Al-Mustaqbal University

College of Engineering & Technology

Biomedical Engineering Department

Subject Name: Physics

1st Class, First Semester

Subject Code: [Insert Subject Code Here]

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Lecture No.:-5

Lecture Title: [Thermal analysis and Thermal process]

Thermal Analysis

Thermal analysis refers to a set of techniques used to study the relationship between a material's properties and temperature. It is commonly applied in material science, engineering, and biomedical fields. The key thermal analysis techniques include:

- When matter is heated, it undergoes

certain physical and chemical changes.

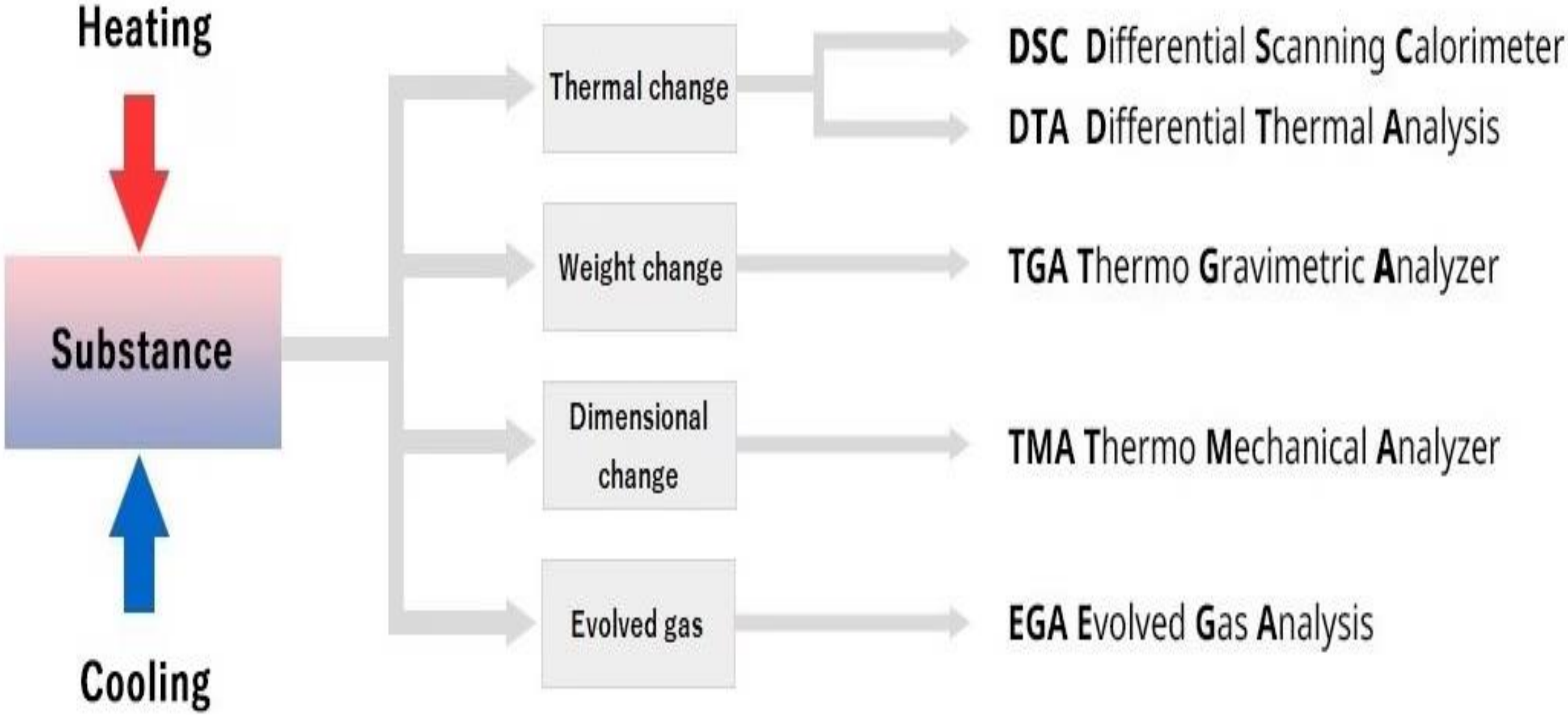
Physical changes include phase changes such as melting, vaporization, crystallization, transitions between crystal structures, changes in microstructure in metal alloys and polymers, volume changes (expansion and contraction), and changes in mechanical behavior.

Chemical changes include reactions to form new products, oxidation, corrosion, decomposition, dehydration, chemisorption, and the like.
These physical and chemical changes take place over a wide temperature range.

- Materials are used over a wide range of temperatures, from Arctic cold to tropical heat, in corrosive environments, variable humidity, and under load (stress).
- It is necessary to **characterize** materials and their behavior over a range of temperatures to determine what materials are suitable for specific uses and to determine what temperature range materials or chemicals can withstand without changing.

Types of thermal analysis

- **Differential Scanning Calorimetry (DSC):** Measures heat flow associated with phase transitions (e.g., melting, crystallization).
- **Thermogravimetric Analysis (TGA):** Evaluates mass changes as a function of temperature (e.g., decomposition, oxidation).
- **Differential Thermal Analysis (DTA):** Identifies temperature differences between a sample and reference material to detect phase transitions.
- **Dynamic Mechanical Analysis (DMA):** Examines material behavior under mechanical stress with temperature variations.
- **Thermomechanical Analysis (TMA):** Studies expansion, contraction, or deformation of materials under temperature influence.


Heating
Substance
Cooling
Thermal change
Weight change
Dimensional change
Evolved gas
DSC Differential Scanning Calorimeter
DTA Differential Thermal Analysis
TGA Thermo Gravimetric Analyzer
TMA Thermo Mechanical Analyzer
EGA Evolved Gas Analysis

Thermal Processes

Thermal processes refer to the methods through which heat energy is transferred, converted, or utilized in different systems. These processes play a crucial role in various fields, including engineering, materials science, and biomedical applications.

