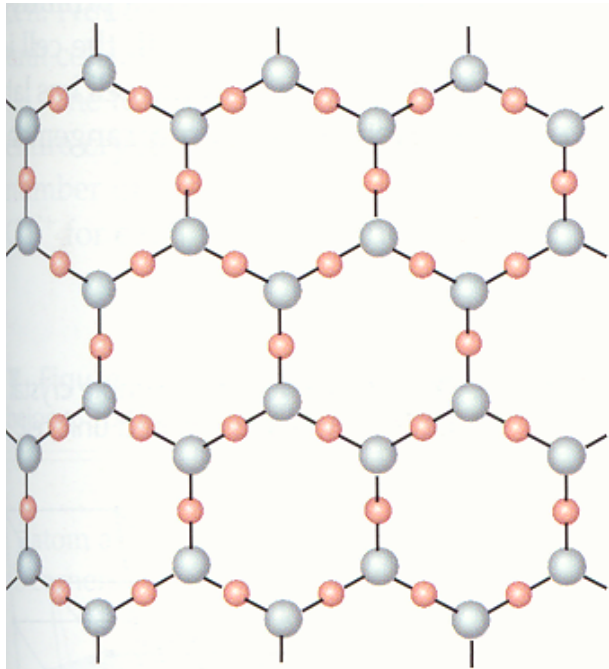


What is a Solid?

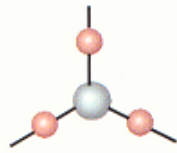
The positions of the atoms in the material do not change relative to each other over time.

Two types of solids:

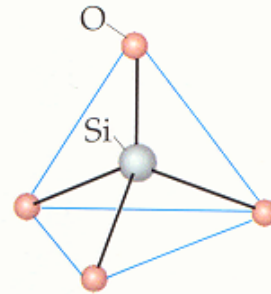
- **Glass** (or amorphous solid): no long range order.
- **Crystalline**: periodic arrangement of atoms in three dimensions.



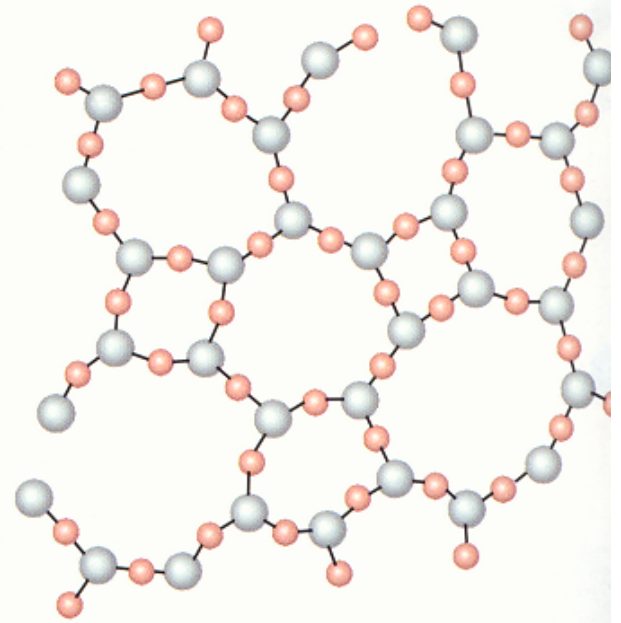
(a)



Two-dimensional
unit



Actual unit



(b)

