Thermal Analysis Option

Thermomechanical Analysis Sample Robot

Efficient and Time-Saving TMA Automation

Thermomechanical analysis is a useful technique for identifying physical transformations in a material as a function of temperature. This is because the corresponding mechanical changes are easily measured. Mechanical measurements usually take a little longer than other thermal analysis techniques because low heating rates between 1 and 3 K/min are recommended.

The development of new automation technology has made TMA measurements more efficient and accessible, allowing for non-stop experimentation for improved efficiency and throughput.

Simple and easy to use operation
Two removable trays, each with 10 positions, mean you have the option of preparing your samples away from the instrument. Alternatively, you can use the convenient sample preparation area on the robot and leave the trays in place.

The robot will then pick up the sample holder from the tray and place it precisely on the measurement stand.

Once the measurement is complete, the sample holder will be removed, allowing the analysis to quickly move on to the next sample.

Features and benefits of the TMA sample robot

- **Up to 20 sample positions** – provides high throughput TMA
- **Patented sample holders** – for expansion, foaming, sintering, sorption, and penetration measurements
- **Ergonomic sample preparation position** – allows an easy experiment set-up
- **Disposal area for measured samples** – enables continuous operation beyond 20 samples
- **Evaluation by EvalMacro** – results in a complete automatic experiment

METTLER TOLEDO

An Innovative Automation Solution
Increase Efficiency and Consistency

The TMA sample robot integrates refined mechanics that can handle a wide range of applications with the STAR^{e} Software to allow fully automate workflows. It is designed to be intuitive and robust to simplify TMA automation. Our goal is to streamline your laboratory tasks and free up operator time.

Details

Sample positions

The robot is equipped with two identical trays, each with 10 positions for sample holders. You have the flexibility to prepare your samples away from the instrument or directly on the robot itself.

Patented sample holders

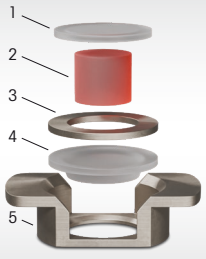
The patented sample holders are a crucial element of the TMA automation system. They are made of Inconel and quartz for use up to 1,100 °C, or ceramic for high-temperature applications up to 1,600 °C. Within the holder, the sample is centered in a sandwich made of the same material as the measurement probe, ensuring accurate and consistent measurements.

When the sample is placed on the TMA measurement stand, the measurement path comprises of only one type of material, according to the temperature range:

- Sample held by quartz sample holder with measurement by a quartz probe.
- Sample held by ceramic sample holder with measurement by a ceramic probe.

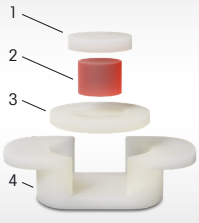
Standard Sample Holder

1. Cover disk (quartz)
2. Sample
3. Centering ring (Inconel)
4. Base (quartz)
5. Support (Inconel)



High Temperature Sample Holder

1. Cover disk (ceramic)
2. Sample
3. Centering disk (ceramic)
4. Support (ceramic)



Standard Sample Holder with 150 µL Alumina Crucible

Crucibles allow the measurement of powders for sintering or foaming applications.

High Temperature Sample Holder with 150 µL Alumina Crucible

Compatible crucibles:
Alumina: 150, 300 µL

Sample disposal
To facilitate continuous operation, a bin area is provided. Rather than returning the sample holders to the tray, the method can be configured to place them directly in the bin area for reuse. This ensures the tray always has free positions available, enabling uninterrupted operation.

With this feature, the TMA is well-suited for high-throughput applications and can perform measurements around the clock without interruption.

Safety check
The sample robot is equipped with a light barrier that serves two safety functions:
1. Checking the height of the sample before placing on the measurement stand to ensure it fits in the TMA measurement area.
2. Confirming that the sample holder has been properly removed before the next one is inserted.

These features ensure safe, 24/7 operation.

