TEMARIO DEL CURSO DE FUNDAMENTOS DE DISPOSITIVOS ELECTRONICOS

1. Introducción a Física Electrónica

1.1 Propiedades de cristales y crecimiento de semiconductores

1.2 Átomos y electrones

1.3 Bandas de energía y portadores de carga en semiconductores

1.4 Exceso de portadores en semiconductores

2. Uniones

2.1 Fabricación de uniones p-n

2.2 Condiciones de equilibrio

2.3 Polarización de uniones en directa e inversa bajo condiciones de estado estacionario

2.4 Ruptura bajo polarización inversa

2.5 Condiciones de transitorio y a-c

2.6 Desviaciones de la teoría sencilla

2.7 Uniones metal-semiconductor

Evaluación

8 exámenes parciales 80%

n exámenes sorpresa 20%

http://www-elec.inaoep.mx/~jmolina

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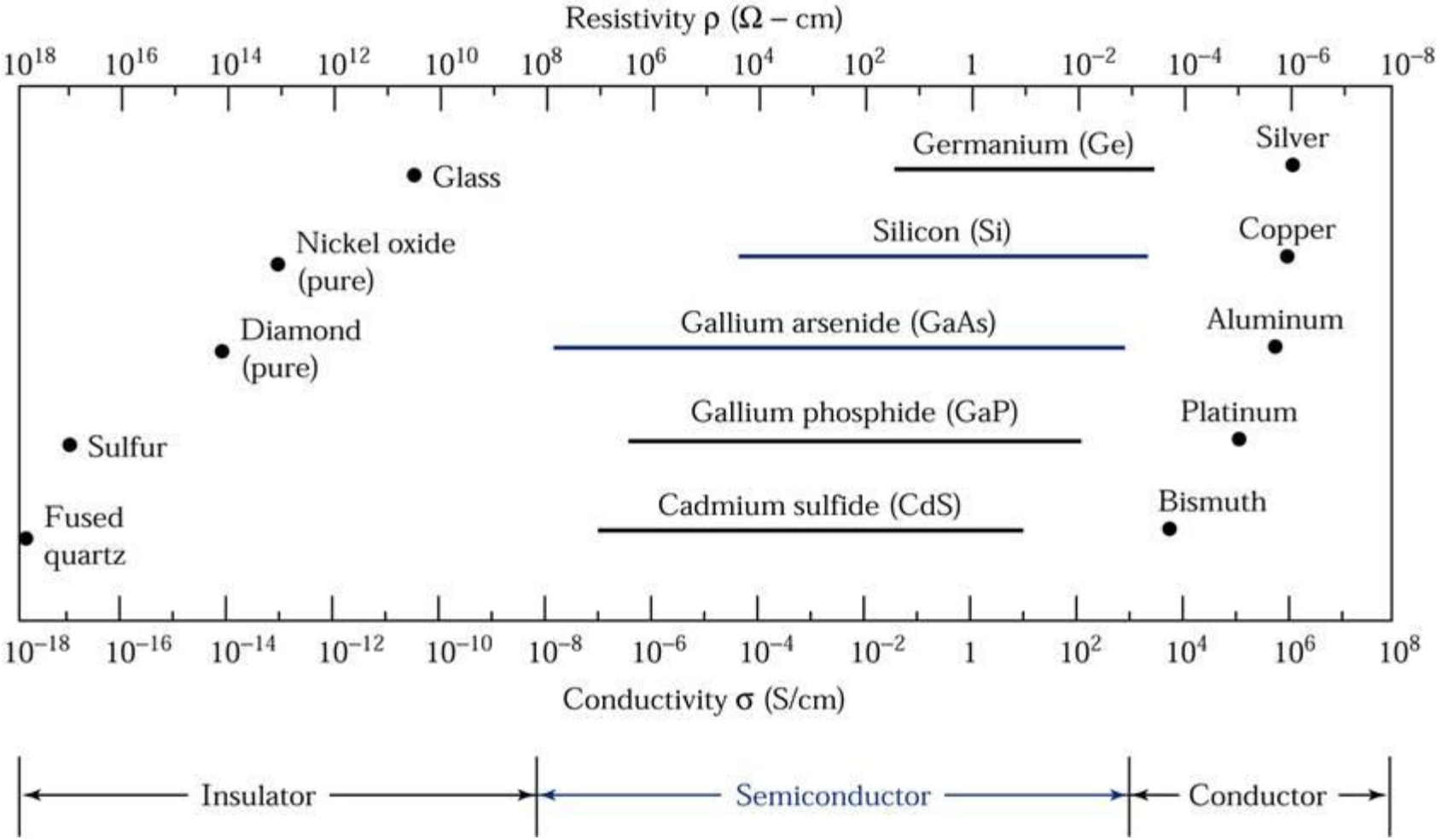
Lunes a Viernes: 16:00 – 17:00. Cubo 9308.