NaCl

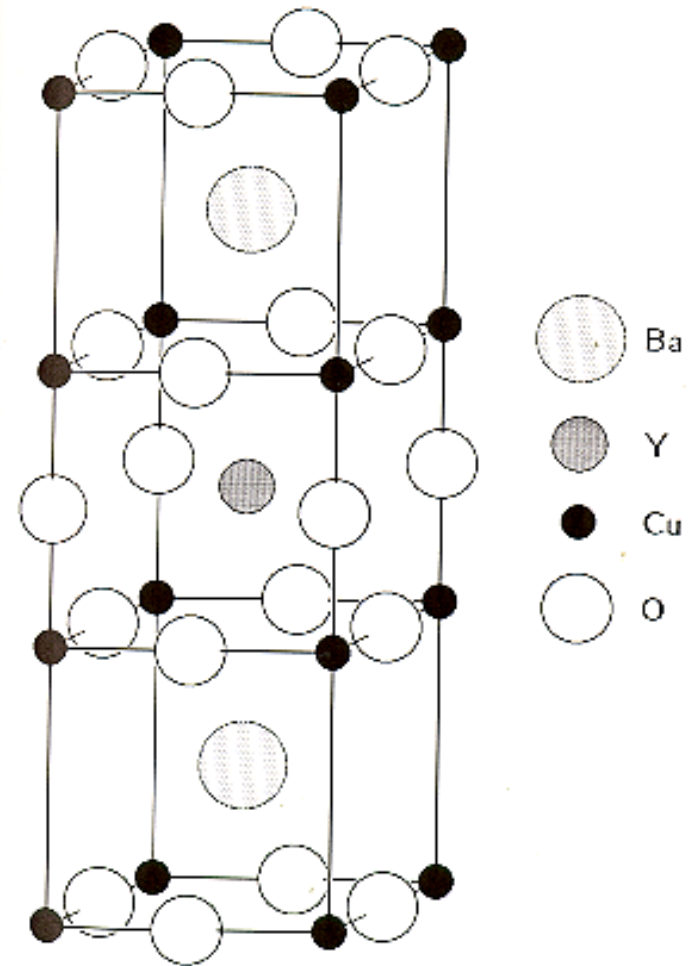
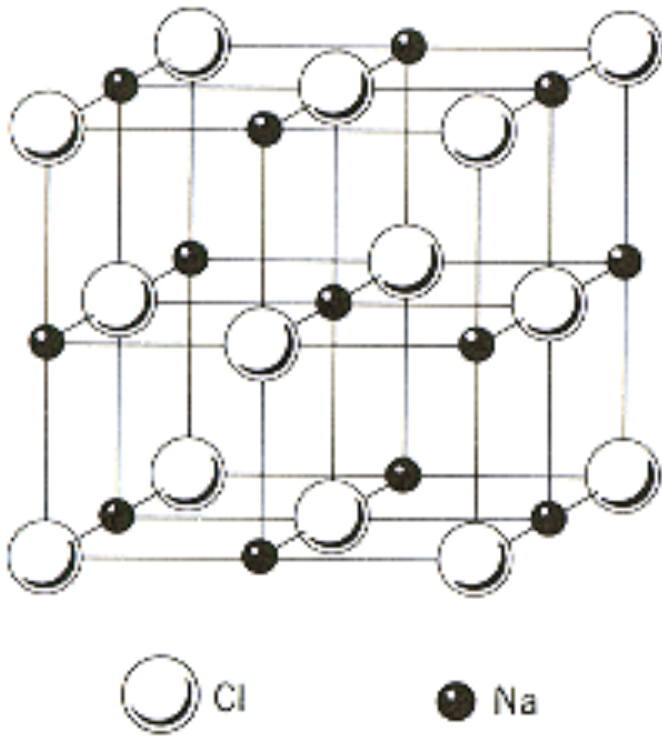
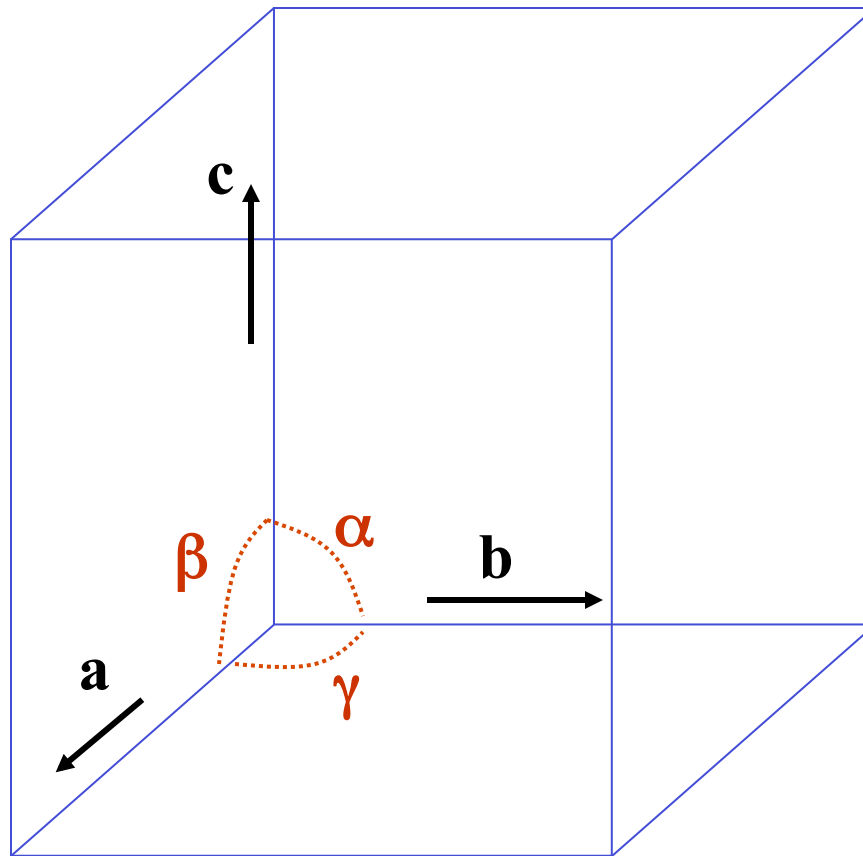


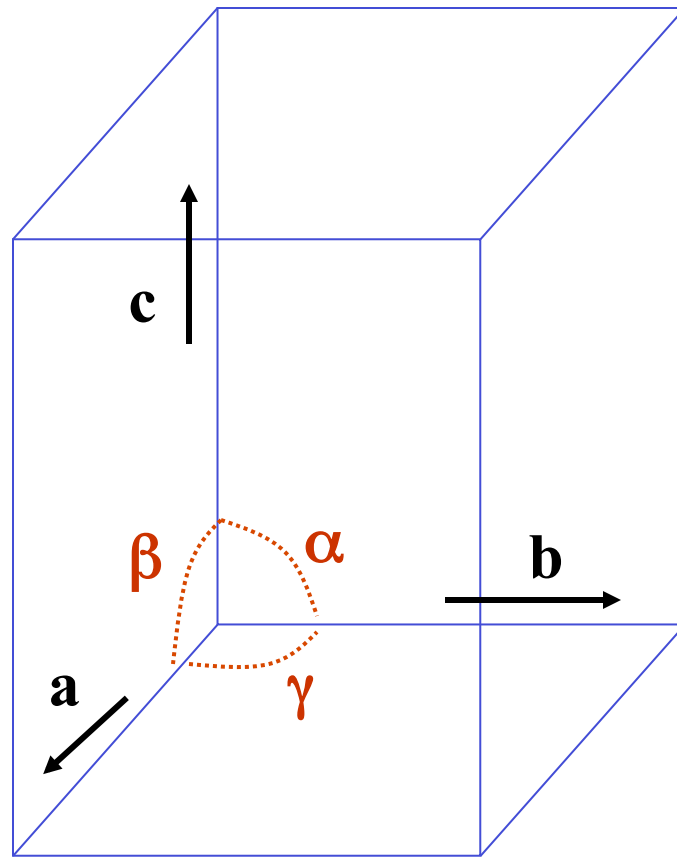
Figure 8.15. The crystal structure of YBa₂Cu₃O₇.