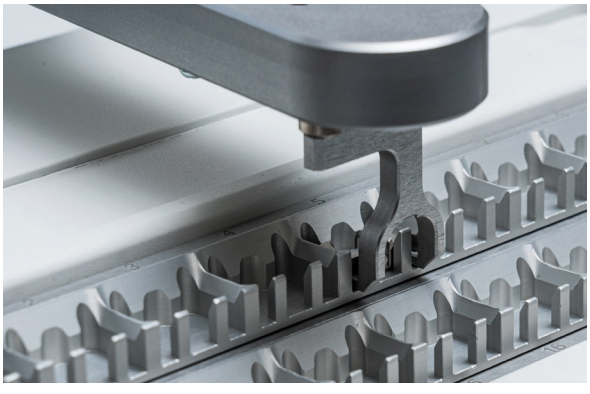
Software
While the robot is an essential component of thermal analysis systems, software plays an equally important role. The METTLER TOLEDO S**TA**R^{e} Software offers three key functionalities that are crucial for accurate and reliable TMA measurements:
- **Auto Blank** ensures highly precise measurement of the expansion coefficient by automatically correcting for any systematic errors caused by the instrument.
- **EvalMacro** enables automatic evaluations and result assessment.
- **Dedicated TMA evaluations** include standard and compliant methods for evaluating the expansion coefficient or glass transition temperature.

These powerful software tools, combined with the TMA's advanced automation capabilities, make it an indispensable tool for research and testing in a wide range of industries.

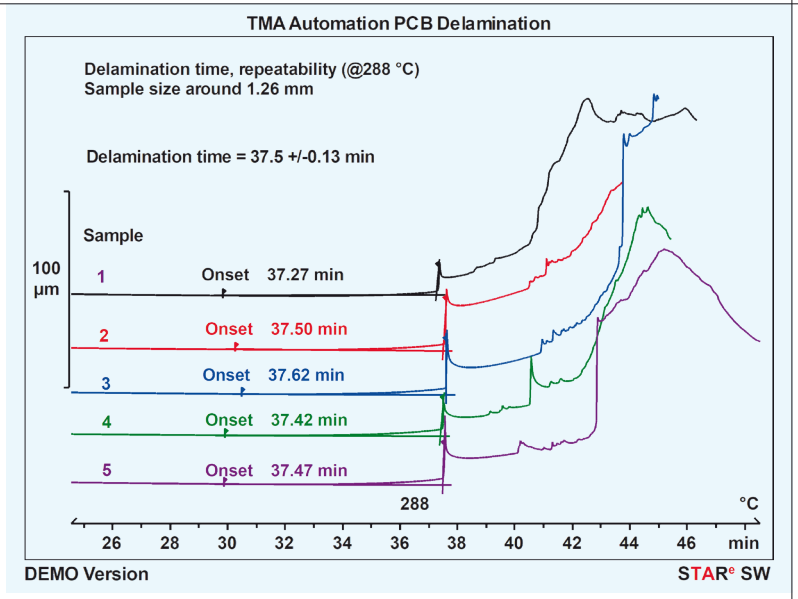
Applications

The TMA sample robot is an incredibly versatile and powerful tool, suitable for both quality control and research applications. Whether you're looking to optimize your production processes or conduct cutting-edge research, you can achieve your goals. With its advanced automation capabilities and intuitive software interface, the TMA robot can turn your existing TMA system into an efficient and highly productive tool.

The following types of applications can be automated:
1. Expansion
2. Delamination
3. Foaming
4. Sintering
5. Sorption
6. Penetration



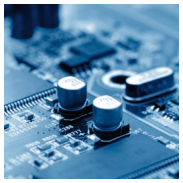
Application Examples

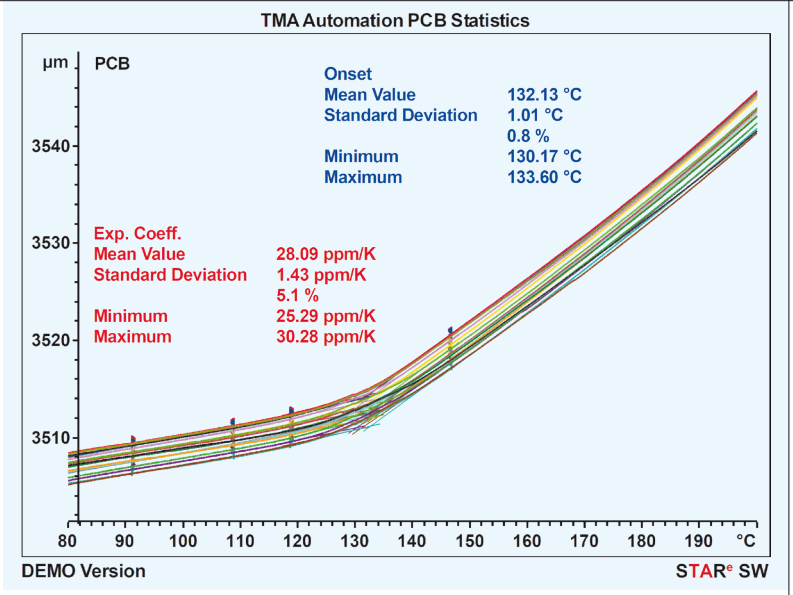


Delamination

Determination of delamination time or temperature of materials, especially electronics or PCBs, is one of the most important applications for the TMA. With the increasing demand for electronics, more and more tests will have to be performed for the development of new materials, or to ensure the quality control of existing materials.
With a TMA robot, multiple samples can be prepared in advance and the analyses programmed to run without further intervention.

