Al-Mustaqbal University College

2021/2022 محاضرة اولى/ علم المواد

Dr. Aiyah Sabah Noori

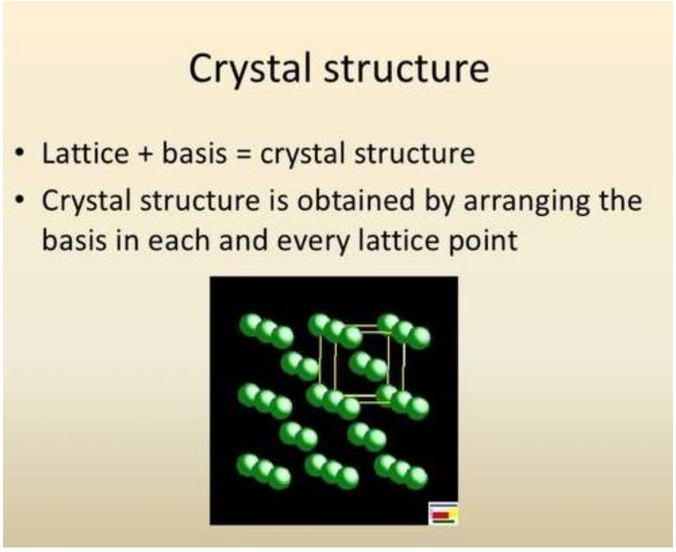
Introduction

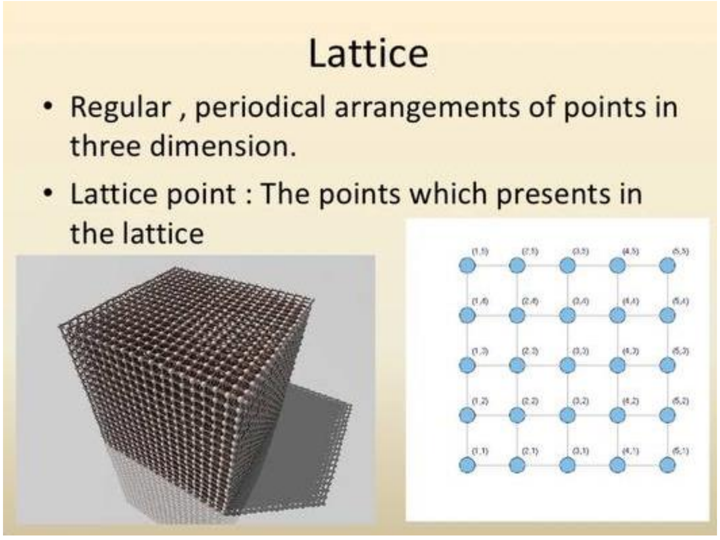
Solid materials may be classified according to the regularity with which atoms or ions are arranged with respect to one another. A crystalline material is one in which the atoms are situated in a repeating or periodic array over large atomic distances—that is, long-range order exists, the atoms will position themselves in a repetitive three-dimensional pattern, in which each atom is bonded to its nearest neighbor atoms.

Crystallography: It is the study of the internal structure of crystals and their connection to the basic characteristic, including the external shapes, as well as the connection of the chemical composition with the structure.

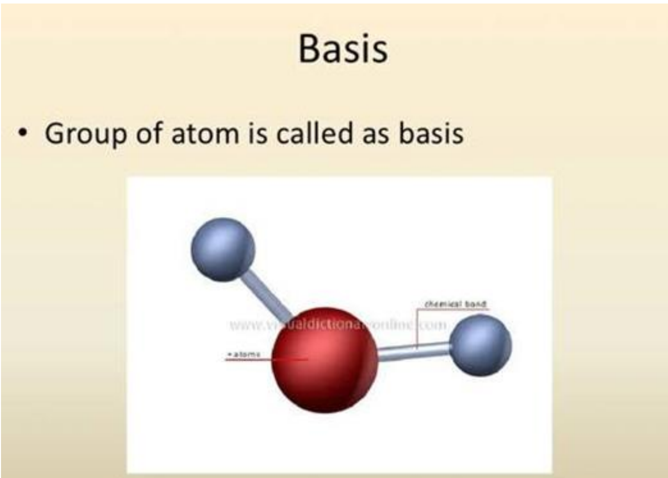
Crystal: - It is defined as a solid body that contains a number of atoms or molecules and has a specific geometric shape and consists of very small units that are regularly repeated in the three dimensions. The basis of the crystal structure is the repetition, which can be likened to the repetition of bricks in the construction.

Crystal lattice: - a kind of mathematical representation of the arrangement pattern of the basic structural unit of a crystalline substance. And this representation consists of an infinite number of points, a parallel grid, arranged in an arrangement, and characterized by symmetry and regular repetition (periodicity) in the blank.