YBa₂Cu₃O₇



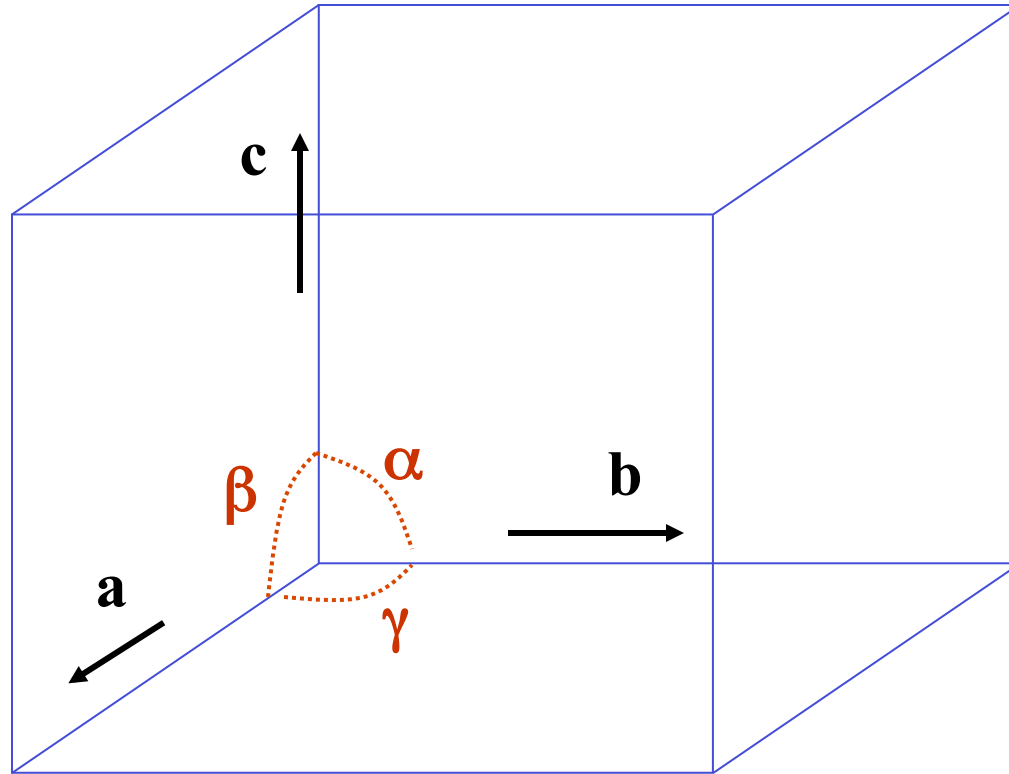
$$a = b = c ; \alpha = \beta = \gamma = 90^\circ$$

cubic



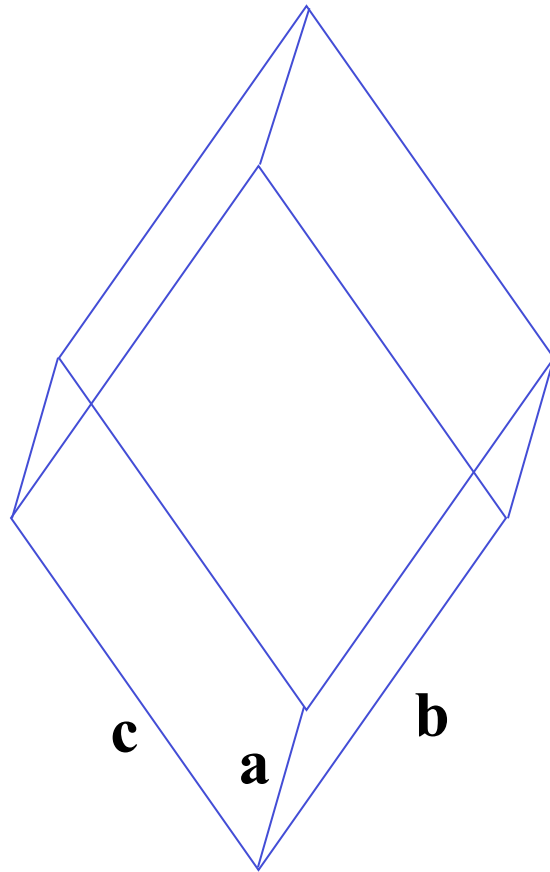
$$a = b \neq c ; \alpha = \beta = \gamma = 90^\circ$$

tetragonal



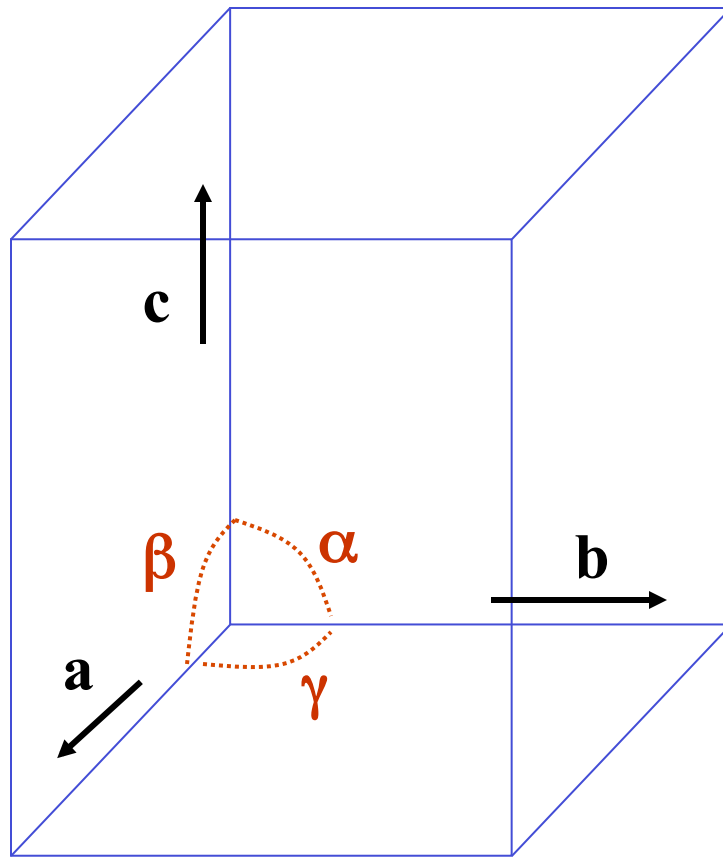
$$a \neq b \neq c ; \alpha = \beta = \gamma = 90^\circ$$

