

Introduction to P-T Equilibrium Phase Diagram

MSE-S203

(Phase Equilibria in Materials)

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P-T Equilibrium Phase Diagram

➤ *P-T Phase Diagram*

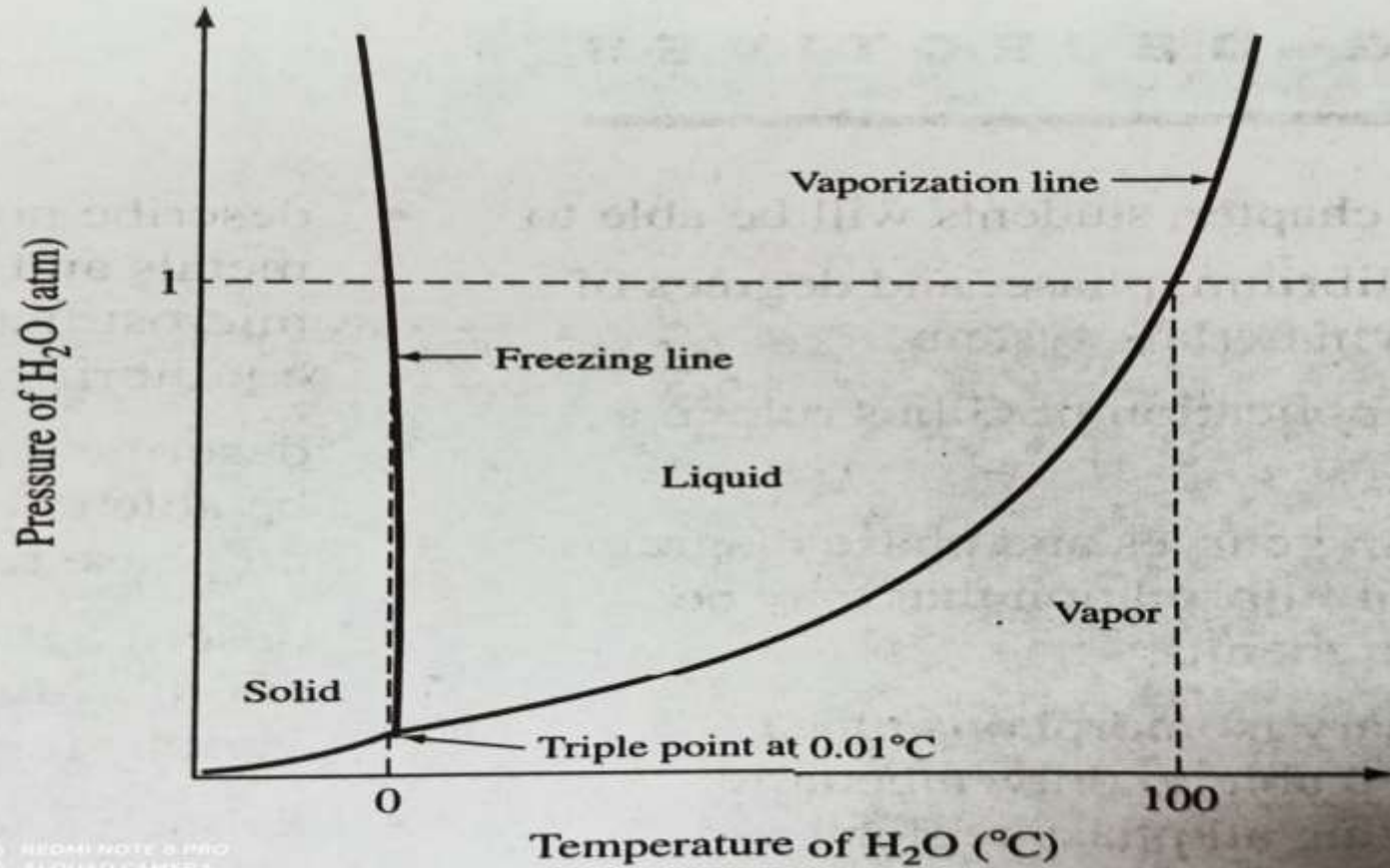
- A substance that has a uniform chemical composition throughout is called a pure substance such as water, air, and nitrogen.
- A pure substance such as water can exist in solid, liquid or vapor phases, depending on the thermodynamic conditions.
- **Example:** Glass of water (liquid phase) with ice cubes (solid phase) in equilibrium.

P-T Equilibrium Phase Diagram

➤ *P-T Phase Diagram*

- In a case of Glass of water (liquid phase) containing ice cubes (solid phase) in equilibrium, solid and liquid water are two separate and distinct phases.
- Solid and liquid water are separated by a phase boundary (surface of the ice cubes).
- At boiling temperature, liquid water and water vapor are two phases in equilibrium.

