SNS College of Engineering Coimbatore – 641 107

Crystal Defects and Crystal Growth Technique

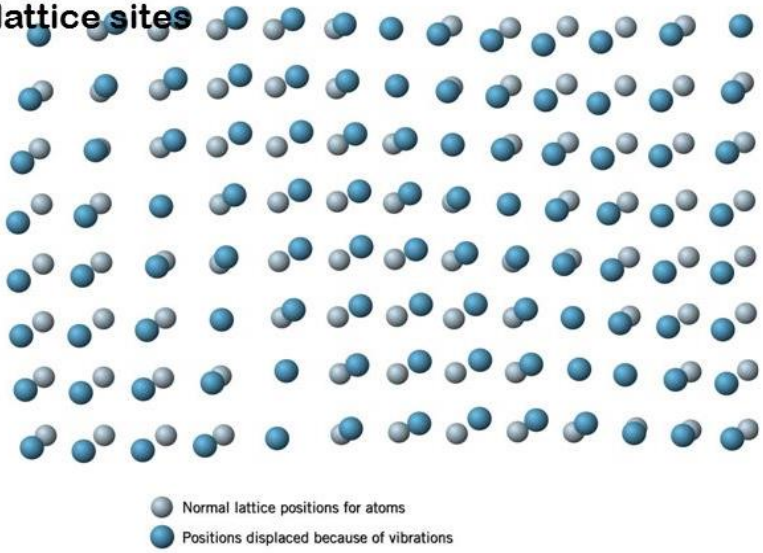
Crystal Defects

- Lattice Vibration or Phonon
- Point Defects
- Line Defects
- Surface Defects
- Volume Defects

Lattice Vibration

Lattice vibration

- Freeze-time model of atoms in a crystal – Lattice vibration may be thought of as a defect since atoms are no longer at their perfect lattice sites



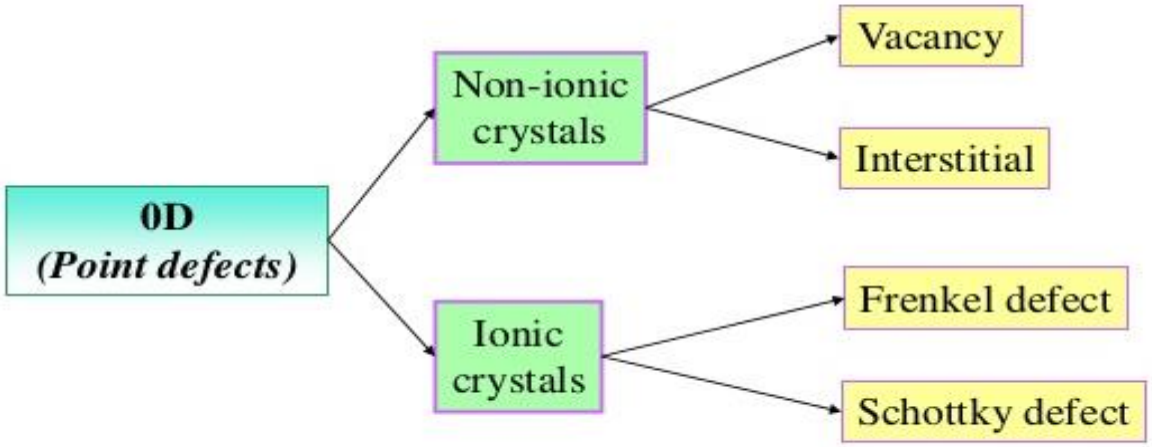
Lattice vibration is a mode of heat transfer through a crystal