orthorhombic



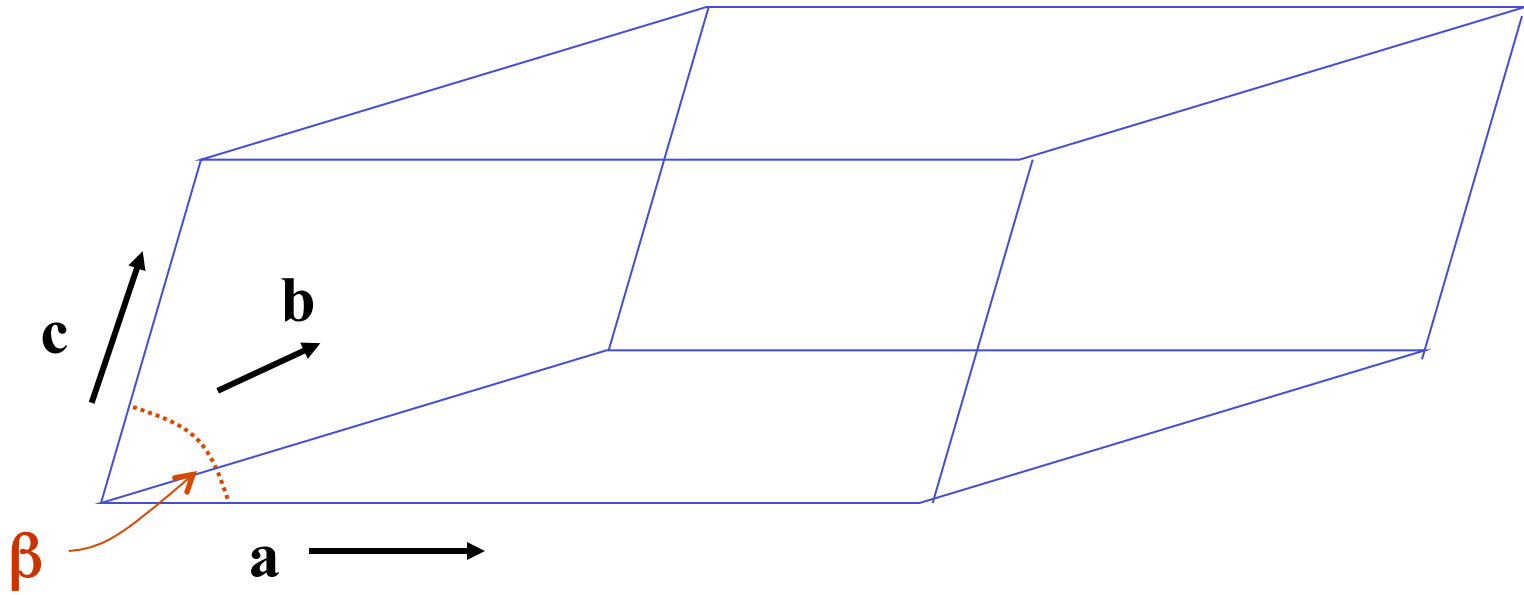
**rhombohedral
(trigonal)**

$$\mathbf{a = b = c ; \alpha = \beta = \gamma \neq 90^\circ}$$



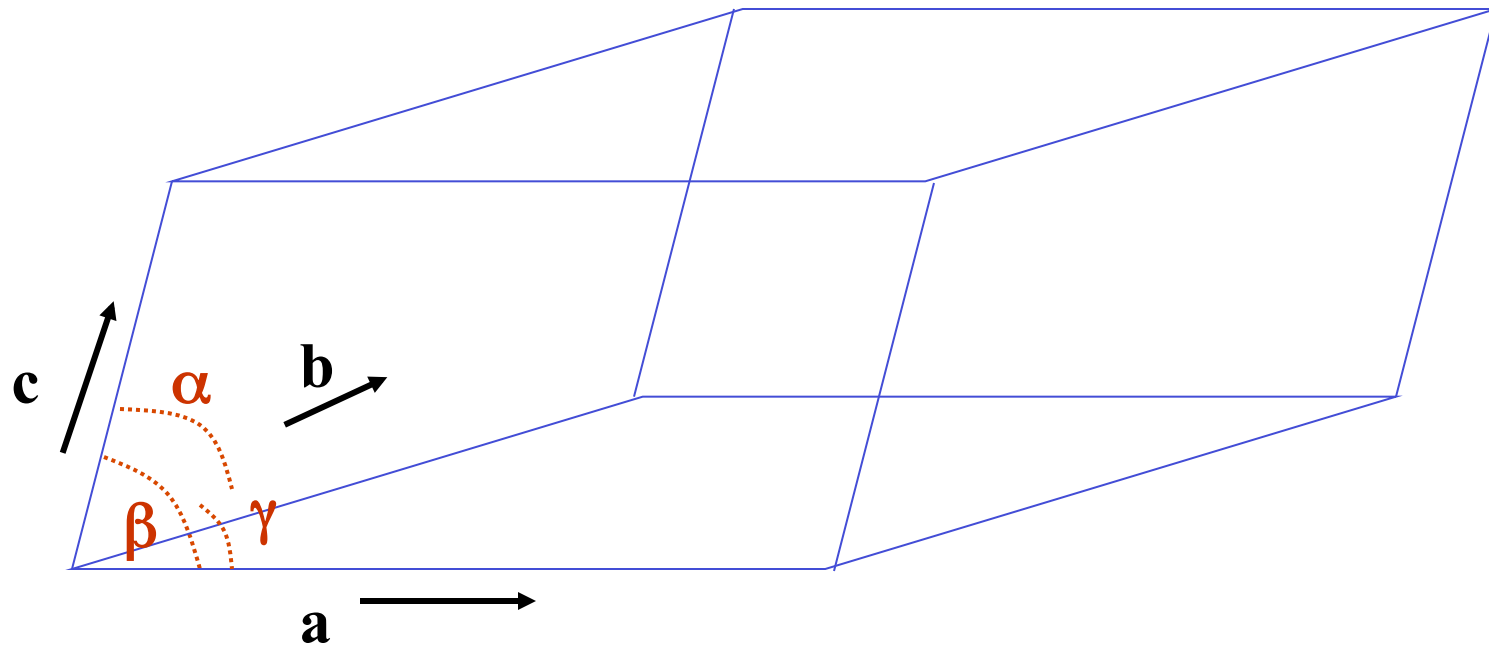
$$a = b \neq c ; \alpha = \beta = 90^\circ, \gamma = 120^\circ$$

