Semiconductor Physics And Devices (4th Edition)

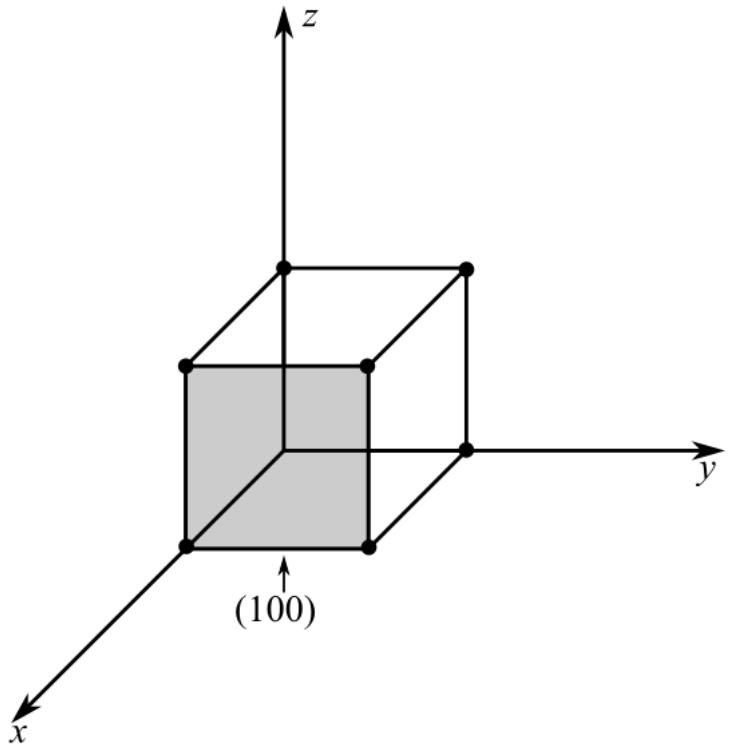
Problem

The lattice constant of a face-centered-cubic structure is 4.25 Å. Calculate the surface density of atoms for a (a) (100) plane and (b) (110) plane.

Step-by-step solution

Step 1 of 6

Draw the diagram for (100) plane of FCC.



Comment

Step 2 of 6

From provided figure it can be seen that for FCC lattice in (100) plane has four spheres at the corners, (contributing $\left(\frac{1}{4}\right)$ to the face) and one sphere at the center.

Therefore, the total number of atoms per lattice plane is equal to,

Total number of atoms per lattice plane = 2.

Write the expression for the area of lattice plane.

$$\text{Area} = a^2$$

Here a is the lattice constant.

Substitute $4.25\ \text{Å}$ for a.

$$\text{Area} = (4.25\ \text{Å})^2$$

$$= \left(4.25\ \text{Å}\right)\left(\frac{\text{cm}}{10^8\ \text{Å}}\right)^2$$

$$= 18.06 \times 10^{-16}\ \text{cm}^2$$

Write the expression for Surface density:

$$\text{Surface den}\quad y = \frac{\text{Numbers of atoms per lattice plane}}{\text{Area}}$$

Substitute 2 for no. of atoms per lattice plane and $18.06' 10^{-16}\ \text{cm}^2$ for Area:

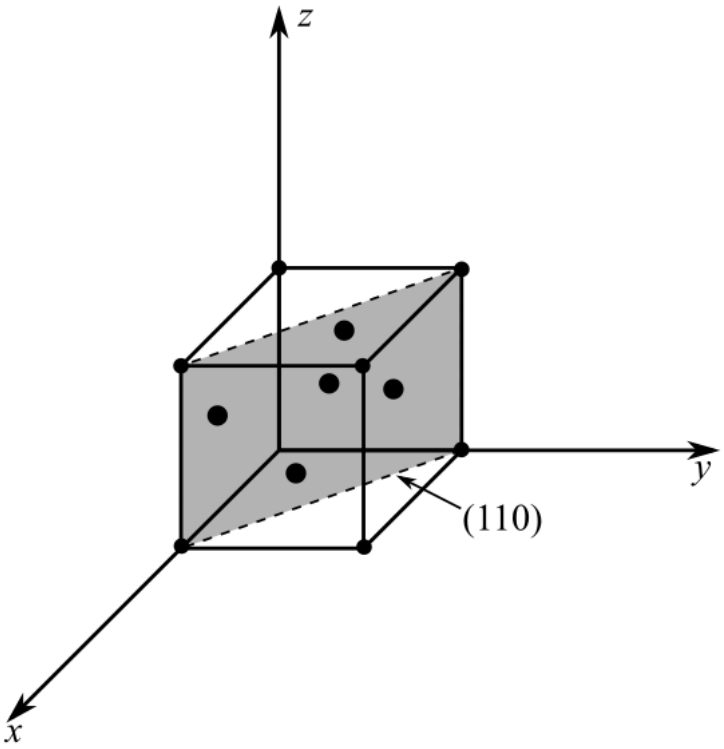
$$\text{Surface density} = \frac{2}{18.06' 10^{-16}\ \text{cm}^2}$$
$$= 1.1' 10^{15}\ \text{cm}^{-2}$$

Hence, the surface density for (100) plane of FCC is $1.1' 10^{15}\ \text{cm}^{-2}$.

Comment

Step 4 of 6

Draw the diagram of (110) plane for FCC.



From provided figure it can be seen that for FCC lattice in (110) plane there are four spheres at the corners, (contributing $\left(\frac{1}{4}\right)$ to the face) and two spheres at the edges contribute $\left(\frac{1}{2}\right)$ each.

Total numbers of atoms per lattice plane = 2.

Comment

Step 5 of 6

Write the expression for the area of lattice plane.

$$\text{Area} = a^2\sqrt{2}$$

Substitute $(4.25\ \text{Å})^2$ for a.

$$\text{Area} = (4.25\ \text{Å})^2\sqrt{2}$$
$$= \left(4.25\ \text{Å}\right)\left(\frac{\text{cm}}{10^8\ \text{Å}}\right)^2\sqrt{2}$$
$$= 2.554' 10^{-15}\ \text{cm}^2$$

Comment

Step 6 of 6

Substitute

$$\text{Surface density} = \frac{2}{2.554' 10^{-15}\ \text{cm}^2}$$
$$= 7.83' 10^{-14}\ \text{cm}^{-2}$$

Hence, the surface density for (110) plane of FCC is $7.83' 10^{-14}\ \text{cm}^{-2}$.

Comment

Was this solution helpful? 7 0

Recommended solutions for you in Chapter 1

Chapter 1, Problem 4

(a) The lattice constant of GaAs is 5.65 Å. Determine the number of Ga atoms and As atoms per cm3. (b) Determine the volume...

See solution

Chapter 1, Problem 20

Determine the surface density of atoms for silicon on the (a) (100) plane, (b) (110) plane, and (c) (111) plane.

See solution