Typical range of conductivities for insulators, semiconductors, and conductors.



Silicon Era within the Electronics industry

- Silicon is presently the most important semiconductor for the electronics industry.
- Silicon is the second in abundance only to oxygen.
- The SiO_2 is easy to form and is chemically very stable.
- Silicon has a band gap of 1.12 eV (smaller leakage current when compared to germanium with 0.66 eV).
- Electronic grade silicon is cheaper than germanium.

Types of solids

- Single-crystal, amorphous, and poly-crystalline are the three general types of solids.

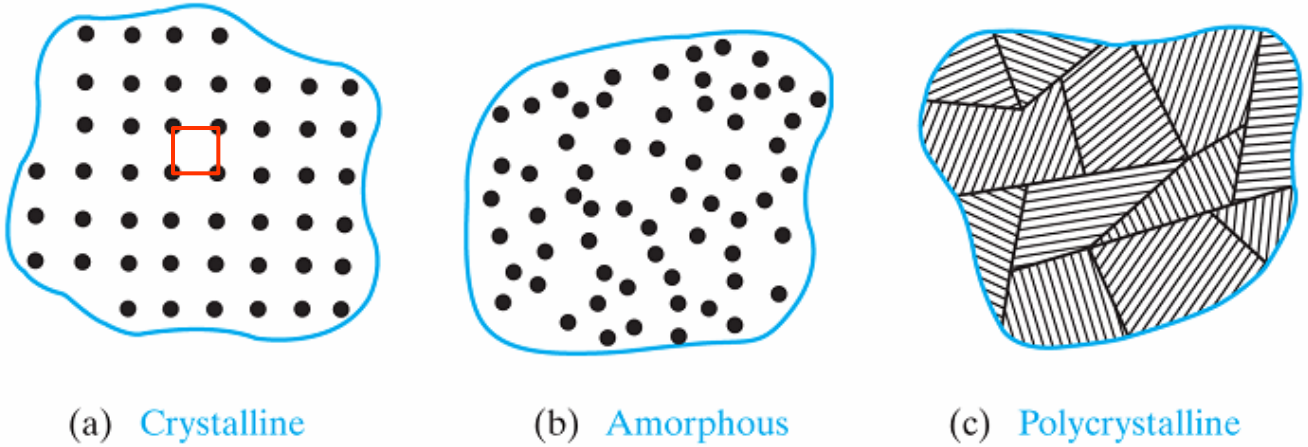
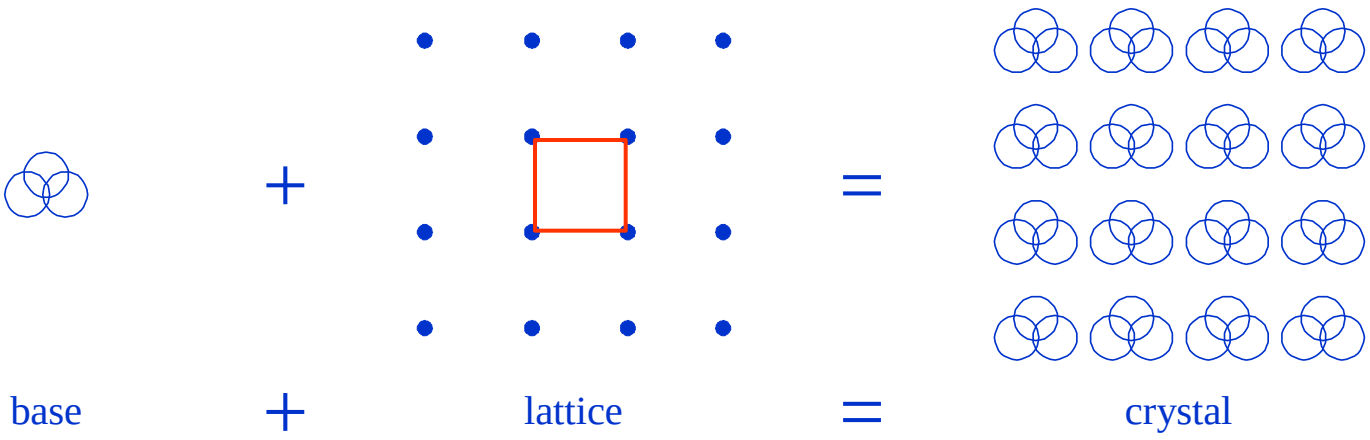