- **Types of Thermal Processes**

1.Heat Transfer Mechanisms:

1. **Conduction:** The direct transfer of heat through a solid or between objects in contact without the movement of material (e.g., heat traveling through a metal rod).
2. **Convection:** Heat transfer through the movement of fluids (liquids or gases), such as warm air rising or water circulating in a pot.
3. **Radiation:** The transfer of heat energy through electromagnetic waves, such as infrared radiation from the sun.

2. Phase Change Processes:

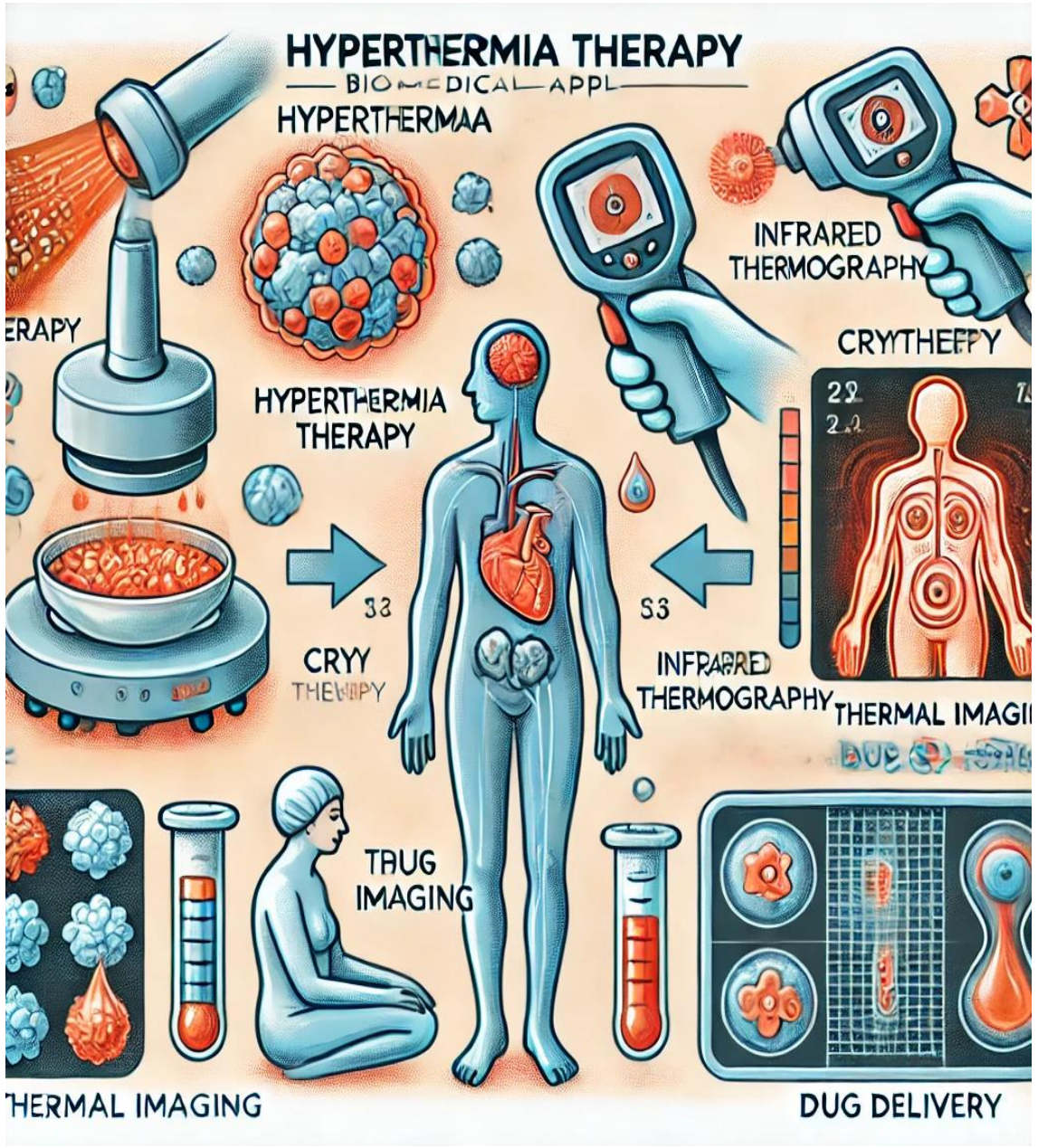
•**Melting:** Transformation from solid to liquid when heat is absorbed.
•**Freezing:** Transition from liquid to solid when heat is released.
•**Evaporation & Boiling:** Liquid changing to gas when heat is added.
•**Condensation:** Gas turning into a liquid when heat is removed.
•**Sublimation & Deposition:** Direct transition between solid and gas without passing through the liquid phase.

3. Thermochemical Processes:

•**Combustion:** A chemical reaction where a substance reacts with oxygen, releasing heat energy.
•**Pyrolysis:** Decomposition of materials at high temperatures in the absence of oxygen.
•**Exothermic & Endothermic Reactions:** Exothermic reactions release heat (e.g., oxidation), while endothermic reactions absorb heat (e.g., photosynthesis).

Biomedical Applications of Thermal Processes:

1. **Hyperthermia Therapy:** Using controlled heat to treat tumors and cancer cells.
2. **Cryotherapy:** Applying extreme cold for pain relief, inflammation reduction, and tissue preservation.
3. **Thermal Imaging:** Infrared thermography for diagnosing medical conditions related to blood flow and inflammation.
4. **Drug Delivery:** Temperature-sensitive materials used in controlled drug release.

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