Differential thermal analysis (DTA) / Thermogravimetric analysis (TG)

Thermal analysis is the analysis of a change in a property of a sample, which is related to an imposed change in the temperature. The sample is usually in the solid state and the changes that occur on heating include melting, phase transition, sublimation, and decomposition.

The analysis of the change in the mass of a sample on heating is known as **Thermogravimetric analysis (TG)**. TG measures mass changes in a material as a function of temperature (or time) under a controlled atmosphere. Its principal uses include measurement of a material's thermal stability and composition. TG is most useful for dehydration, decomposition, desorption, and oxidation processes.

The most widely used thermal method of analysis is **Differential thermal analysis (DTA)**. In DTA, the temperature of a sample is compared with that of an inert reference material during a programmed change of temperature. The temperature should be the same until thermal event occurs, such as melting, decomposition or change in the crystal structure. In an endothermic event takes place within the sample, the temperature of the sample will lag behind that of the reference and a minimum will be observed on the curve. On the contrary, if an exothermal event takes place, then the temperature of the sample will exceed that of the reference and a maximum will be observed on the curve. The area under the endotherm or oxotherm is related to the enthalpy of the thermal event, *ΔH.*

For many problems, it is advantageous to use both DTA and TG, because the DTA events can then be classified into those which do or do not involve mass change. A good example is shown as following:

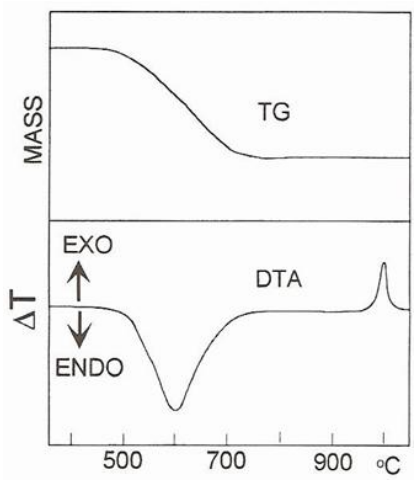

Fig.1 TG & DTA curves for $Al_4(Si_4O_{10})(OH)_8$

At the temperature range 500 to 700°C there is a change in mass occurred on the TG curve, which corresponds to dehydration of $Al_4(Si_4O_{10})(OH)_8$, and this dehydration shows up on DTA curve as an endotherm. At 950 to 980°C, a second DTA effects occurs but this effect not occurs on the TG curve, because this event corresponds to recrystallization of the dehydrated kaolin. This recrystallization process is oxothermic.

TG-DTA modes can be used to determine the following:-

- Melting points
- Glass transition temperatures
- Cristallinity

- Moisture/ volatile content
- Thermal and oxidative stability
- Purity
- Transformation temperatures

Q&A: 1. What kind of reference materials is used in DTA

The ideal reference material is a substance with the same thermal mass as the sample, but with no thermal events over the temperature range of interest. In DTA is usually used alumina (Al_2O_3), carborundum(SiC) or magnesium oxide(MgO) powder as the reference material for the analysis of inorganic compounds.

2. What's the difference between DSC and DTA

The difference between DTA and DSC is that, in DTA the temperature of the sample is monitored with respect to a reference sample; in DSC the sample and the reference are maintained at the same temperature throughout the procedure.

Reference:

D.F. Shriver, P. W. Atkins, *Shriver & Atkins' Inorganic Chemistry,* 4th edition, Oxford University Press, Oxford 2006, *pp. 189-190*.

Anthony R. West, *Basic Solid State Chemistry,* 2nd Edition, Wiley, London, 2001*, pp. 203-210.*

http://tetra.simtech.a-star.edu.sg/afbsUpload/FactSheet/ICES/TA%20Analyzer.pdf