Figure 1.1

Three types of solids, classified according to atomic arrangement: (a) crystalline and (b) amorphous materials are illustrated by microscopic views of the atoms, whereas (c) polycrystalline structure is illustrated by a more macroscopic view of adjacent single-crystalline regions, such as (a).

Representation of single-crystal materials

- A crystal can be represented like the combination of two parts: a base and a lattice.
- The lattice is an array of points in the space, whereas the base consists of an atom or an molecule that is repeated in each point of the network.



Representation (vector) of single-crystal materials

An important property of a cubic lattice is its definition by three $\mathbf{a}_1$, $\mathbf{a}_2$ and $\mathbf{a}_3$ vectors such that a lattice point **R'** can be obtained by translation from any other lattice point **R**.

$$\mathbf{R}' = \mathbf{R} + u_1\mathbf{a}_1 + u_2\mathbf{a}_2 + u_3\mathbf{a}_3$$

where $\mathbf{a}_1$, $\mathbf{a}_2$ and $\mathbf{a}_3$ are called translation vectors, and they indicate the interatomic separation throughout three directions, whereas $\mathbf{u}_1$, $\mathbf{u}_2$ and $\mathbf{u}_3$ are arbitrary integer numbers; thus, the whole network can be generated by means of the variation of these last three numbers.

