MPE-03 Lecture 3

Materials Characterizations

Thermal Analysis

Syllabus

Introduction to materials, preparation and characterization techniques; Spectroscopic methods- UV-visible and vibrational spectroscopy- Infrared and Raman, Electron spectroscopies - X-ray photoelectron spectroscopy, Ultraviolet photoelectron spectroscopy, Auger electron spectroscopy; Optical microscopy, Electron microscopy- SEM, TEM; Scanning Probe Microscopies: STM, AFM; **Thermal analysis- TGA, DTA, DSC;** Materials analysis by Non-destructive testing (NDT).

Thermal Analysis

THERMAL ANALYSIS (TA) refers to a group of techniques in which a property of a sample is monitored against time or temperature while the temperature of the sample, in a specified atmosphere, is programmed.

Or

THERMAL ANALYSIS (TA) means the analysis of a change in a property of a sample, which is related to an imposed temperature alteration.

Types of Thermal analytical techniques

THERMAL TECHNIQUE	PROPERTY	USES
Thermogravimetry (TG)	Mass	Decomposition, oxidation reactions
Differential Thermal Analysis (DTA)	Temperature difference	Phase change reactions
Differential Scanning Calorimetry (DSC)	Heat flow	Heat capacity, phase change reactions
Thermo mechanical Analysis (TMA)	Deformations	Softening, Expansion
Dynamic mechanical Analysis (DMA)	Deformations	Phase changes
Di-electrical Thermal Analysis (DETA)	Electrical	Phase changes

Thermal Analysis Techniques

Thermogravimetric Analysis (TGA)

TGA measures the weight changes of the as a function of time or temperature. This method is effective in determining decomposition, oxidation or loss of solvent or water.

Differential Scanning Calorimetry (DSC)

DSC is used to measure the energy absorbed or released on the sample, as a function of time or function of the temperature. DSC is useful to make the measurements for melting points, heats of reaction, glass transition, and heat capacity

Thermal Analysis Techniques

Differential Thermal Analysis (DTA)

DTA measures the temperature difference between the sample and the reference as the function of time temperature. This method is similar to DSC, but not quantify the amount of energy. It is usually working under high temperature. This method is used in the measurement of glass transitions, phase changes, and melting points can be measured.

Thermomechanical Analysis (TMA)

TMA measures the dimensional changes on a sample as function of temperature. The various probes, were used to measure the properties of expansion, contraction, penetration, softening of the sample as well as glass transition.

Thermal Analysis Techniques

Dynamic Mechanical Analysis (DMA)

Dynamic Mechanical Analysis (**DMA**) is a technique that is widely used to characterize a material's properties as a function of temperature, time, frequency, stress, atmosphere or a combination of these parameters.
It is most useful for studying the viscoelastic behavior of polymers. A sinusoidal stress is applied and the strain in the material is measured.

Dielectric thermal analysis (DETA)

Dielectric thermal analysis (DETA) is a materials science technique in which an oscillating electric field is used to analyze changes in the physical properties of a number of polar materials.

Summary

There are six thermal analysis techniques :

- **TGA**
- **DSC**
- **DTA**
- **TMA**
- **DMA**
- **DETA**

In next class Thermal Gravimetric analysis will be explained.