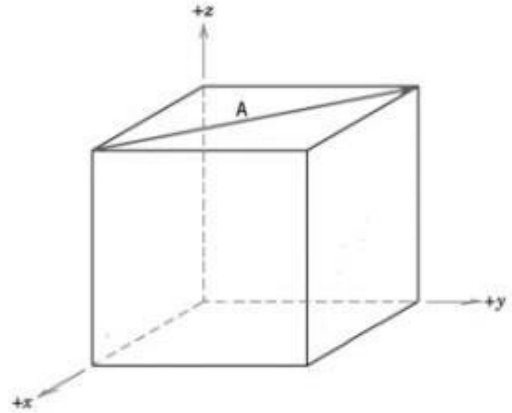
3.18 *Determine the indices for the directions shown in the following cubic unit cell:*

For Direction A



We determine the indices of this direction vector using Equations 3.10a-3.10c—that is, by subtracting vector tail coordinates from head coordinates. Tail coordinates are as follows:

$$x_1 = a \qquad y_1 = 0b \qquad z_1 = c$$

Whereas head coordinates are as follows:

$$x_2 = 0a \qquad y_2 = b \qquad z_2 = c$$

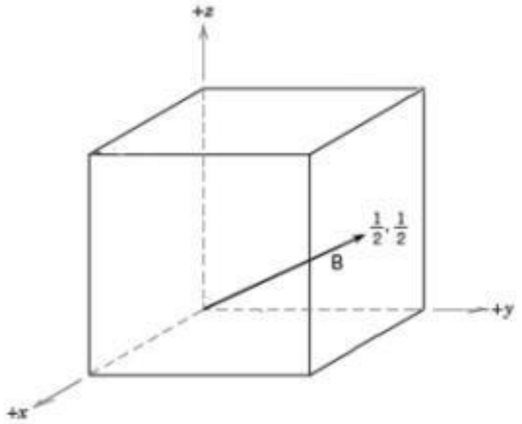
From Equations 3.10a, 3.10b, and 3.10c assuming a value of 1 for the parameter n

$$u = n\left(\frac{x_2 - x_1}{a}\right) = (1)\left(\frac{0a - a}{a}\right) = -1$$

$$v = n\left(\frac{y_2 - y_1}{b}\right) = (1)\left(\frac{b - 0b}{b}\right) = 1$$

$$w = n\left(\frac{z_2 - z_1}{c}\right) = (1)\left(\frac{c - c}{c}\right) = 0$$

Therefore, Direction A is $[\bar{1}10]$.



We determine the indices of this direction vector using Equations 3.10a-3.10c—that is, by subtracting vector tail coordinates from head coordinates. Because the tail passes through the origin of the unit cell, its coordinates are as follows:

$$x_1 = 0a \qquad y_1 = 0b \qquad z_1 = 0c$$

Whereas head coordinates are as follows:

$$x_2 = a/2 \qquad y_2 = b \qquad z_2 = c/2$$

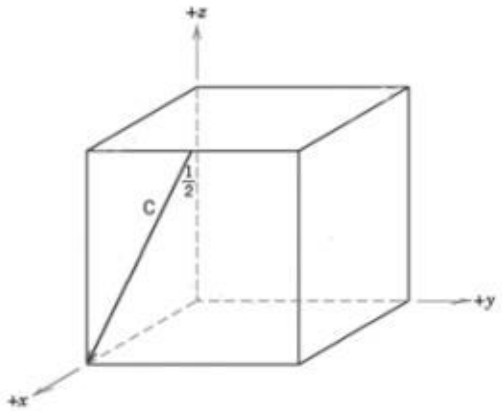
From Equations 3.10a, 3.10b, and 3.10c assuming a value of 2 for the parameter n

$$u = n\left(\frac{x_2 - x_1}{a}\right) = (2)\left(\frac{a/2 - 0a}{a}\right) = 1$$

$$v = n\left(\frac{y_2 - y_1}{b}\right) = (2)\left(\frac{b - 0b}{b}\right) = 2$$

$$w = n\left(\frac{z_2 - z_1}{c}\right) = (2)\left(\frac{c/2 - 0c}{c}\right) = 1$$

Therefore, Direction B is [121].