PT Equilibrium Phase Diagram for Pure Water



PT Equilibrium Phase Diagram for Pure Water

➤ *P-T Phase Diagram*

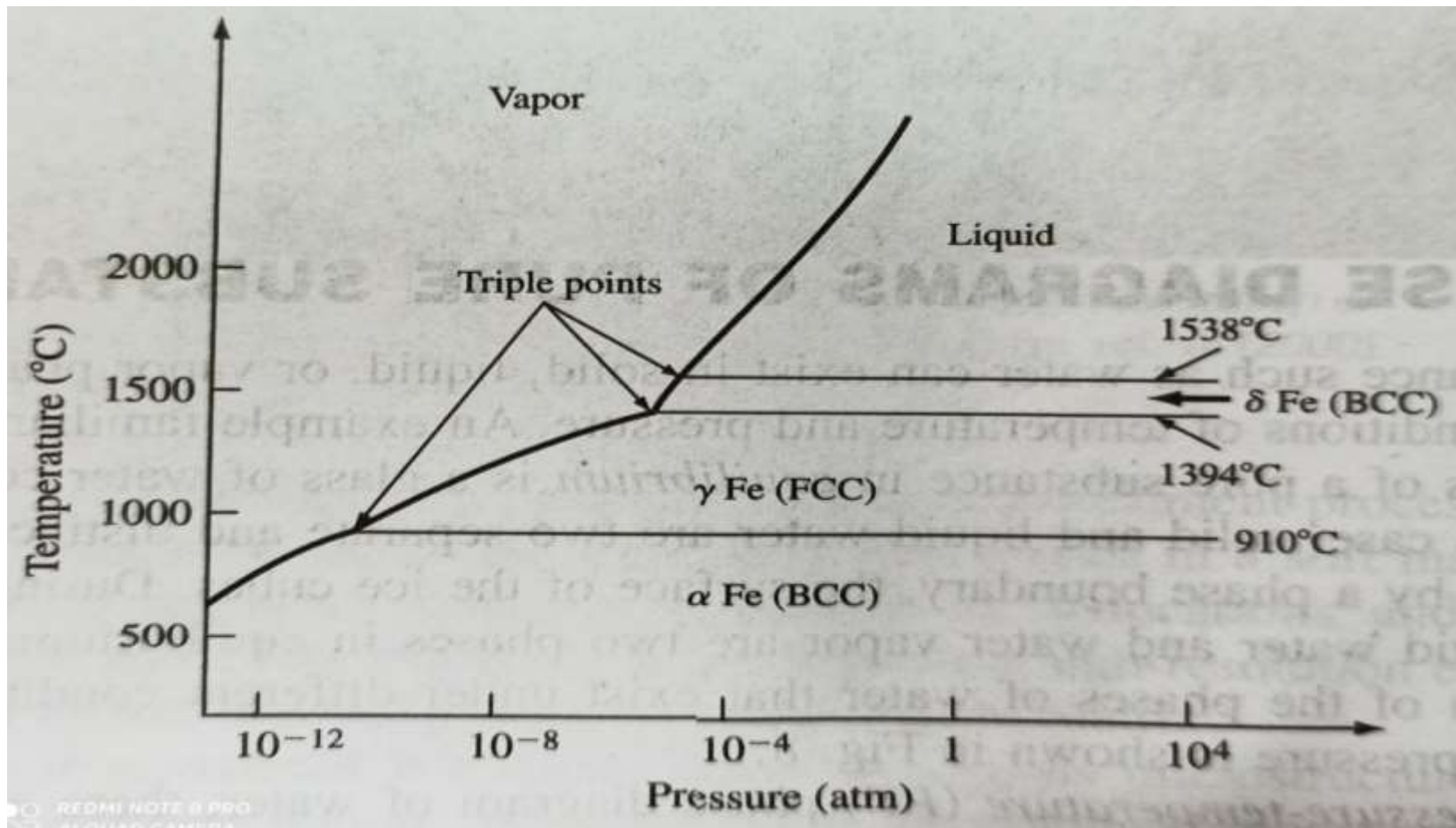
- In the Pressure- Temperature (P-T) phase diagram of pure water, there exist a triple point (solid, liquid and vapor phases of water coexist) at low pressure (0.006 atm) and low temperature (0.0098°C).
- Liquid and vapor phases exist along the vaporization line (phase boundary).
- Liquid and solid phases exist along the freezing line (phase boundary).

P-T Equilibrium Phase Diagram

➤ *P-T Phase Diagram*

- P-T equilibrium phase diagrams also can be constructed for other pure substances.
- **Example:** P-T equilibrium phase diagram for pure iron.
- P-T equilibrium phase diagram for pure iron is different from P-T equilibrium phase diagram for pure water.
- There are three separate and distinct solid phases.

PT Equilibrium Phase Diagram for Pure Iron



PT Equilibrium Phase Diagram for Pure Iron

➤ *P-T Phase Diagram*

- Alpha Fe, gamma Fe and delta Fe are the three separate and distinct solid phases, present in P-T equilibrium phase diagram for pure iron.
- Alpha and delta iron have BCC crystal structure, whereas gamma iron has FCC crystal structure.
- Phase boundaries in the solid state have the same properties as the liquid and solid phase boundaries.