hexagonal



$$a \neq b \neq c ; \alpha = \gamma = 90^\circ \neq \beta$$

monoclinic



$$a \neq b \neq c ; \alpha \neq \beta \neq \gamma \neq 90^\circ$$

triclinic

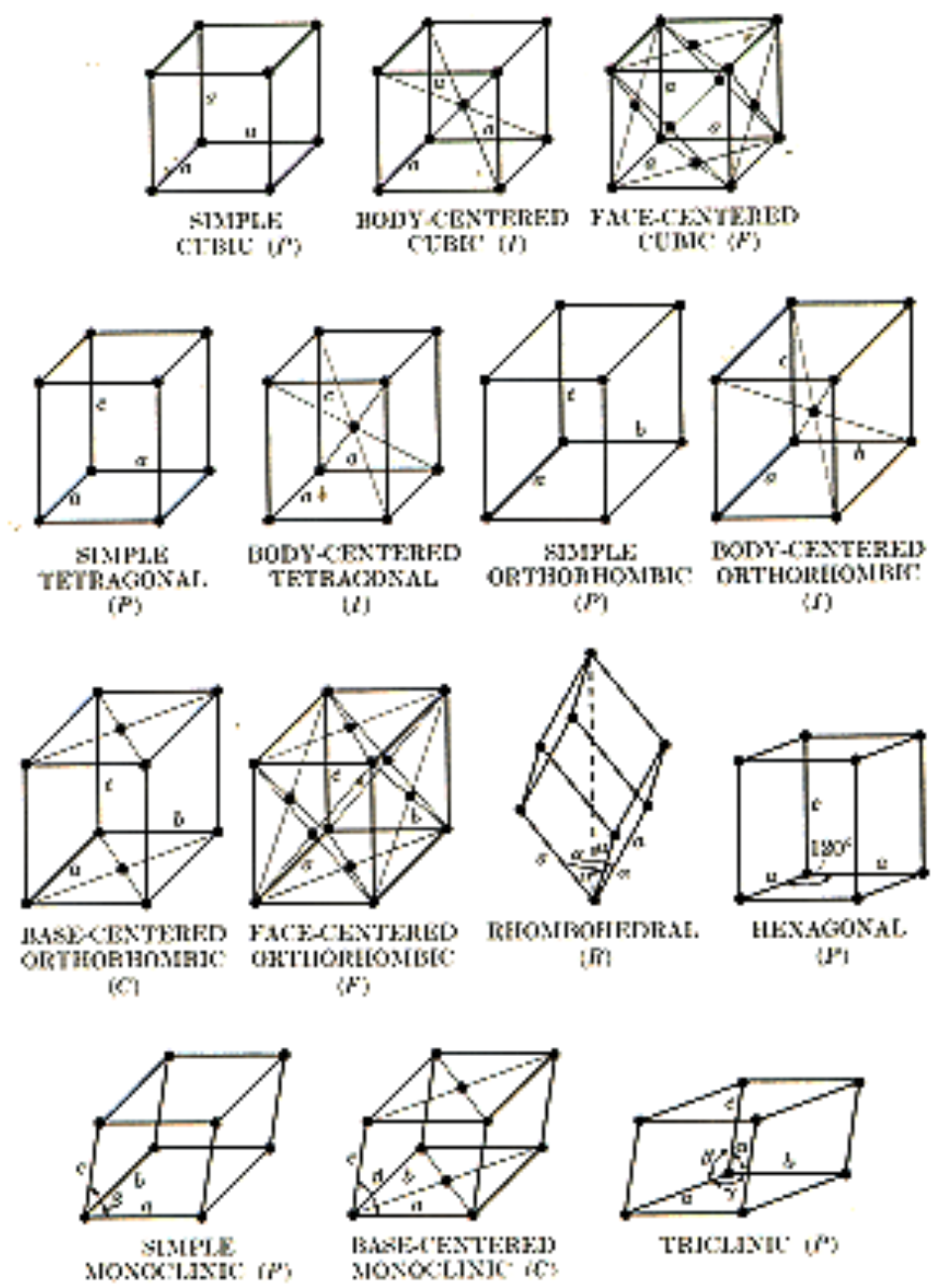
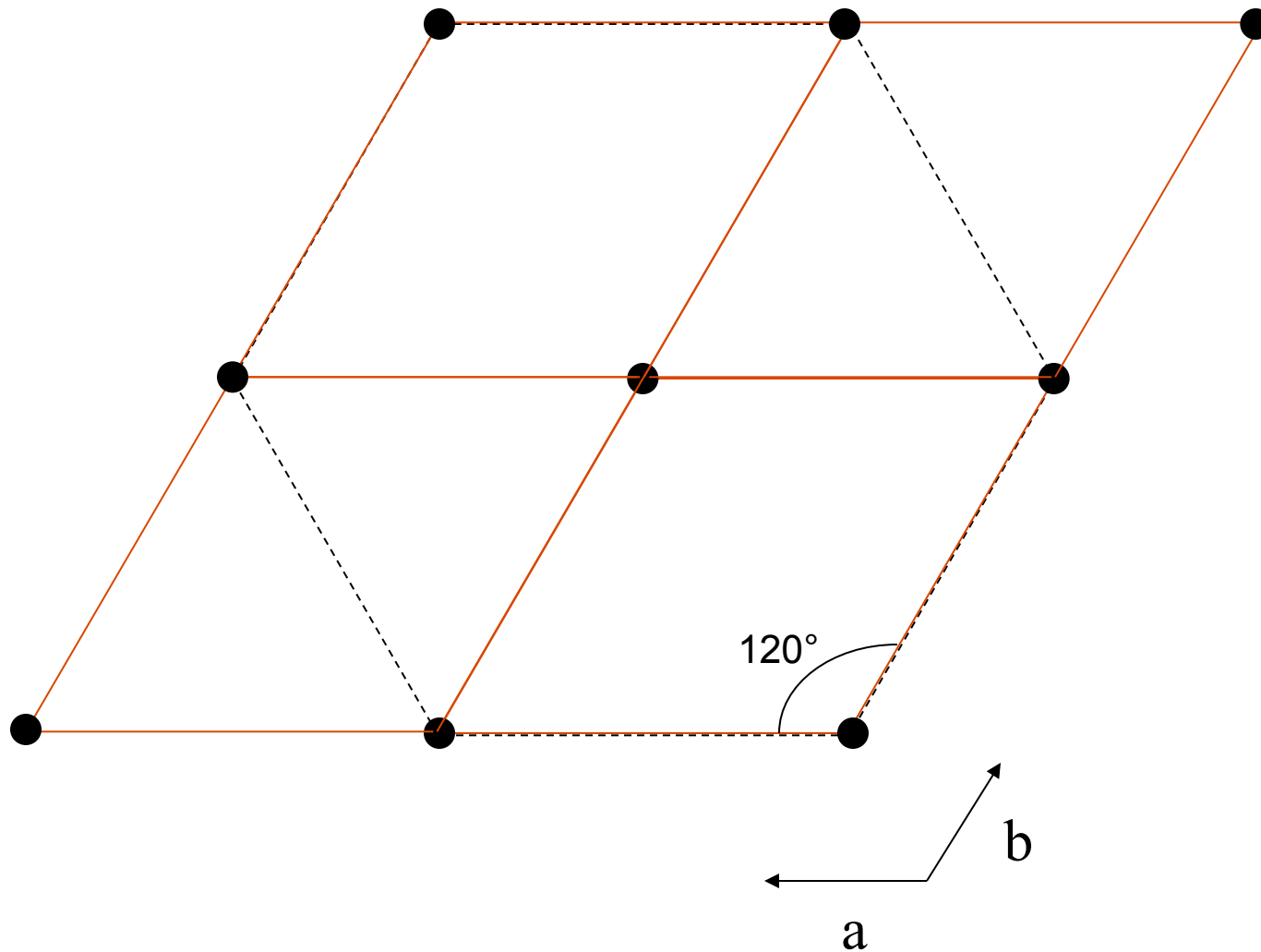
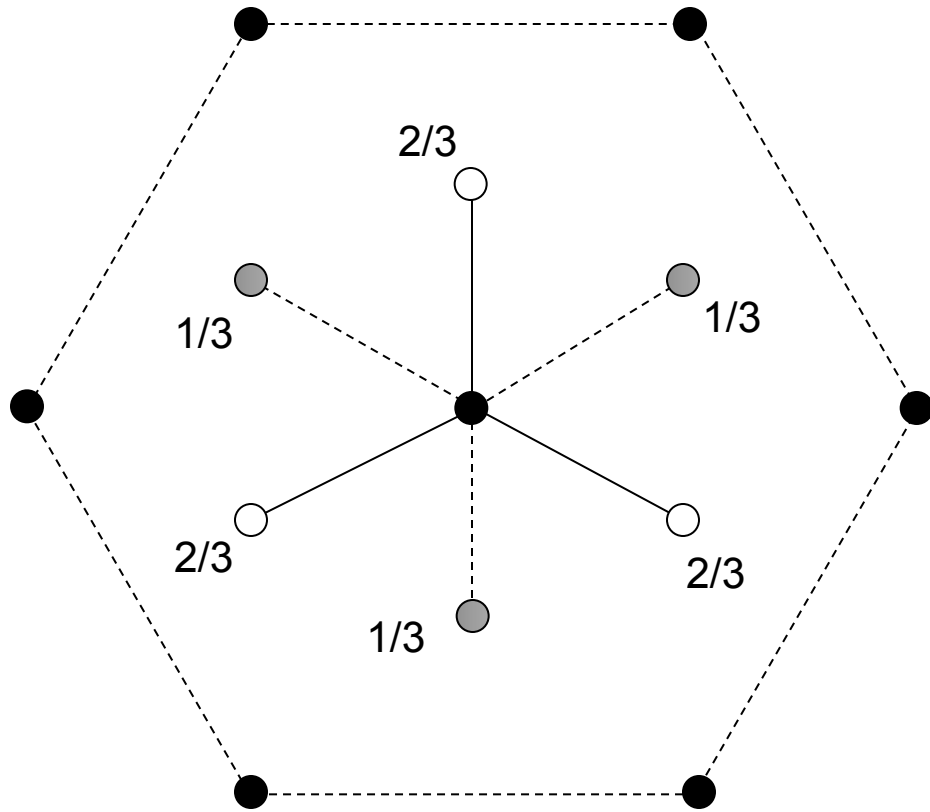