2-D Lattice and Unit Cell

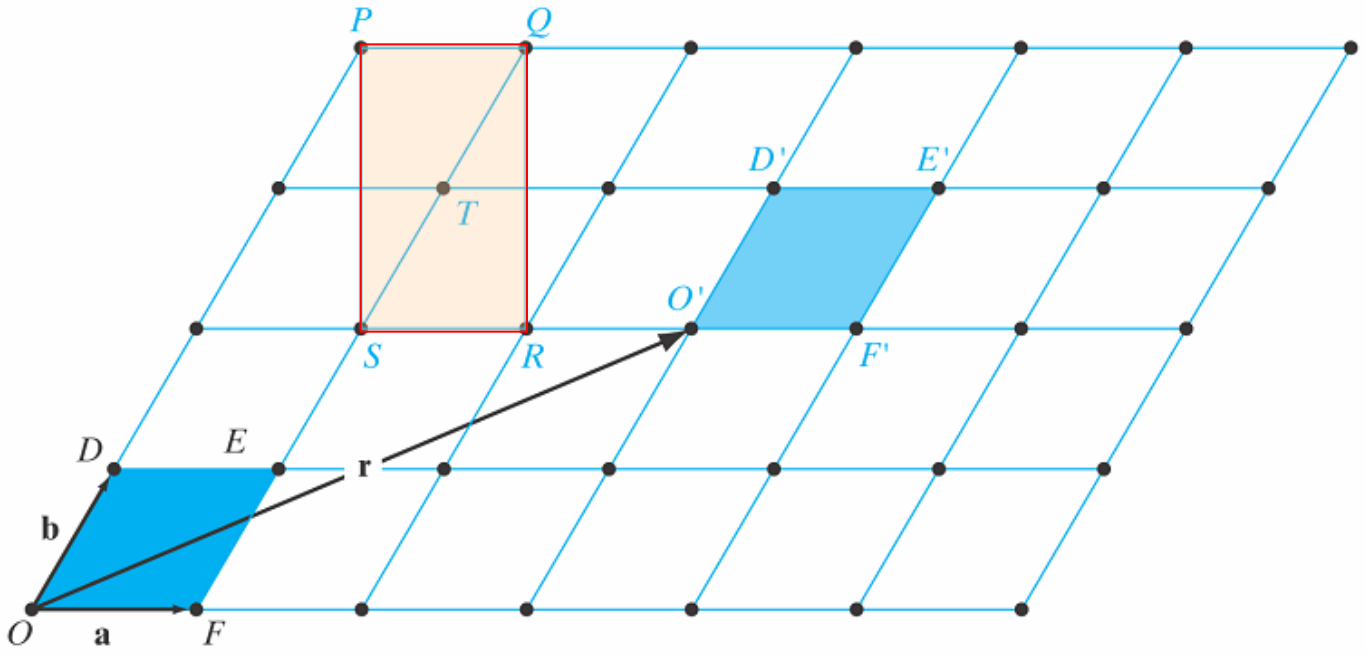


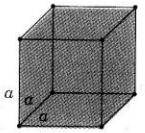
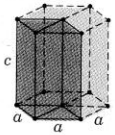
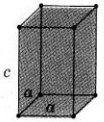
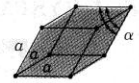
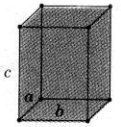
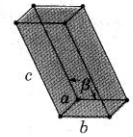
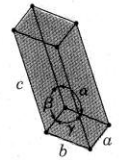
Figure 1.2

A two-dimensional lattice showing translation of a unit cell by $\mathbf{r} = 3\mathbf{a} + 2\mathbf{b}$.

Lattice parameters of a crystal structure

The unit cell geometry is completely defined in terms of 6 parameters:

- 3 edge lengths (a, b, c)
- 3 interaxial angles (α, β, γ).

Crystal System	*Axial Relationships*	*Interaxial Angles*	*Unit Cell Geometry*
Cubic	$a = b = c$	$\alpha = \beta = \gamma = 90°$	
Hexagonal	$a = b \neq c$	$\alpha = \beta = 90°, \gamma = 120°$	
Tetragonal	$a = b \neq c$	$\alpha = \beta = \gamma = 90°$	
Rhombohedral	$a = b = c$	$\alpha = \beta = \gamma \neq 90°$	
Orthorhombic	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90°$	
Monoclinic	$a \neq b \neq c$	$\alpha = \gamma = 90° \neq \beta$	
Triclinic	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma \neq 90°$	

Unit cell and primitive cell

- A Unit cell is a small volume of the crystal that can be used to reproduce the entire crystal.
- A Primitive cell is the smallest unit cell that can be repeated to form the lattice.

There is no unique way to choose the primitive vectors. A selection method is as follows:

$\mathbf{a}_1$ being the shortest period of the lattice

$\mathbf{a}_2$ being the shortest period not parallel to $\mathbf{a}_1$

$\mathbf{a}_3$ being the shortest period not coplanar with $\mathbf{a}_1$ and $\mathbf{a}_2$