The base: It is an atom, a molecule, or groups of atoms, or a base. The molecules stick to the points of the crystal lattice and represent the real crystal structure. The basis has an important role in the crystal structure, as it must be identical in structure, direction, and arrangement.



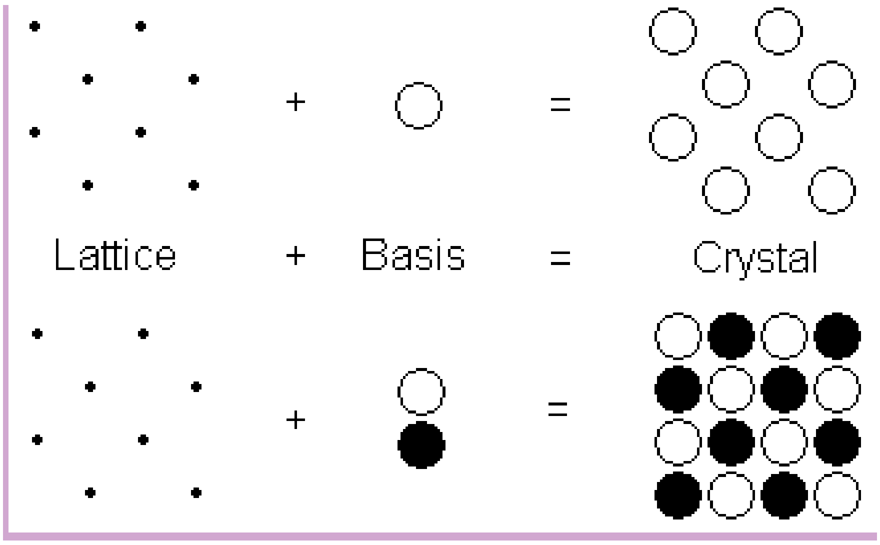
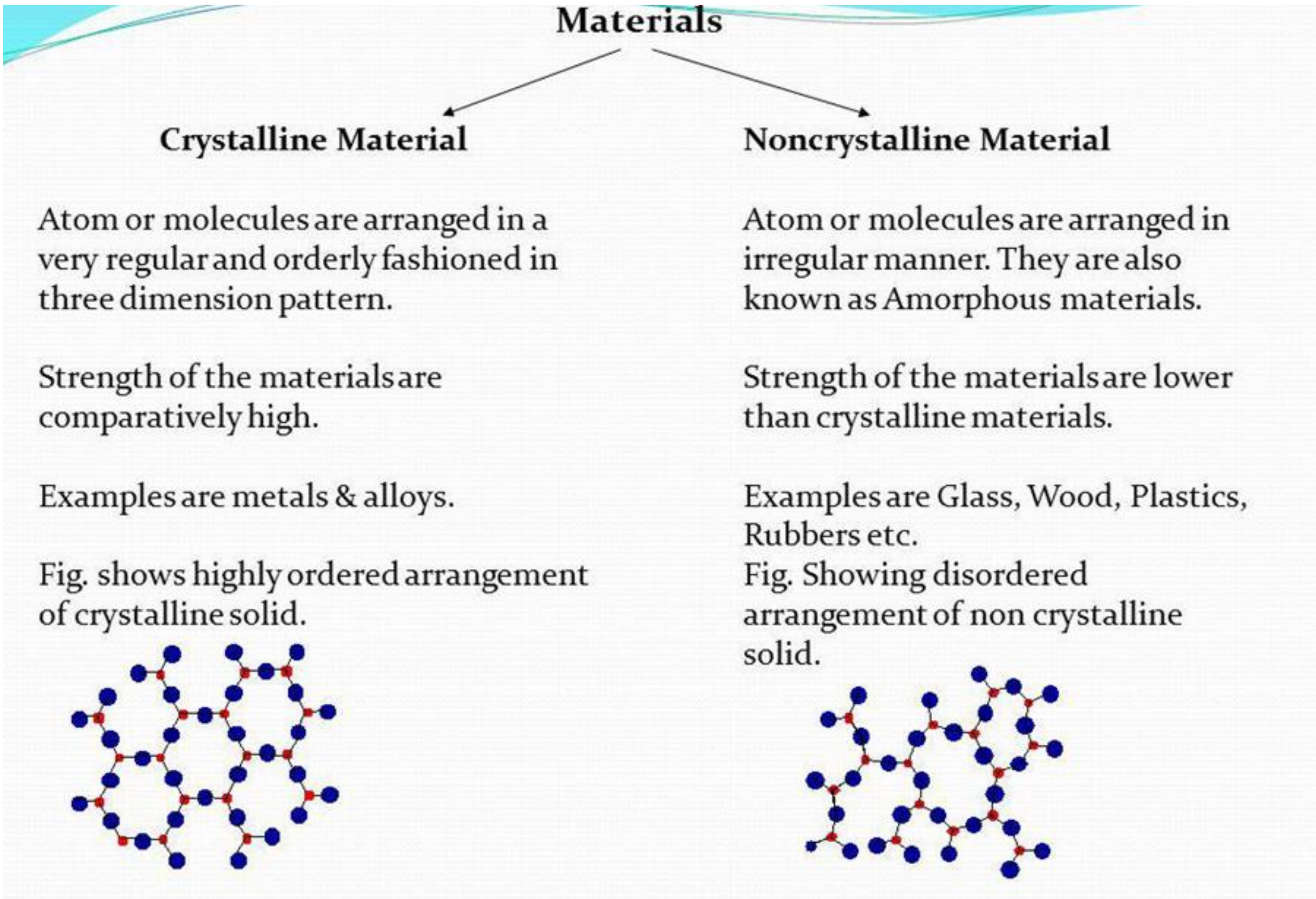