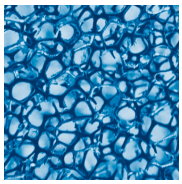
All measurements can be measured according to the guideline given in the IPC-TM-650 standard.

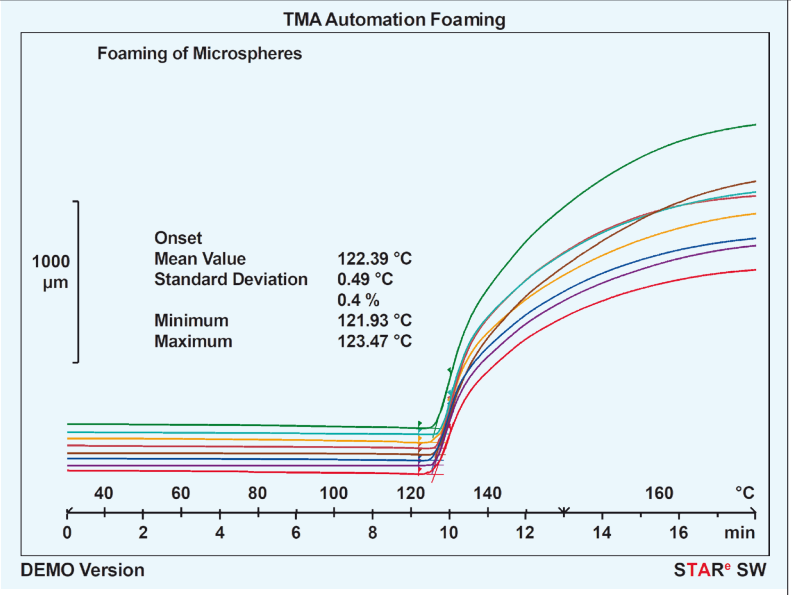




Expansion PCB

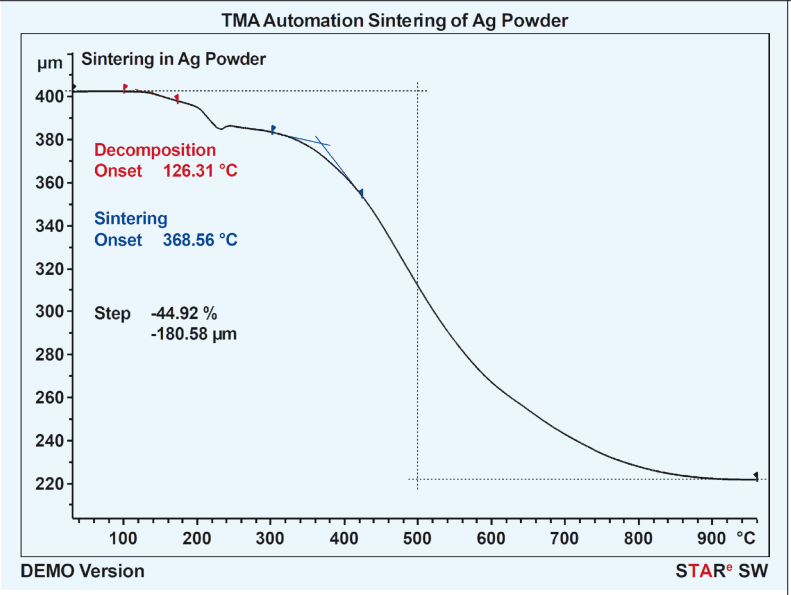
TMA experiments can be long, and the user needs to manually change the sample after each measurement. With the TMA sample robot, multiple experiments can be performed without manual exchange of the sample, allowing you to get useful statistics that would otherwise have been too time consuming to obtain. The TMA sample robot can operate overnight or during the weekend to ensure the required throughput for routine measurements.





Foaming

The TMA sample robot can easily handle large volume changes during the experiment. The example shown here is of a foaming polymer that expands almost 900% of its originally length, then collapses onto itself. The TMA and the sample robot have no issues with this type of application. Careful sample preparation and well-designed sample holders prevent the foaming material from sticking to the probe.