Chapter 4-

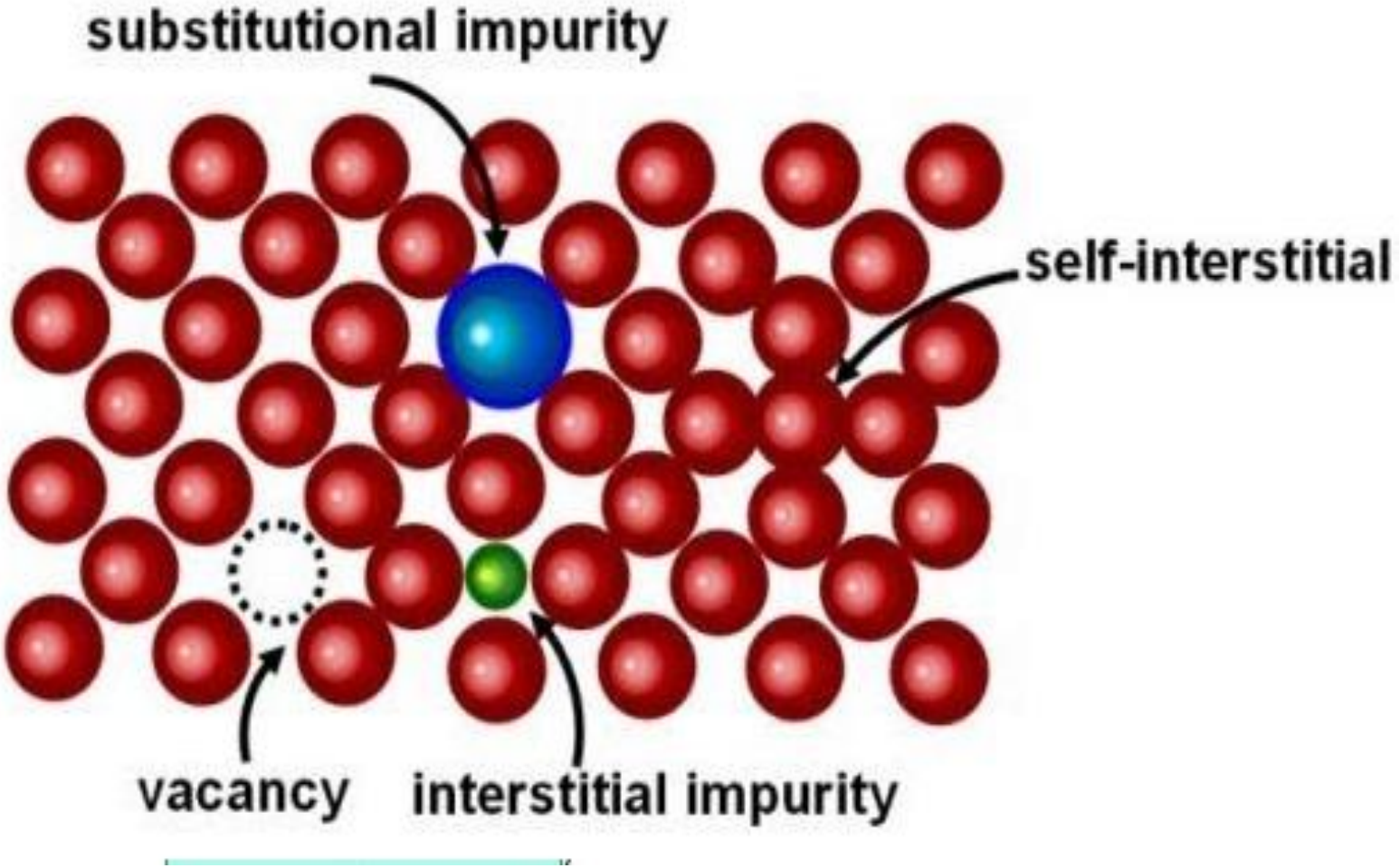
Point Defects

POINT DEFECTS

Point Defects are the irregularities or deviations from ideal arrangement around a point or an atom in a crystalline substance.



