



Lecture 3: Crystal Imperfections and Solidification of Metals and Alloys

1. Introduction

In materials science, the **atomic structure of solids** strongly influences their **mechanical, electrical, magnetic, and thermal properties**.

Perfect crystals are idealized concepts; in reality, **all crystals contain defects**, which are deviations from the perfect periodic arrangement of atoms.

Why defects matter:

- Determine **strength, hardness, and ductility**
- Affect **electrical conductivity and magnetic behavior**
- Influence **diffusion, corrosion, and fracture mechanisms**
- Crucial for **designing alloys and engineering materials**

Studying defects allows engineers to **control material behavior** for specific applications.

2. Classification of Crystal Defects (Dimensional View)

Defects are classified by **dimensionality**:

Defect Type	Dimension	Examples
Point Defects	0D	Vacancy, Interstitial, Substitutional, Frenkel, Schottky
Linear Defects	1D	Edge Dislocation, Screw Dislocation
Interfacial Defects	2D	Grain Boundaries, Twin Boundaries
Bulk Defects	3D	Pores, Cracks, Inclusions

3. Point Defects (0D)

Definition: Localized defects involving one or a few atoms.

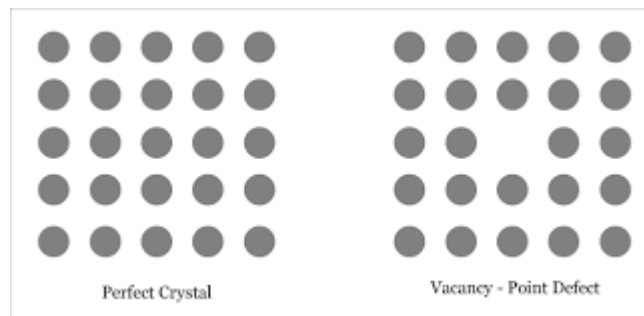


Al-Mustaqbal University / College of Technical Engineering
Department of Aircraft Technical Engineering
Class (First Year)
Subject (Materials engineering) / Code (UOMU0210025)
Lecturer (Asst. Lect. Alboraq Hayder Mohsin)
2nd term – Lecture No5. & Lecture Name (Crystal Imperfections)

Types and Examples:

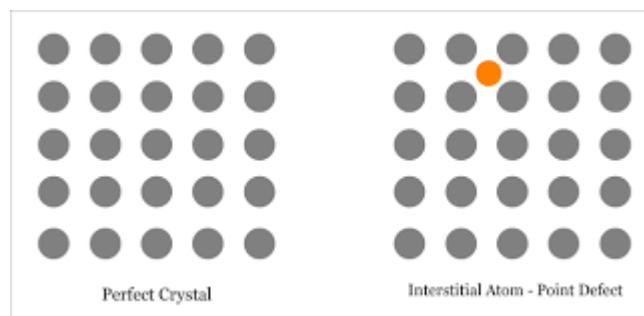
1. Vacancy Defect

- Atom missing from its lattice site
- Increases with temperature
- *Effect:* Enhances atomic diffusion
- *Example:* Missing copper atom in FCC copper



2. Interstitial Defect

- Extra atom in the space between lattice atoms
- *Effect:* Lattice distortion, increased hardness
- *Example:* Carbon in interstitial site of iron (steel)



3. Substitutional Defect

- Atom replaced by a different atom of similar size
- *Effect:* Alters electrical, thermal, and mechanical properties
- *Example:* Zinc replacing copper in brass alloy



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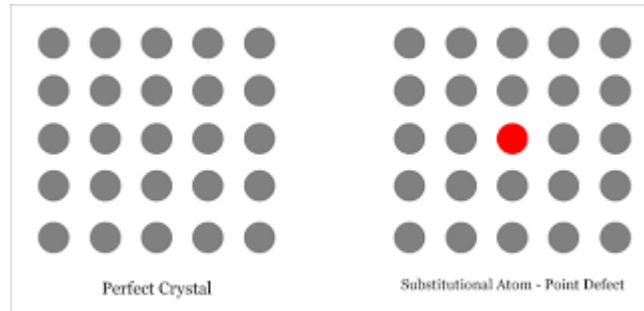
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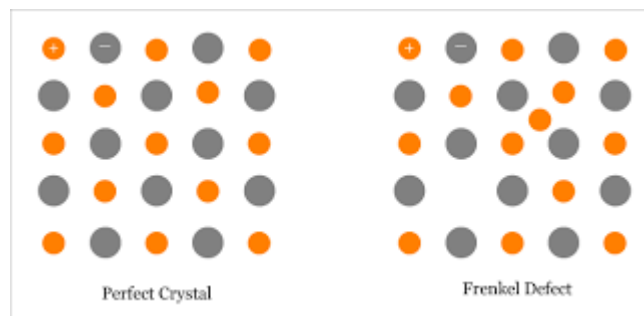
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4. Frenkel Defect

- Atom moves from lattice site to interstitial position
- *Effect:* Vacancy-interstitial pair affects ionic conductivity
- *Example:* Silver ion in AgCl



5. Schottky Defect

- Equal number of cation and anion vacancies to maintain charge neutrality
- *Effect:* Reduces density of ionic crystals
- *Example:* NaCl with missing Na⁺ and Cl⁻ ions

