetric Precision<sup>e, e</sup></b>						+/- 2 % <sup>f</sup>	+/- 1 %
<b>Temperature precision<sup>e, e</sup></b>						+/- 0.8 °C	+/- 0.4 °C
<b>Temperature Accuracy<sup>e, e</sup></b>						+/- 0.4 °C	+/- 0.25 °C

<sup>a</sup> Value at Patm, may vary according to pressure / <sup>b</sup> Under helium flow / <sup>c</sup> Typical data / <sup>d</sup> Pressure dependent / <sup>e</sup> Based on metal standard melting / <sup>f</sup> If calibrated / RT = Room Temperature  
Specifications are subject to change

Option : AKTS Thermokinetics software for comprehensive investigation of reaction or decomposition



## CONTACTS



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