Fig. 2-3 The fourteen Bravais lattices.





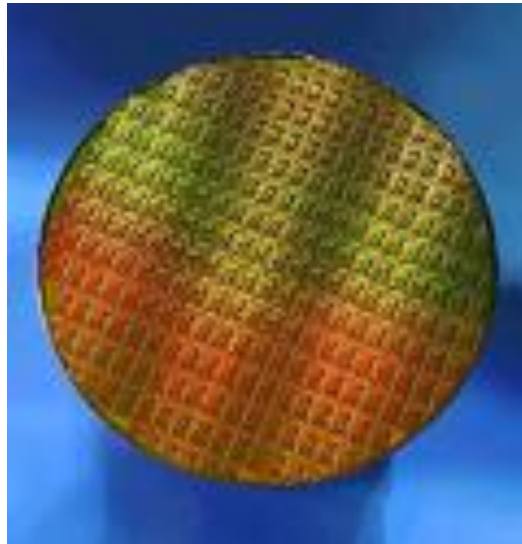
hexagonal setting of a rhombohedral cell

Minimum Symmetry Elements in the 7 Crystal Systems

Cubic	Four 3-fold rotation axes
Tetragonal	One 4-fold rotation axis
Orthorhombic	Three \perp 2-fold rotation axes
Rhombohedral	One 3-fold rotation axis
Hexagonal	One 6-fold rotation axis
Monoclinic	One 2-fold rotation axis
Triclinic	none