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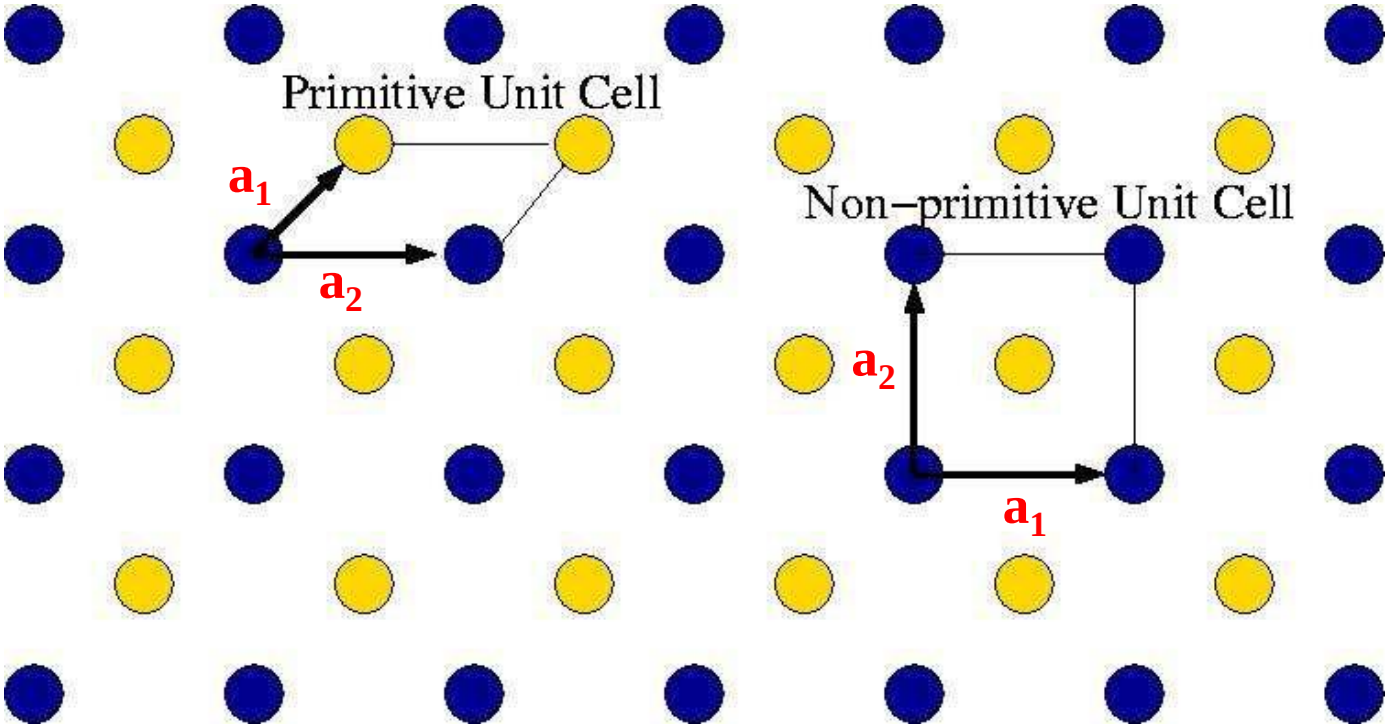