Point Defects



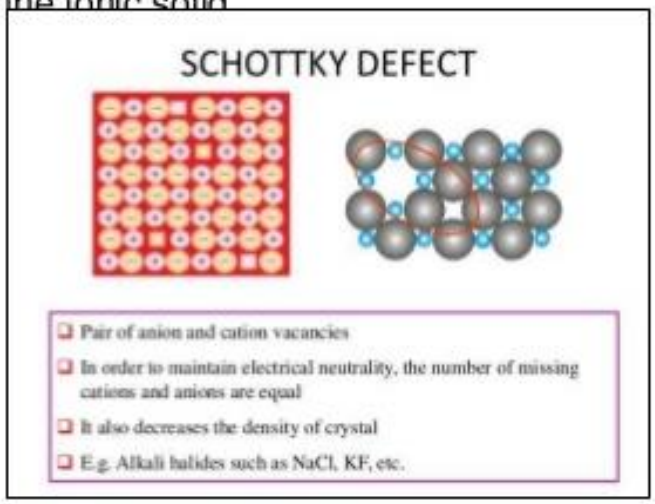
SCHOTTKY DEFECT

A Schottky defect is a type of point defect in a crystal lattice named after Walter. H.Schotty.

In non-ionic crystals it means a lattice vacancy defect.

In ionic crystals, the defect forms when oppositely charged ions leave their lattice sites, creating vacancies.

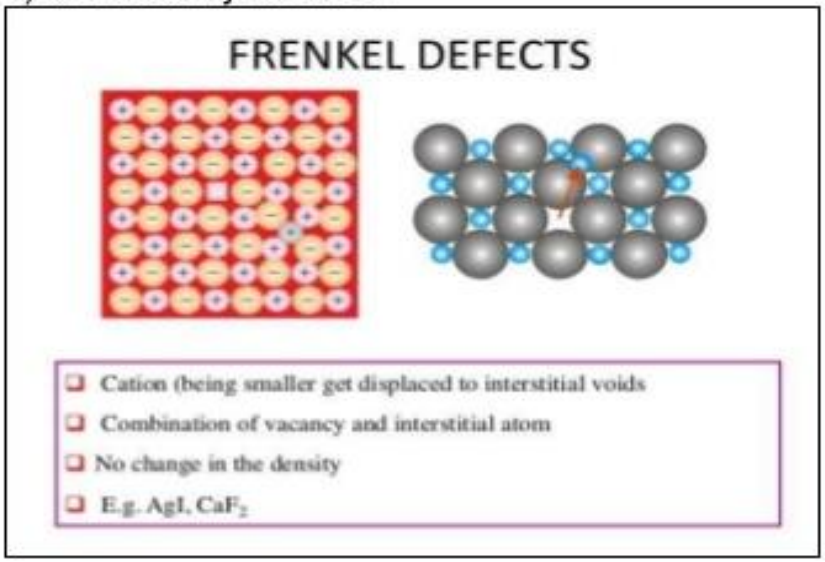
These vacancies are formed in stoichiometric units, to maintain an overall neutral charge in the ionic solid



FRENKEL DEFECT

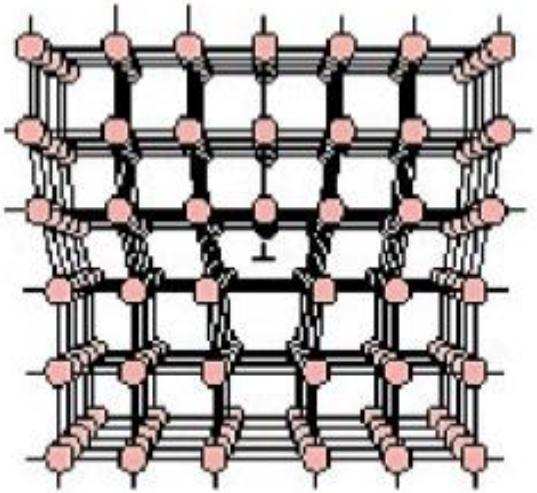
A Frenkel defect is also known as Frenkel pair or Frenkel disorder, it is a type of point defect in a crystal lattice.

The defect forms when an atom or smaller ion(usually cation) leaves its place in the lattice, creating a vacancy, and becomes an interstitial by lodging (accommodation) in a nearby location.