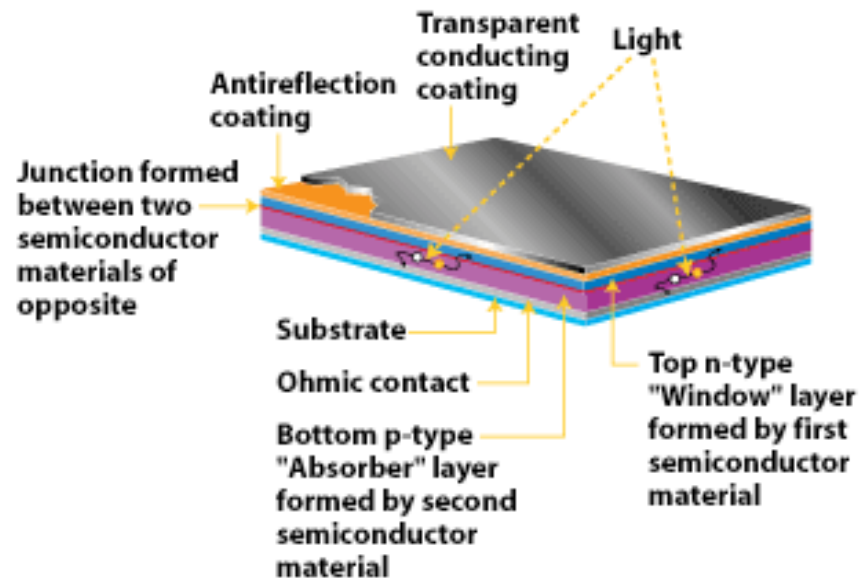
Solids are typically prepared in one of three general categories:

- Single crystals (frequency doublers, silicon wafers, lasers)



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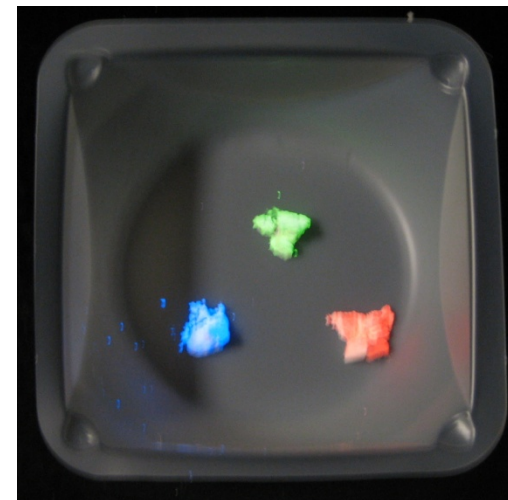
- Single crystals (frequency doublers, silicon wafers, windows)
- Thin films (sensors, optical converters, solar cells)

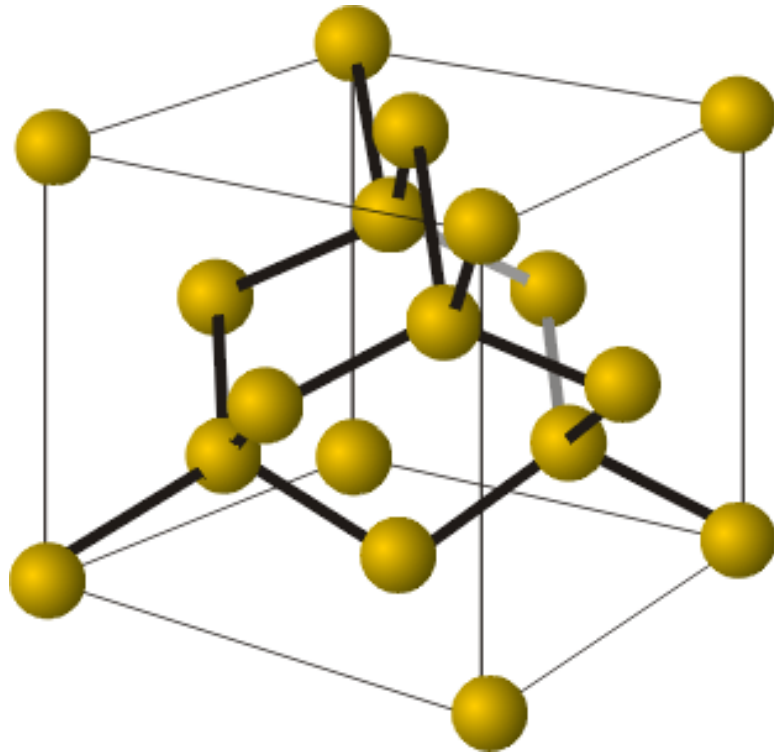


Solids are typically prepared in one of three general categories:

- Single crystals (frequency doublers, silicon wafers, windows)
- Thin films (sensors, optical converters)
- Powders, for device applications (lighting, display)