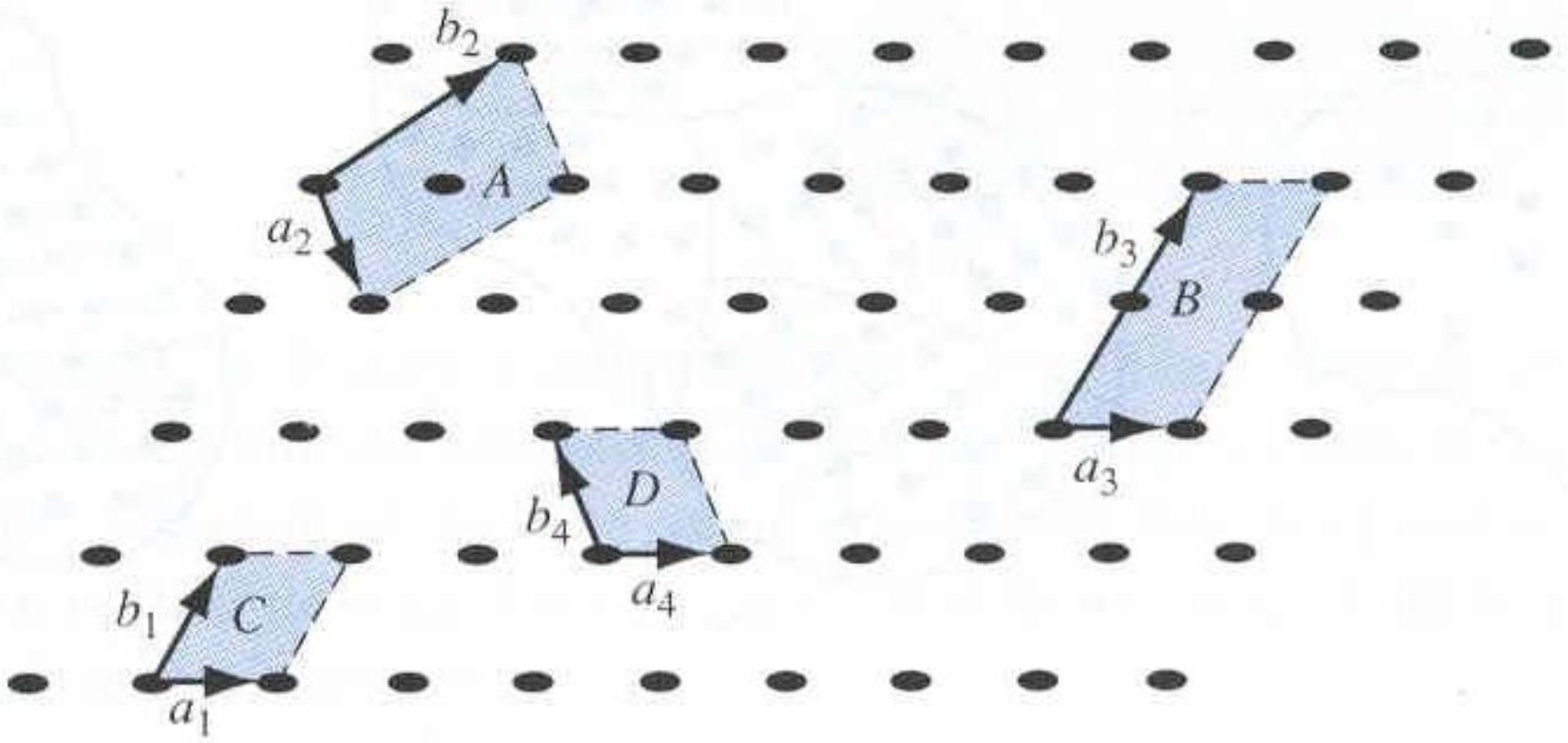
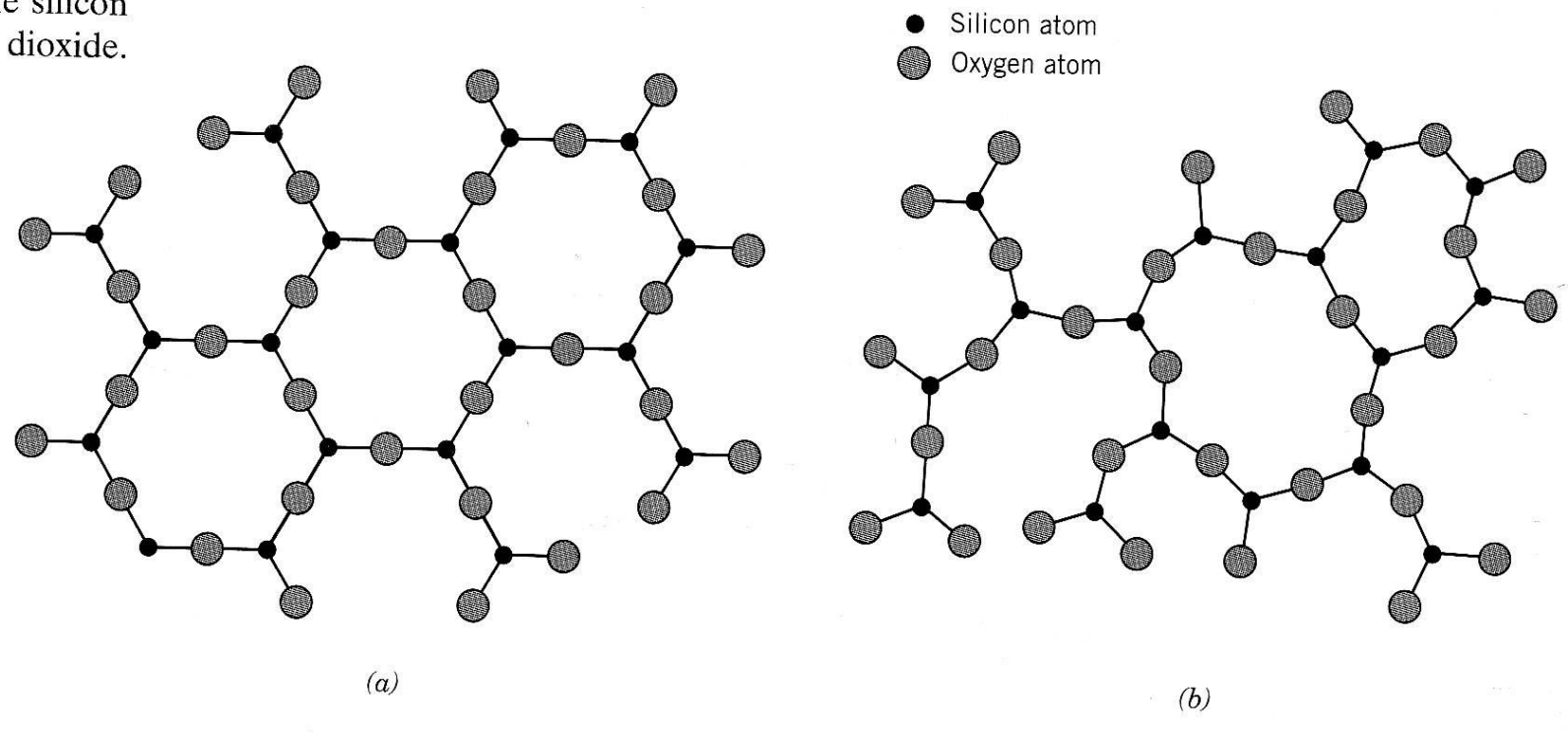


