University of Anbar

College of Science

Department of Physics

UNIVERSITY OF ANBAR

فيزياء الحالة الصلبة

Solid state Physics

المرحلة الرابعة

الكورس الاول

صلبة 1

Syllabus of this course مفردات الكور س

1- crystal structure
2- x-ray diffraction
3- lattice vibration
4- thermal properties in solids
5- free electron model

Introduction

Solid state is a branch of physics which deal with the physical properties of the solid states. Solid state physics (SSP) explains the properties of solid materials as found of earth. The properties are expected to follow from Schroedinger equations for an atomic nuclei and electron interacting with electrostatic forces. We will deal with crystalline solids, that is solids with an atomic structure based on a regular repeated pattern. Many important solids are crystalline. More progress has been made in understanding the behaviour of crystalline materials since the calculation are easier in crystalline materials. (SSP) also known as condensed matter physics, is the study of the behaviour of atoms when they are placed in close proximity to one another.

Crystal Structure

Crystals are built of a periodic array of atoms or groups of atoms. Arrangement of atoms in the crystal, which is a solid composed of atoms, ions, or molecules arranged in a pattern that is repeated in three dimensions.

Crystalline materials

Crystal structure can be obtained by attaching atoms, groups of atoms or molecules which are called basis to the lattice sides of the lattice point.

A material in which atoms (ions or molecules) are located in repeating (or periodic) three dimensions pattern, have a long-range order, for example: NaCl, as in (Fig. 1).

Note: If the atoms or molecules periodicity appear in one or two direction only, the material known as semi-crystalline.

• **Amorphous** (non-crystalline) materials. Short range order, not periodic; ex.: liquid water, glass

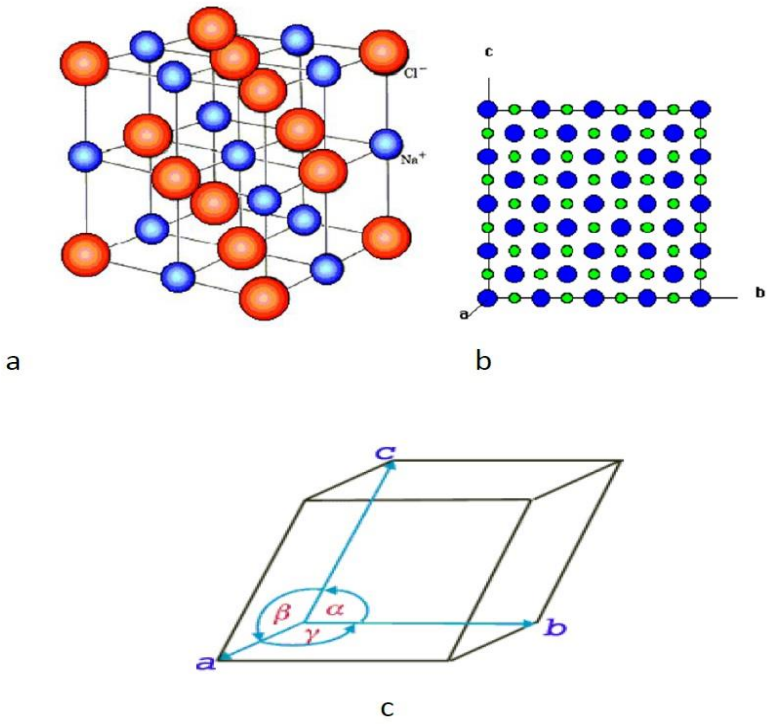


Fig.1 a- Order in three dimensions, which represents a real crystallization, b- Order in two dimensions, and c- Dimensions of a unit cell.

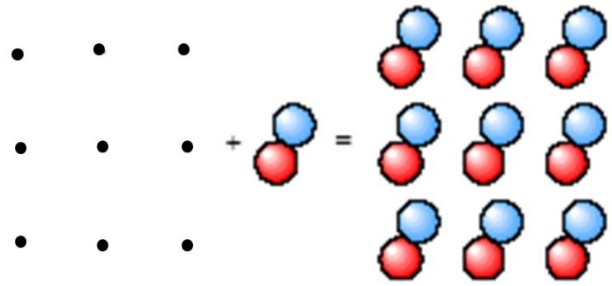
Basis: Is an atom, a molecule, or a group of atoms or molecules, located in each lattice point. Every basis in a given crystal is identical to every other in composition, arrangement, and orientation.The position of the center of an atom of the basis relative to the associated lattice point is:

$r_j = x_j + y_j + z_j$ where $0 \leq x_j, y_j, z_j \leq 1$

Lattice: The set of mathematical points to which the basis is attached is called the lattice.

Crystal structure:

Basis + **Lattice⟶ Crystal structure**



Lattice translation vectors:

The Lattice in 3D may be defined by 3 translation vectors a , b ,c , such that the arrangement of atoms in the crystal looks the same when viewed from the point (r1) as when viewed from every point (r2) translated by an integral multiple of the lattice constant a, b, c (see Fig.2):

$$\vec{r}_2 = \vec{r}_1 + n_1\vec{a} + n_2\vec{b} + n_3\vec{c} \quad \text{or} \quad \vec{r}_2 = \vec{r}_1 + \vec{T}$$

where $\vec{T} = n_1\vec{a} + n_2\vec{b} + n_3\vec{c}$ ($\vec{T}$ draw between two points and defines a primitive Lattice translation vectors or a space lattice or Bravais lattice).

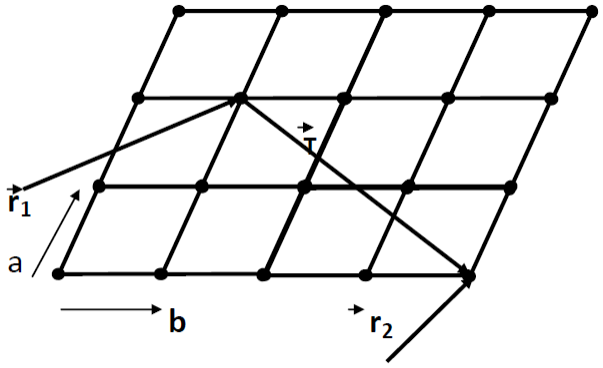


Fig-2-

References

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2- J. S. Blakemore - Solid State Physics-Cambridge University Press (1985)
3- M. A. OMAR Elementary-solid-state-physics