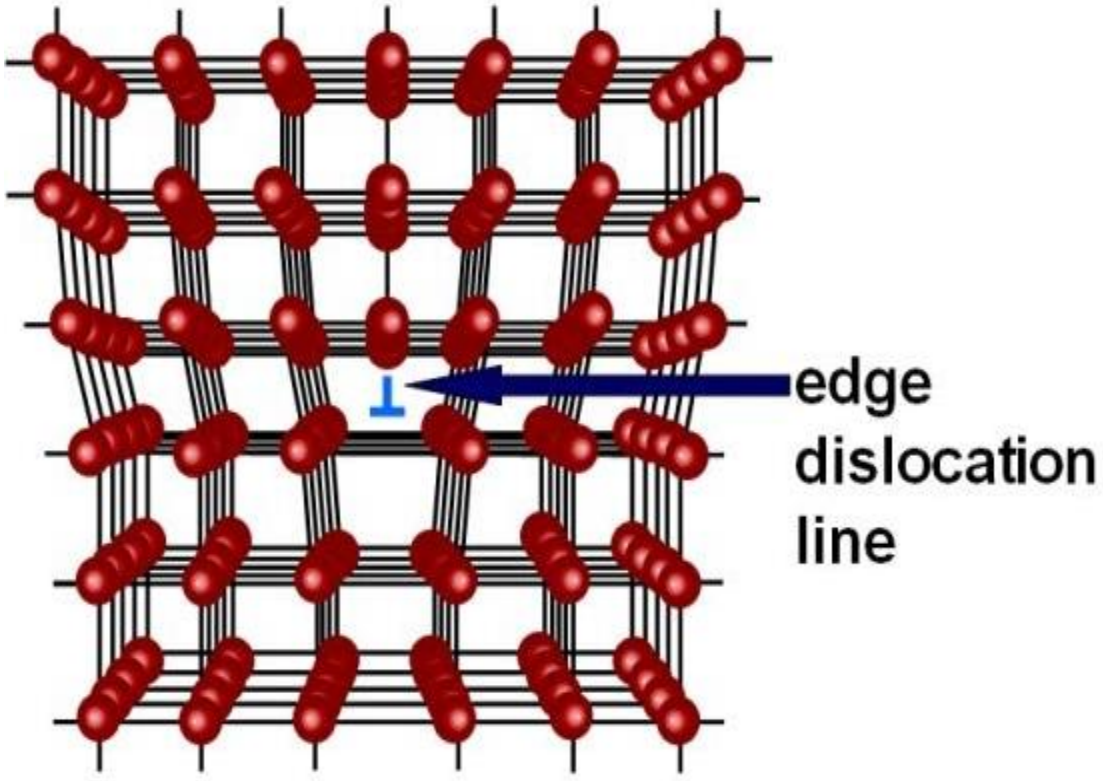
LINE DEFECTS

- Line defects are the irregularities or deviations from ideal arrangement in entire rows of lattice points.

