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Physical and Chemical Analyses of Materials

Overview on the analyses of materials

Introduction

⇨ The analysis of materials relates to the analysis of solids.

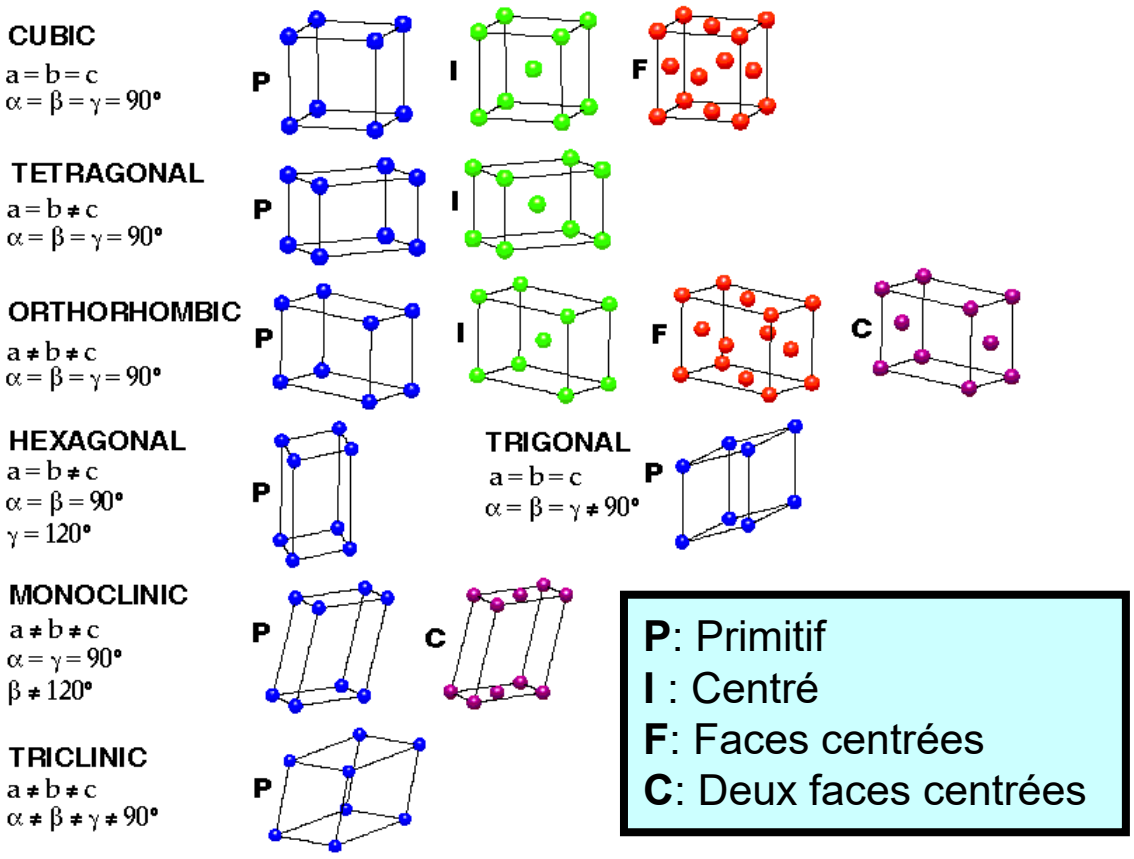
⇨ Solids could be either crystalline, amorphous or a mixture of both.

$CuSO_4$, 5 H_2O (triclinique)

SiO_2 / CaO / metallic oxydes (amorphous) / Na_2O

↳ In crystalline solids, atoms, ions or molecules are well ordered according to a define paving forming a crytal lattice (14 Bravais lattices).

Below are depicted the14 Bravais lattices:



↳ In amorphous solids, there is no long periodicity.

↳ With mixte solids, one can find amorphous and crystallin structures. Crystallin structures could also be made of different lattices separated by grain boundaries.

↳ As a conclusion, materials are often non-homogeneous and the analysis of which should take this fact into account…

Characterisation of materials

⇨ The characterisation of materials could be achived by surface and/or bulk analyses.

↳ Surface analysis provides morphological, topographical, structural and chemical informations.

↳ Bulk analysis provides structural and chemical informations.

Morphological informations

⇨ Morphological studies concern the determination of surface shapes and structures of a given material.

↳ Morphological studies are achieved by microscopy using photons or electrons.

Topographical informations

⇨ Topographical studies rely on the determination of the surface relief of a given material.

⇩ Surface relief is assessed by electron microscopy, scanning probe microscopy and/or profilometry.

Structural informations

⇨ Structural informations concern the determination of surface and bulk organisation of the matter at the atomic level such as crystallinity, lattice defects, atomic environment…

⇩ These studies use photons of high energy (*e.g.* X-Ray), electrons of low and high energy for surface and bulk studies respectively and neutrons. These technics are related to absorption, scattering and diffraction (specific scattering) of the exciting beam by the matter.

Chemical informations

⇨ Chemical informations could be obtained either from the surface or from the bulk of a material. To perform chemical analyses, one must use an exciting beam that interacts with the chemical species constituting the studied material.

- The beam could be made of photons, electrons and ions (proton included), the energy of which determines the depth of analysis, *i.e.* probing either the surface or the bulk of the studied material.

- The relaxation of the excited matter by the beam provides the chemical composition of the studied material.