Figure 1: A crystal from a lattice and a basis. The dots represent lattice points. Notice that the same lattice can be used to form different crystals by using different bases.

Solid materials

Solid materials can be classified into two types: crystallized solids, as is the case in metals, most chemical compounds and alloys, and amorphous solids such as glass and wax. Also, some liquid and gaseous materials turn into crystalline materials when frozen, such as ice and inert gases.

The different between crystal and none crystal materials



Note / The None crystal materials also called amorphous

Unit cells

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.

It is the smallest geometric shape that can be repeated to obtain the unit cell.

The lattice constant is the shortest vertical distance between the lattice levels.

Density of materials

$$\text{Density} = \rho = \frac{\text{Mass of Atoms in Unit Cell}}{\text{Total Volume of Unit Cell}}$$

$$\rho = \frac{nA}{N_A V_C}$$

where n = number of atoms per unit cell

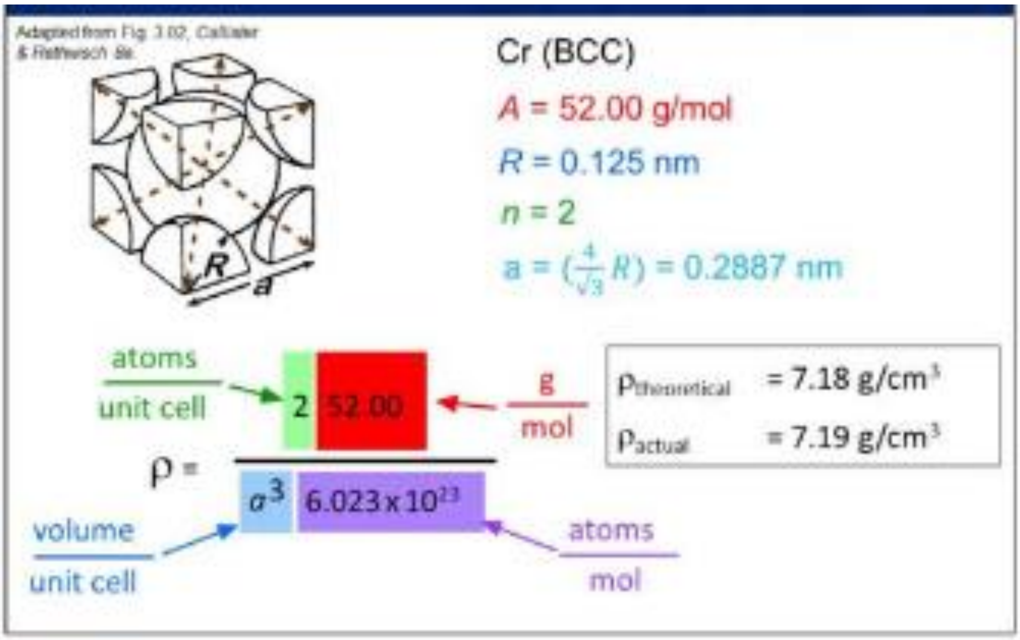
N_A = Avogadro's number = 6.023×10^{23} atoms/mol

A = atomic weight

V_C = Volume of unit cell

So here is an example. We are asked to calculate the theoretical density for Chromium, given that it has a body centered cubic structure, and the atomic weight is 52g per mole. We are also given the atomic radius of 0.125 nm. We know from previous slides that the number of atoms per unit cell is 2, and we can calculate the unit cell edge length in terms of R.

Therefore the theoretical density is the number of atoms per unit cell, which is two, divided by Avogadros' number, multiplied by the atomic weight of chromium, divided by the volume of the unit cell. If we do this we get a value of 7.18 g per cm^3, which is in good agreement with the actual measured value.



- Bravais and None Bravais lattice