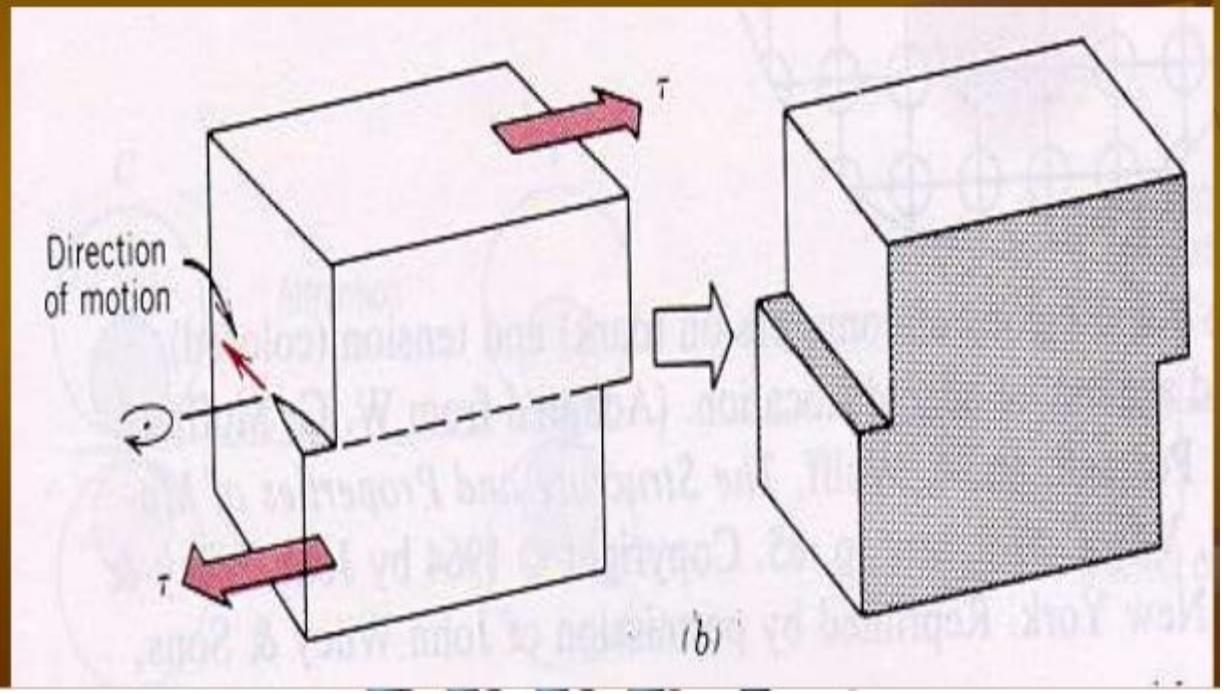


- Interatomic bonds significantly distorted in immediate vicinity of dislocation line.
- Dislocation affects the mechanical properties.

Edge Dislocation



Screw Dislocation



SURFACE DEFECTS

- Surface defects are associated with boundaries that are separate regions of the materials and have different crystal structure.
- Two Dimensional defect.
- Due to change in orientation of the atomic planes and stacking sequence of atomic planes.
- Caused during solidification or mechanical or thermal treatment of material.
- Effect the mechanical properties, electrical resistance and corrosion resistance.

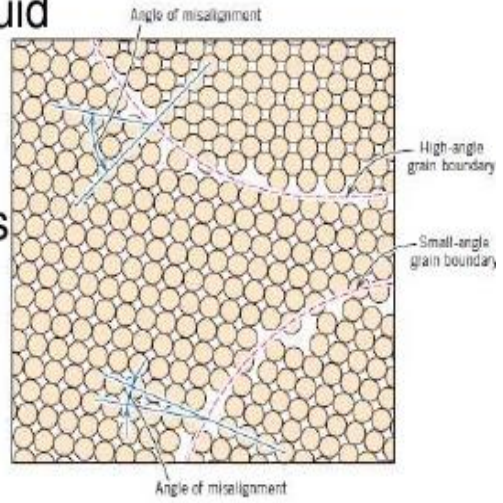
Surface Defects

1.External Surface:

- Surface atoms have **unsatisfied atomic bonds,** and higher surface energies, than the bulk atoms.
- To reduce surface free energy, material tends to minimize its surface areas against the surface tension (e.g. liquid drop).

2.Grain boundaries:

- regions between two adjacent grains
- slightly disordered
- low density in grain boundaries
  - high mobility
  - high diffusivity



3.Tilt Boundary:

- A Tilt Boundary, between two slightly mis-aligned grains appears as an *array of edge dislocations*.
- Rotation axis is parallel to the boundary plane

4. Twist Boundary:

- Rotation axis is perpendicular to the boundary plane
- Low angle grain boundaries, that appear as *an array of Screw dislocations.*