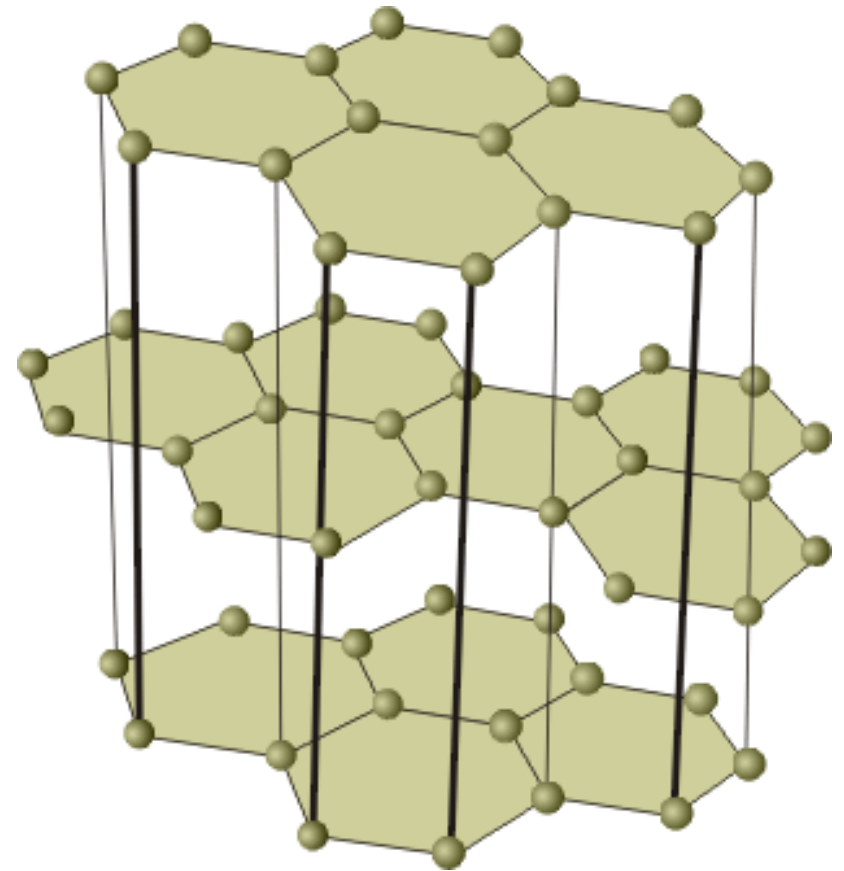
or as precursors (ceramics)





Diamond

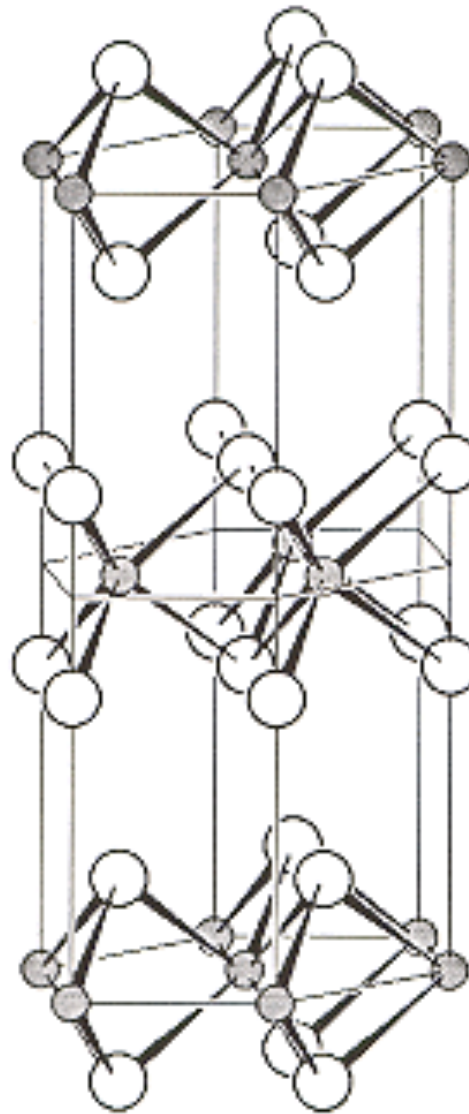
Graphite



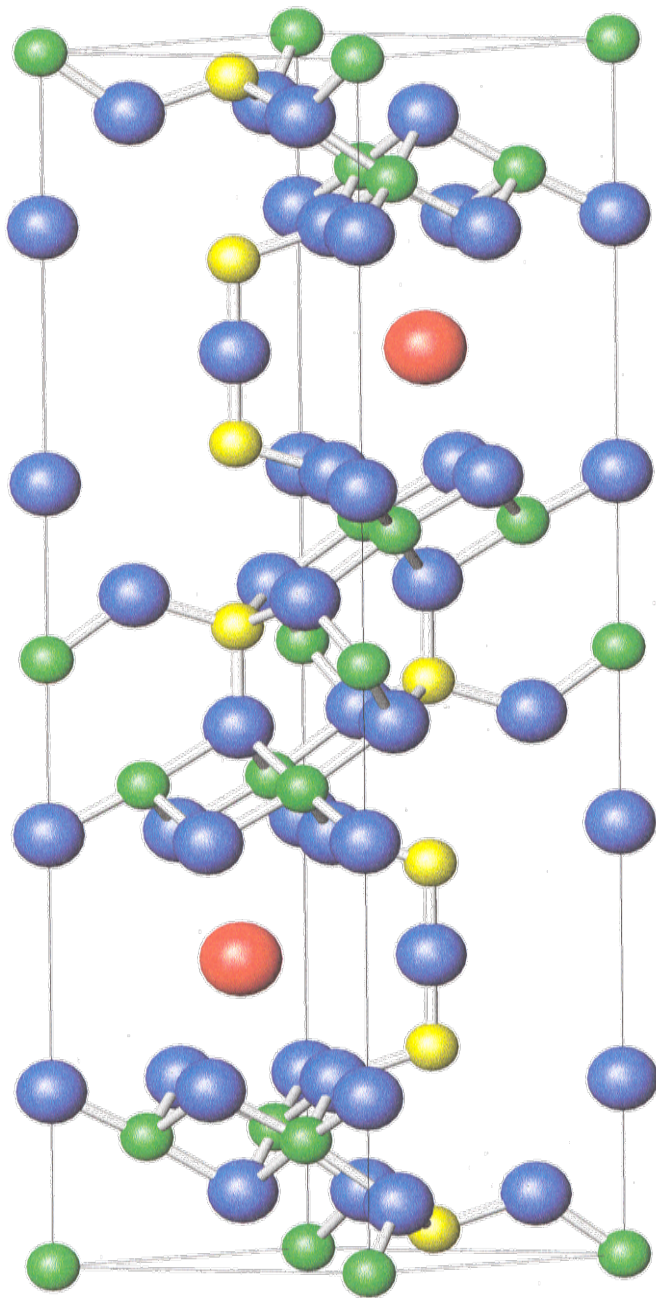
MoS₂

a = 3.16 Å

c = 12.32 Å



● Mo ○ S





hexagonal, c/a ≈ 4