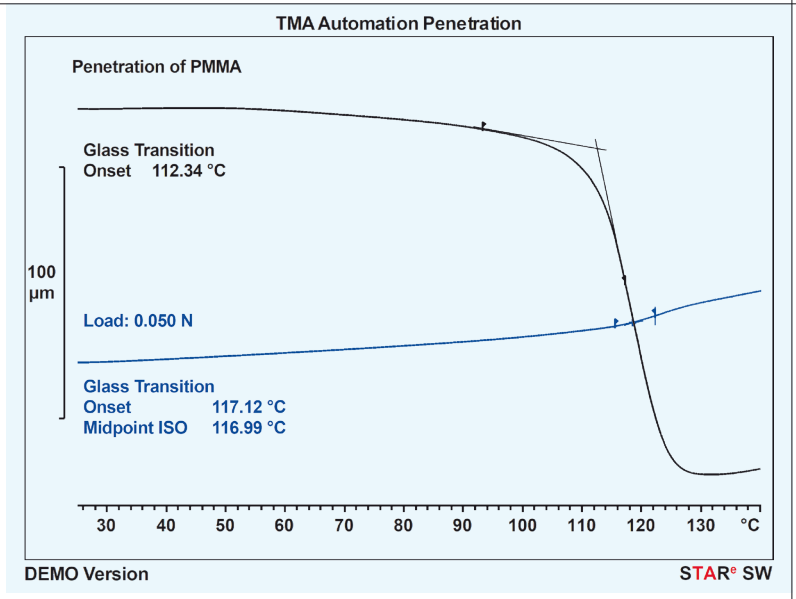


Sintering of an Ag powder for PV electrodes

Sintering experiments often start with a powder. Due to the careful design of our sample holders, standard crucible can be used. In this case a silver powder was sintered using the TMA sample robot without having the worry about loose powder. A 150 µL alumina crucible was used to hold the powder, leaving the sample holder intact and ready for another measurement. The crucible can be cleaned or disposed of after the measurement.

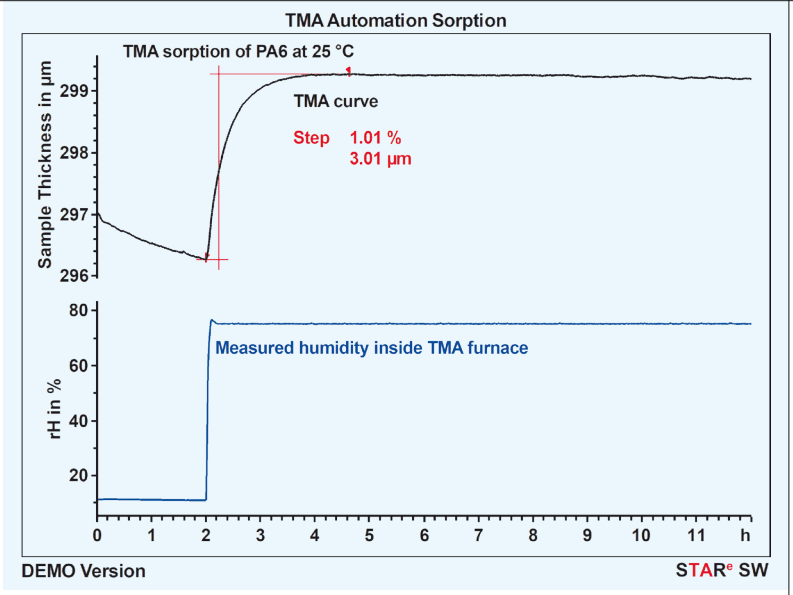
METTLER TOLEDO crucibles that can be used with the sample holders:

Alumina
150 µL, 300 µL



Penetration

Penetration experiments provide a lot of information about the softening of a material. With careful batch sample preparation techniques, the TMA sample robot can handle penetration measurements without the sample sticking to the sample probe after measurement. In this case a thin layer of aluminium foil was placed on top of a PMMA disc to ensure accurate results and reliable automation.



TMA Sorption

The TMA-Sorption system allows measurements under conditions of controlled relative humidity. It provides information that is important for understanding the effects that moisture content can have on the properties of a wide range of materials. These experiments can be long, ending during non-working hours. The TMA sample robot can automate the sample exchange reducing idle instrument time. Also, this is just another example of how we are continuously improving our products.

METTLER TOLEDO Group
Analytical Instruments
Local contact: www.mt.com/contacts

www.mt.com/ta-tma
For more information

30972527
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