# UTTAR PRADESH TEXTILE TECHNOLOGY INSTITUTE

## Department of Engineering

Semester : 4th

Subject: Material Science

Faculty: Arpit Srivastava

Date: 21/4/2020

# Topic covered:

- Basic about crystal material

# What is **crystalline material**?

- A **crystalline material is one in which the** atoms are situated in a repeating or periodic array over large atomic distances; that is, long-range order exists, such that upon solidification, the atoms will position themselves in a repetitive three-dimensional pattern, in which each atom is bonded to its nearest-neighbor atoms.

# What is **crystalline material**?

- All metals, many ceramic materials, and certain polymers form crystalline structures under normal solidification conditions. For those that do not crystallize, this long-range atomic order is absent; these *noncrystalline or amorphous* materials

# What is **Crystal Structure**?

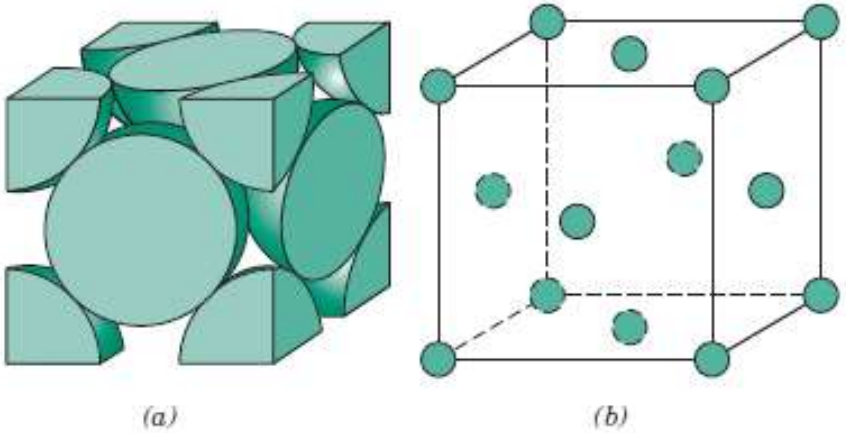
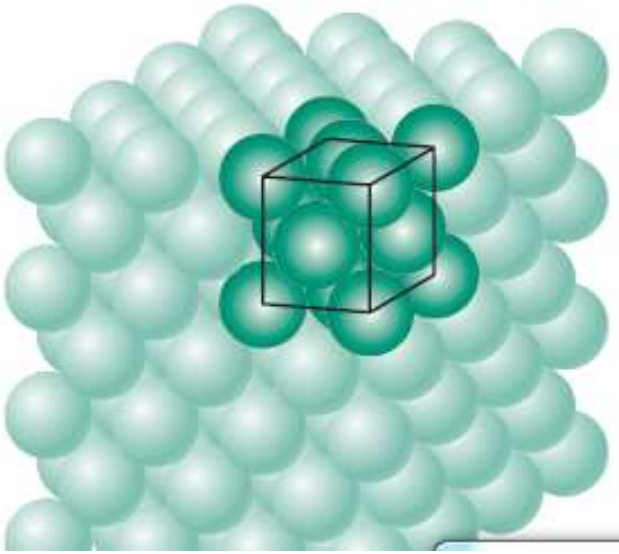



**Figure 3.1** For the face-centered cubic crystal structure, (*a*) a hard-sphere unit cell representation, (*b*) a reduced-sphere unit cell, and (*c*) an aggregate of many atoms. [Figure (*c*) adapted from W. G. Moffatt, G. W. Pearsall, and J. Wulff, *The Structure and Properties of Materials*, Vol. I, *Structure*, p. 51. Copyright © 1964 by John Wiley & Sons, New York. Reprinted by permission of John Wiley & Sons, Inc.]

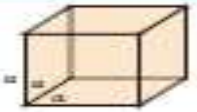
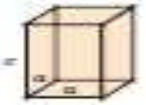
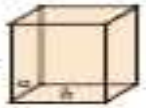
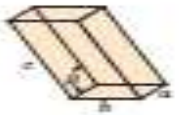


# What is **Unit Cell**?

- The atomic order in crystalline solids indicates that small groups of atoms form a repetitive pattern.
- Thus, in describing crystal structures, it is often convenient to subdivide the structure into small repeat entities called **unit cells.**

# Crystal System

**Table 3.2** Lattice Parameter Relationships and Figures Showing Unit Cell Geometries for the Seven Crystal Systems

| Crystal System | Axial Relationships | Interaxial Angles | Unit Cell Geometry |
|---|---|---|---|
| Cubic | $a = b = c$ | $\alpha = \beta = \gamma = 90^\circ$ |  |
| Hexagonal | $a = b \neq c$ | $\alpha = \beta = 90^\circ, \gamma = 120^\circ$ |  |
| Tetragonal | $a = b \neq c$ | $\alpha = \beta = \gamma = 90^\circ$ |  |
| Rhombohedral (Trigonal) | $a = b = c$ | $\alpha = \beta = \gamma \neq 90^\circ$ |  |
| Orthorhombic | $a \neq b \neq c$ | $\alpha = \beta = \gamma = 90^\circ$ |  |
| Monoclinic | $a \neq b \neq c$ | $\alpha = \gamma = 90^\circ \neq \beta$ |  |
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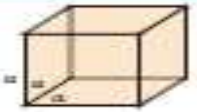
| Cubic | $a = b = c$ | $\alpha = \beta = \gamma = 90^\circ$ |  |
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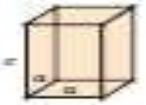
| Tetragonal | $a = b \neq c$ | $\alpha = \beta = \gamma = 90^\circ$ |  |
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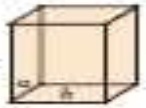
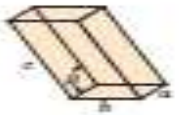
| Orthorhombic | $a \neq b \neq c$ | $\alpha = \beta = \gamma = 90^\circ$ |  |
| Monoclinic | $a \neq b \neq c$ | $\alpha = \gamma = 90^\circ \neq \beta$ |  |
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# Imperfection in solids

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- Thus far it has been tacitly assumed that perfect order exists throughout crystalline materials on an atomic scale. However, such an idealized solid does not exist; all contain large numbers of various defects or **imperfections**
- *Crystalline defect refers to a lattice irregularity having one or more of its* dimensions on the order of an atomic diameter.

# Imperfection in solids

- Point Defect
    1. **VACANCIES AND SELF-INTERSTITIALS**
- DISLOCATIONS—LINEAR DEFECTS
- **INTERFACIAL DEFECTS**
- **BULK OR VOLUME DEFECTS**
- **(Once read these topics from ref book ask if needed)**