

# Thermo plus EVO3 STAvesta™

—Next-Generation Simultaneous Thermal Analyzer TG-DSC—

## Simultaneous Thermal Analyzer



### Abstract

A simultaneous thermal analyzer (STA) is an instrument that can simultaneously perform multiple thermal analyses to obtain multifaceted knowledge about the sample to be measured. The long-awaited new STA model, STAvesta, differs from its predecessor STA8122 in its ability to perform simultaneous TG and DSC measurements. We would like to introduce STAvesta, a next-generation STA, which features innovative design, significantly enhanced sensitivity and separation resolution, and improved operability.

### 1. Introduction

STAvesta is the highly anticipated new STA that brings together Rigaku's advanced thermal analysis technologies. It is suitable for a wide range of fields such as polymeric materials, pharmaceuticals, and metallic materials, and accommodates a wide range of measurements for all users, from beginners in thermal analysis to seasoned professionals.

With conventional STA (TG-DTA), it was possible to infer and analyze reactions such as decomposition and combustion by simultaneously measuring mass changes associated with changes in temperature and endothermic/exothermic behavior. STAvesta, which is a TG-DSC instrument, delivers significantly higher measurement accuracy through greatly improved baseline stability. Furthermore, the technological evolution from DTA to DSC has enabled more accurate and reliable measurements in the quantitative evaluation of thermal reactions and simultaneous measurement of mass changes.

### 2. Features

#### 2.1. Improved baseline stability and measurement accuracy

STAvesta uses a horizontal differential balance with a TG baseline reproducibility of 10  $\mu\text{g}$  or less.

The innovative “FlatBlank” function automates blank correction, intelligently corrects data, and automatically achieves a “flat baseline.” Automating the previously manual baseline correction process has further improved operational efficiency.

In the standard furnace, high-temperature furnace, and indirectly heated furnace, the isothermal unit is incorporated into a protection tube to ensure uniform heat distribution around the sample area, effectively suppressing heat transfer by radiation, and minimizing the influence of convection.

These improvements have greatly enhanced baseline stability, making STAvesta a TG-DSC instrument capable of highly accurate and reliable quantitative measurements.

To compare the separation resolution of the new STAvesta with the conventional instrument (STA8122), Figure 1 shows the DSC results for indium melting measured with each instrument. Measurement results of STA8122 are converted from DTA data to DSC. Comparing the two datasets reveals that STAvesta provides higher and sharper peaks with a narrower full width at half maximum, demonstrating improved sensitivity and separation resolution compared to STA8122.

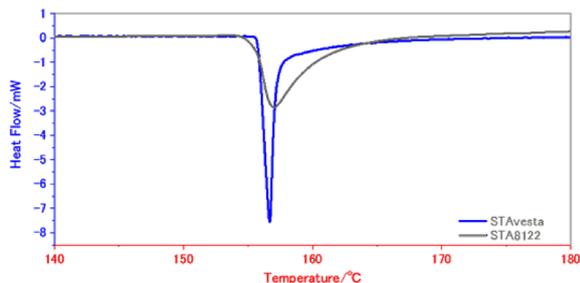


Fig. 1. Comparison of separation resolution with conventional instrument.

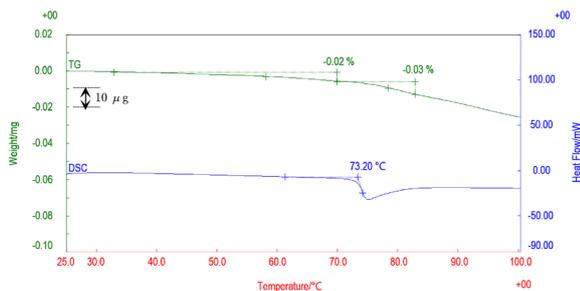


Fig. 2. Detection of minute mass changes on the order of 10 µg.

Figure 2 shows the results of measuring PET pellets with STAvesta. Thanks to the significant improvement in baseline stability, mass loss caused by volatile components in PET pellets (30°C to 70°C) and approximately 10 µg of mass loss associated with trace gas release during glass transition (around 70°C to 85°C) were detected.

### 2.2. Innovative instrument design for enhanced scalability and operability

STAvesta has undergone major design changes from the previous STA model, developing a multi-purpose configuration that enables diverse thermal analyses with a single instrument. STAvesta offers seven types of electric furnaces\*1 that can be selected according to the measurement purpose and conditions. All of these furnaces can be installed and exchanged on a single STAvesta, enabling highly flexible operation. To improve ease of sample exchange, the instrument design was revamped by adjusting the height of the hand rest bar and enhancing left-hand accessibility to the sample holder. Guide labels are provided to clearly indicate the positions of the sample and reference, allowing even users unfamiliar with thermal analysis to confidently prepare for measurement.

\*1 Some countries may have six types.

### 2.3. Outstanding temperature control performance

STAvesta has greatly improved the programmability of the sample temperature compared to its predecessor. With the newly developed Rapid control (patented\*2), which combines PID (Proportional-Integral-Derivative) control with rate control, STAvesta can follow the

configured temperature program and control temperature with even greater precision.

The newly designed Advanced control (Mode 2) minimizes the temperature difference between the programmed temperature and sample temperature during measurement. It records the relationship between the two in a preliminary measurement, corrects the programmed temperature based on that relationship, and performs control. Minimizing the slowdown in the heating rate and shortening the time required to reach the target temperature as much as possible enables more accurate analysis of reactions to be evaluated in a temperature-hold state (Figure 3).

\*2 Japanese patent 7265772, Chinese patent 202011310975.6, and other patents pending.