Unit cell and primitive cell



Crystalline and amorphous SiO_2

(*a*) crystalline silicon dioxide and (*b*) noncrystalline silicon dioxide.



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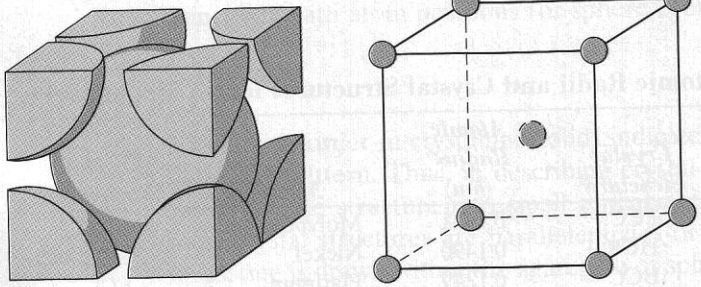
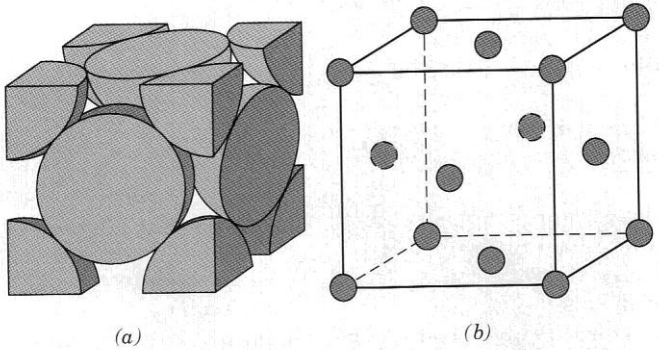
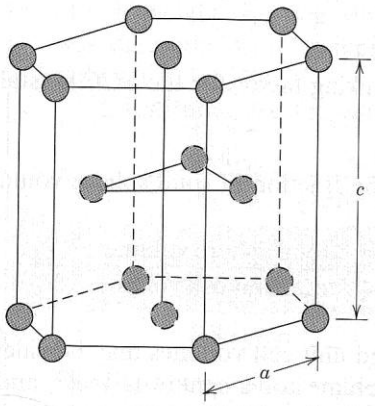
Crystal structures

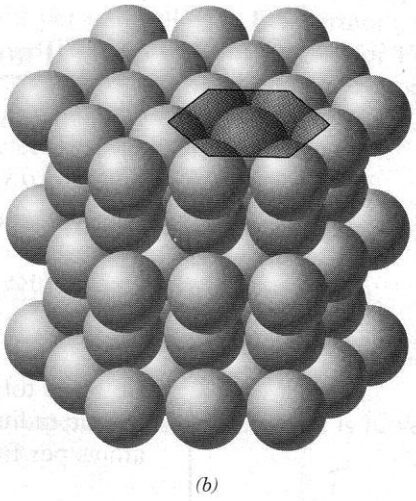
BCC

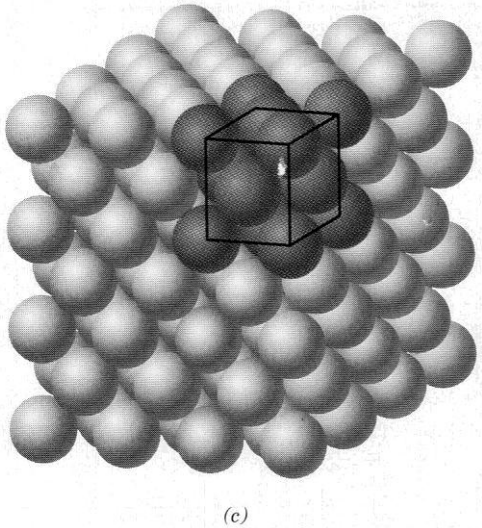






HCP





FCC