Bulk or Volume Defects

- Pores

  affect optical, thermal, and mechanical properties

- **Cracks**

  affect mechanical properties

- **Foreign inclusions**

  affect electrical, mechanical, optical properties

Activity

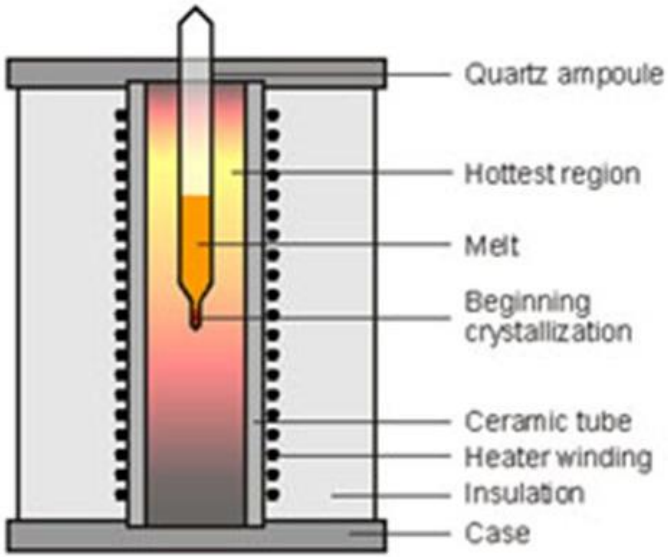
Crystal Growth Technique

- Bridgman Technique
- Czochralski Method

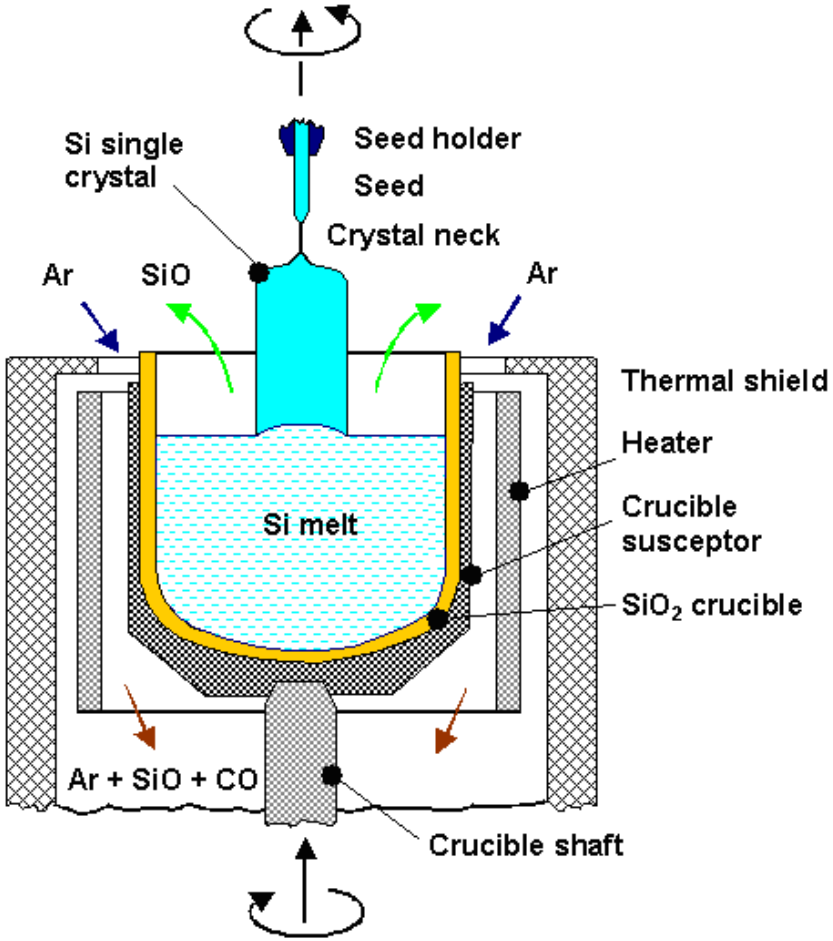
Bridgman Technique

Bridgman Method

The method involves heating polycrystalline material in a container above its melting point and slowly cooling it from one end where a seed crystal is located. Single crystal material is progressively formed along the length of the container. The process can be carried out in a horizontal or vertical geometry.



Czochralski Method




thank you