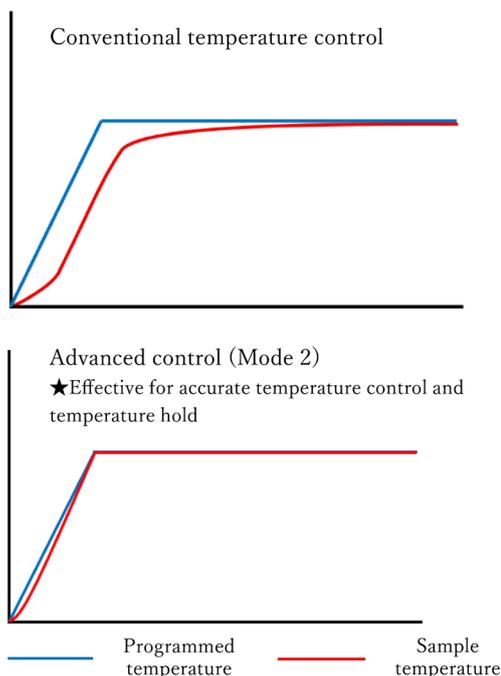


Fig. 3. Example of temperature control in thermal analysis measurement.

The combination of the Rapid control and Advanced control (Mode 2), newly implemented in STAvesta, allows the sample temperature to be brought closer to an ideal temperature curve with respect to the programmed

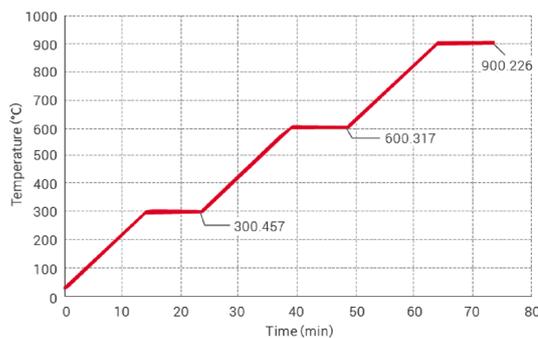


Fig. 4. Example of temperature hold at 300°C, 600°C, and 900°C.

temperature. Figure 4 shows the results of heating at 20°C/min and holding temperature at 300°C, 600°C, and 900°C for 10 minutes each while using Advanced control (Mode 2).

#### 2.4. Self-diagnosis of instrument status—vestaeye™

STAvesta is equipped with vestaeye, a self-diagnostic function, as a part of the standard configuration. Self-diagnosis starts as soon as the instrument is turned on, and the status of the instrument is constantly monitored before and during measurement. Thus, any abnormality can be detected before measurement starts, which prevents the loss of valuable samples due to errors during measurement. The condition of the instrument can also be checked if it has not been used for a while or before nighttime operation, making it easy to pinpoint the cause of any malfunction. Information for Rigaku's field support engineer can be generated with a single click, enabling smooth support with more accurate details regarding the status of the instrument. Early detection of potential issues ensures reliable and worry-free operation for daily use.

#### 2.5. Automatic sample changer ASC52

STAvesta uses ASC52 as the ASC (automatic sample changer), which significantly increases the number of samples that can be set up compared to previous models. ASC52 accommodates 52 measurement samples (including 4 calibration samples) and 3 reference samples, enabling up to 1,000 consecutive measurements. This greatly enhances automation and contributes to high-throughput performance. ASC52 can be installed for all types of electric furnaces and, since it is mounted on the top of the instrument, it can be used without increasing the installation area.

The sample section of the tray comes with gas-flow compatibility as a part of its standard specifications. Gas flow in the sample section reduces contact with atmospheric air, which is effective for sample preservation when measuring samples such as highly hygroscopic powders (Figure 5).

The “FlatBlank” function can be used even during continuous measurements with the ASC52. This

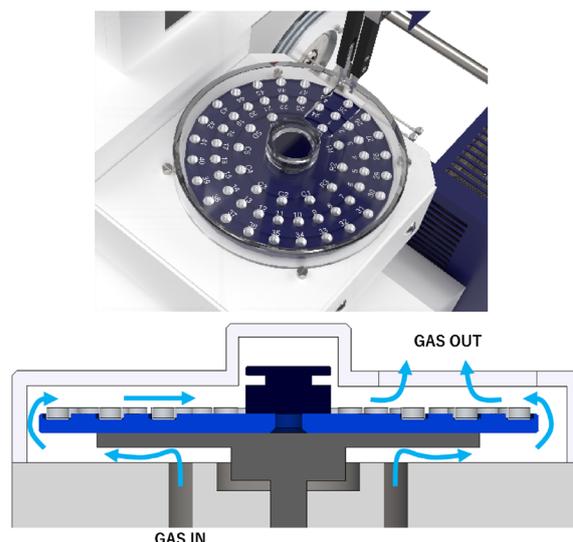


Fig. 5. ASC52 and schematic drawing of gas flow.

eliminates the need for individual blank measurements and correction. Before measurement begins, correction processing is completed automatically, allowing a smooth transition to continuous measurement.

### 3. Summary

STAvesta is an innovative STA (TG-DSC) instrument that sets itself apart from conventional models. It enables simultaneous quantitative evaluation of mass changes, associated with changes in temperature, and thermal reactions allowing for more precise thermal analysis. Thanks to a major design overhaul, seven types of electric furnaces can be mounted and exchanged on a single STAvesta. This enables flexible operation tailored to different measurement purposes and sample types. STAvesta is designed with everyday usability in mind—offering automated workflow for greater efficiency, easy sample exchange, enhanced temperature control performance, and the vestaeye self-diagnostic function. From beginners in thermal analysis to seasoned experts, this instrument delivers satisfaction across a wide range of users. We invite you to experience the next generation of thermal analysis with the evolved STAvesta.