2010 Spring **04. 08. 2010**

"Amorphous Materials"

Class # _____ Name _____

1. Fill in the blank or choose right answer from words in parenthesis. (15 points)

Thermal analysis is a branch of materials science where the properties of materials are studied as they change with ( ). Several methods are commonly used - these are distinguished from one another by the property which is measured:

- Differential scanning calorimetry (DSC): ( )
- Differential thermal analysis (DTA): ( )
- Thermomechanical analysis (TMA): ( )
- Dilatometry (DIL): ( )
- Dynamic mechanical analysis (DMA) : ( )

Differential scanning calorimetry (DSC) is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and ( ) are measured as a function of temperature. Both the sample and ( ) are maintained at nearly the same ( ) throughout the experiment. Generally, the temperature program for a DSC analysis is designed such that the sample holder temperature increases linearly as a function of time. The reference sample should have a well-defined ( ) over the range of temperatures to be scanned.

Differential thermal analysis (or DTA) is a thermoanalytic technique, similar to ( ). In DTA, the material under study and an inert reference are made to undergo (**identical / different**) ( ), while recording any ( ) between sample and reference. This value is then plotted against time, or against temperature (DTA curve). Changes in the sample, either exothermic or endothermic, can be detected relative to the inert ( ). Thus, a DTA curve provides data on the transformations that have occurred, such as glass transitions, crystallization, melting and ( ). The area under a DTA peak is the ( ) and is not affected by the ( ) of the sample.

A dilatometer is a scientific instrument that measures ( ) caused by a physical or chemical process. A familiar application of a dilatometer is the mercury-in-glass thermometer, in which the change in volume of the ( ) column is read from a graduated scale. Because mercury has a fairly (**linear / constant**) rate of ( ) over normal temperature ranges, the ( ) are directly related to temperature.

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Thermomechanical analysis measures the ( ) of a sample as a function of temperature and is a very interesting and complementary method to ( ) that provides you with a large amount of additional information. TMA measures materials deformation changes under controlled conditions of force, atmosphere, ( ) and temperature. TMA deformation modes include expansion, ( ), compression, tension, and 3-point bending, which can be applied using specially designed ( ). TMA measures intrinsic material properties (e.g., expansion coefficient, ( ), Young's modulus), plus processing/ product performance parameters (e.g., softening points).

Dynamic Mechanical Analysis (DMA) is most useful for observing the ( ) of polymers. Two methods are currently used: One is the decay of free oscillations and the other is forced oscillation. Free oscillation techniques involve applying a force to a sample and allowing it to oscillate after the force is ( ). Forced oscillations involve the continued application of a force to the sample. An oscillating force is applied to a sample of material and the resulting ( ) of the sample is measured. Samples can be either solids or melts. Most solids are tested by linearly applied **(strain/ shear)** and melts or liquids are normally tested in **(strain / shear).**

The sample deforms under the load. From this, the **(modulus / stiffness / damping property)** of the sample can be determined, and the sample **(modulus/ stiffness /damping property)** can be calculated. By measuring the ( ) in the displacement compared to the applied force it is possible to determine the **(modulus/ stiffness /damping property)** of the material. The time lag is reported as a phase lag, which is an angle. The damping is called tan delta, as it is reported as the tangent of the phase lag.

The glass transition temperature (Tg) is often measured by ( ), but the DMA technique is more ( ) and yields more easily interpreted data. DMA can also be used to investigate the frequency (and therefore time) dependent nature of the transition. This is usual as the degree of dependence is specific to the transition type. **(Tg / Melting)** has a strong dependence on frequency but **(Tg / Melting)** is frequency independent. DMA can also resolve sub- Tg transitions, like beta, gamma, and delta transitions, in many materials that the ( ) technique is not sensitive enough to pick up.

DSC/ DTA/ TMA/ DIL/ DMA/ time / temperature/ pressure/ length/ area/ volume/ dimension/ time lag/ temperature lag/ displacement/ reduction/ expansion/ penetration/ solid/ amorphous/ liquid/ volume change/ enthalpy change/ entropy change/ dimensional change/ heat flow/ heat capacity/ expansion coefficient/ thermal cycles/ heat difference/ temperature difference/ viscoelastic nature/ viscosity/ mechanical stiffness & damping/ sample/ reference/ sample holder/ probes/ glass transition/ melting/ evaporation/ sublimation/ added/ removed/ exact/ sensitive

*** Suggestion for class or request for personal conversation:**

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