Definitions of
Differential Thermal Analysis (DTA)

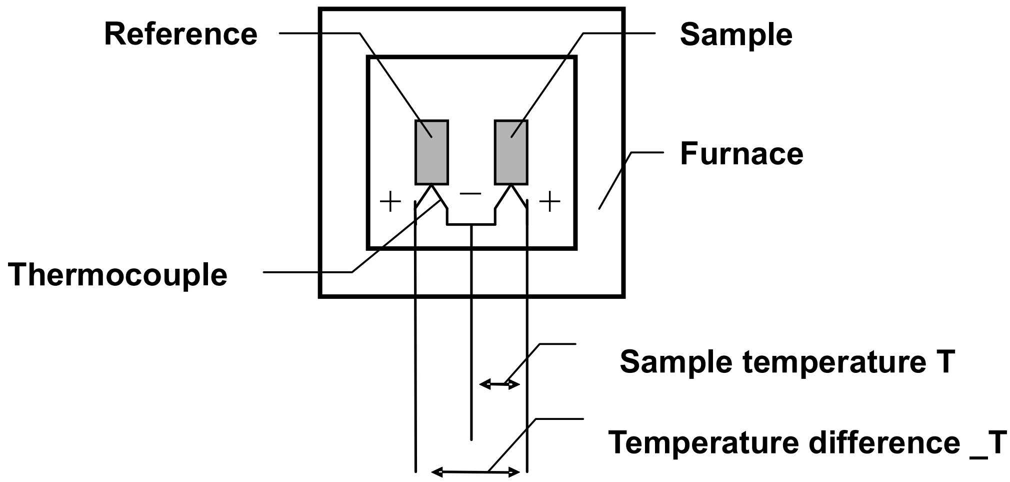
- A technique in which the difference in temperature between the sample and a reference material is monitored against time or temperature while the temperature of the sample, in a specified atmosphere, is programmed.

- A technique in which the temperature of reference material and a sample is varied according to a specified program and the temperature difference between reference material and the sample is measured as a function of the temperature.

The above are definitions of Differential Thermal Analysis (DTA).
The first is the definition from ICTAC publication “For Better Thermal Analysis and Calorimetry” and the second is from JIS K-0129 “General Principles of Thermal Analysis”.

As stated in the definitions, DTA is a technique that detects the temperature difference between the sample and reference material. With this technique, temperature difference between the sample and the reference material, which changes in response to melting or other reaction of sample to temperature change, is detected

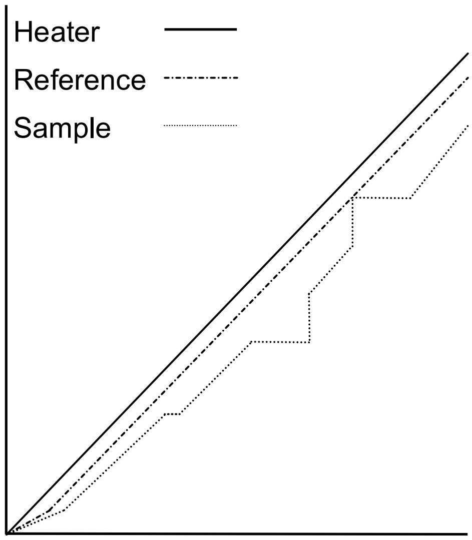
DTA Device Structure

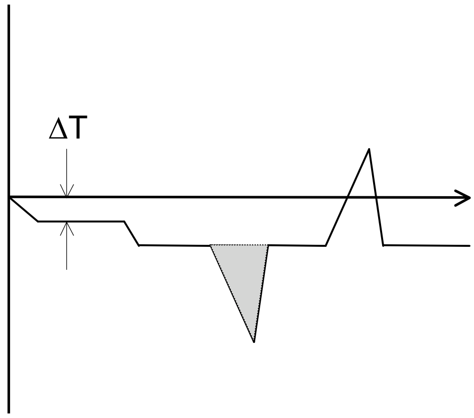


The above diagram shows the configuration of a DTA device.

The sample and the reference are placed symmetrically. The furnace is controlled under a temperature program and the temperature of the sample and reference are changed. During this process, a differential thermocouple is set up to detect the temperature difference between the sample and reference.
Also, the sample temperature is detected from the thermocouple on the sample area.

DTA Measurement Principle





The above diagrams show DTA’s measurement principles.

Graph (a) shows the temperature change of the furnace, reference and sample against time.
Graph (b) shows the change in temperature difference (ΔT) against time detected with the differential thermocouple.
ΔT signal is referred to as the DTA signal.
Matters that do not change in the measurement temperature range (usually a alumina) are used as reference.
When the furnace warming begins, the reference and sample begin warming with a slight delay depending on their respective heat capacity, and eventually warm up in according to the furnace temperature.
ΔT changes until a static state is reached after the warming begins, and after achieving stability, reaches a set amount compliant with the difference in heat capacity between the sample and reference. The signal at the static state is known as the baseline.
When the temperature rises and dissolution occurs in the sample, for example, the temperature rise stops as shown in graph (a) and the ΔT increases. When the dissolution ends, the temperature line rapidly reverts to the upward curve.
At this point, the ΔT signal reaches the peak, as shown in graph (b).
From this, we can detect the sample’s transition temperature and reaction temperature from the ΔT signal (DTA signal).
In graph (b), the temperature difference due to the sample’s endothermic change is shown as a negative value and the temperature difference due to the sample’s exothermic change is shown as a positive value.

1. Definition and Principles of Thermal Analysis