🌡️ Thermal Decomposition Graphs – TGA & DSC (16 Marks)

🔷 1. Introduction

- **Thermal Analysis** is used to study how materials behave when heated.
- Two key methods:
  - **TGA (Thermogravimetric Analysis)**: Measures **weight change** with temperature.
  - **DSC (Differential Scanning Calorimetry)**: Measures **heat flow** during heating/cooling.

🔷 2. TGA – Thermogravimetric Analysis

📌 Principle:

- Measures **mass loss** of a material as temperature increases.
- Used to detect **decomposition, oxidation, and evaporation**.

📊 Graph:

- **X-axis**: Temperature (°C or K)
- **Y-axis**: % Weight (mass)
- The curve shows **mass decreasing** with temperature.

📉 Stages:

1. **Initial flat region**: No change – stable.
2. **Drop region**: Sudden weight loss – decomposition or evaporation.
3. **Plateau**: No further reaction – residue remains.

🔍 Applications:

- Checking **thermal stability**.
- Studying **decomposition temperature**.
- Measuring **moisture, volatile content**, and **residue**.

🔷 3. DSC – Differential Scanning Calorimetry

📌 Principle:

- Measures **heat flow difference** between sample and reference as they are heated/cooled.
- Identifies **endothermic** (heat absorbed) or **exothermic** (heat released) events.

📊 Graph:

- **X-axis**: Temperature (°C)

- **Y-axis**: Heat Flow (mW or mJ/sec)
- Peaks indicate thermal transitions.

📈 **Types of Peaks:**

- **Endothermic peak (downward)**: Melting, dehydration, glass transition.
- **Exothermic peak (upward)**: Crystallization, curing, combustion.

🔍 **Applications:**

- **Melting point, crystallization temperature**.
- Studying **glass transition**.
- **Polymer and drug** analysis.

📊 4. Diagram Description

✅ **TGA Graph:**

- Straight line → Sudden drop → Flat line.
- Label: “Mass (%) vs Temperature (°C)”
- Drop = decomposition or weight loss.

✅ **DSC Graph:**

- Baseline → Peak (up/down) → Return to baseline.
- Label: “Heat Flow vs Temperature”
- Downward peak = melting (endothermic)
- Upward peak = crystallization (exothermic)

✅ 5. Advantages

TGA	DSC
Simple setup	Precise heat flow measurement
Measures mass change	Identifies phase transitions
Useful for residue and moisture	Determines melting & glass points

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❌ 6. Disadvantages

TGA	DSC
Cannot identify chemical changes	No weight change is detected
Needs inert gas for accuracy	Sensitive to sample mass & heating rate

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📄 8. Summary

- **TGA** shows **weight loss** vs temperature → used for decomposition and stability study.
- **DSC** shows **heat flow** vs temperature → used for melting, glass transition, and curing.
- Both are essential in **thermal analysis** of materials.
