

Series 2

19 September 2025

Exercise 1: FCC structure

- 1.1 Draw the face-centered cubic structure (FCC). Draw the base of the direct and the reciprocal lattice. Does a primitive cell exist?
- 1.2 Indicate the dense planes and directions on the drawing and express them with the Miller indices. What is the distance between dense planes?
- 1.3 Why are dense planes called octahedral planes? Can we, with these planes, build a tetrahedron?
- 1.4 Indicate on the drawing the directions $\langle 112 \rangle$
- 1.5 Calculate the APF for an FCC structure, showing all steps in your calculation.
- 1.6 What is the coordination number for an FCC crystal structure? Explain why certain metals have an FCC structure and coordination number.
- 1.7 Consider a material with an FCC structure, with atomic weight (M) and density (ρ). Write an expression for calculating the density of the material in terms of the lattice parameter a , the number of atoms in the unit cell, and M .
- 1.8 Calculate the density of copper (Cu) assuming its atomic radius is 0.128 nm and its atomic weight is 63.55 g/mol. The Avogadro's number is 6.022×10^{23} atoms/mol.

Exercise 2: Phase transformation of zirconium dioxide

At about 1000°C, zirconium dioxide transforms from the high-temperature tetragonal to the low-temperature monoclinic phase.

The constants of the monoclinic lattice are: $a = 5.156 \text{ \AA}$, $b = 5.191 \text{ \AA}$, $c = 5.304 \text{ \AA}$

The angle β is about 98.9°.

The constants of the tetragonal lattice are: $a = 5.094 \text{ \AA}$ and $c = 5.304 \text{ \AA}$

Is there a contraction or an expansion during the transformation? What could be the advantage of the mechanical properties of this ceramic?

Exercise 3: Crystalline polyethylene

Polyethylene crystallizes in an orthorhombic structure. How many carbon (and hydrogen) atoms will be in one cell, knowing that the PE s density is $\rho=0.9972 \text{ g/cm}^3$?

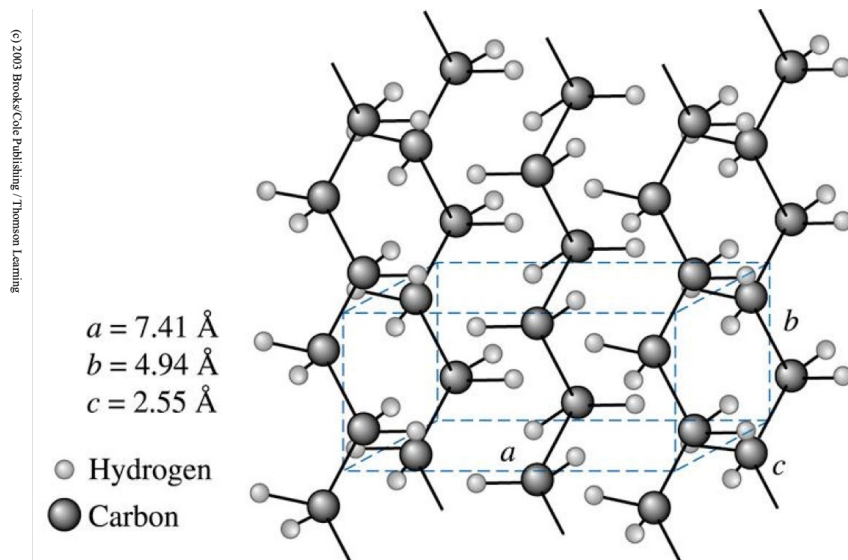


Fig. 3.1 Representation of the cell of crystalline polyethylene