We determine the indices of this direction vector using Equations 3.10a-3.10c—that is, by subtracting vector tail coordinates from head coordinates. The tail coordinates are as follows:

$$x_1 = a \qquad y_1 = b/2 \qquad z_1 = c$$

Whereas head coordinates are as follows:

$$x_2 = a \qquad y_2 = 0b \qquad z_2 = 0c$$

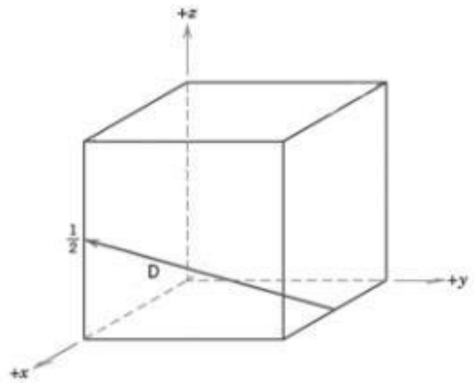
From Equations 3.10a, 3.10b, and 3.10c assuming a value of 2 for the parameter n

$$u = n\left(\frac{x_2 - x_1}{a}\right) = (2)\left(\frac{a-a}{a}\right) = 0$$

$$v = n\left(\frac{y_2 - y_1}{b}\right) = (2)\left(\frac{0b - b/2}{b}\right) = -1$$

$$w = n\left(\frac{z_2 - z_1}{c}\right) = (2)\left(\frac{0c - c}{c}\right) = -2$$

Therefore, Direction C is $[0\bar{1}\bar{2}]$.



We determine the indices of this direction vector using Equations 3.10a-3.10c—that is, by subtracting vector tail coordinates from head coordinates. Tail coordinates are as follows:

$$x_1 = a/2 \qquad y_1 = b \qquad z_1 = 0c$$

Whereas head coordinates are as follows:

$$x_2 = a \qquad y_2 = 0b \qquad z_2 = c/2$$

From Equations 3.10a, 3.10b, and 3.10c assuming a value of 2 for the parameter n

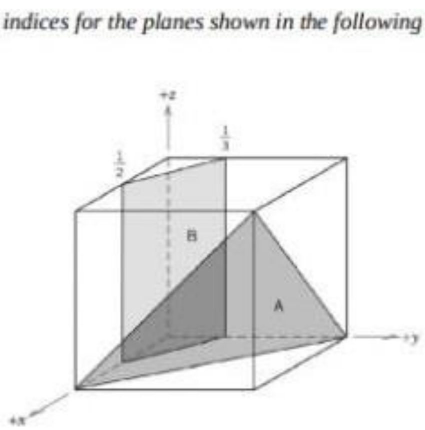
$$u = n\left(\frac{x_2 - x_1}{a}\right) = (2)\left(\frac{a - a/2}{a}\right) = 1$$

$$v = n\left(\frac{y_2 - y_1}{b}\right) = (2)\left(\frac{0b - b}{b}\right) = -2$$

$$w = n\left(\frac{z_2 - z_1}{c}\right) = (2)\left(\frac{c/2 - 0c}{c}\right) = 1$$

Therefore, Direction D is $[1\bar{2}1]$.

3.26 *Determine the Miller indices for the planes shown in the following unit cell:*



Solution

For plane A, the first thing we need to do is determine the intercepts of this plane with the x, y, and z axes. If we extend the plane back into the plane of the page, it will intersect the z axis at $-c$. Furthermore, intersections with the x and y axes are, respectively, a and b. The is, values of the intercepts A, B, and C, are a, b, and $-c$. If we assume that the value of n is 1, the values of h, k, and l are determined using Equations 3.13a, 3.13b, and 3.13c as follows:

$$h = \frac{na}{A} = \frac{(1)a}{a} = 1$$

$$k = \frac{nb}{B} = \frac{(1)b}{b} = 1$$

$$l = \frac{nc}{C} = \frac{(1)c}{-c} = -1$$

Therefore, the A plane is a $(11\overline{1})$ plane.

For plane B, its intersections with with the x, y, and z axes are $a/2$, $b/3$, and ∞c (because this plane parallels the z axis)—these three values are equal to A, B, and C, respectively. If we assume that the value of n is 1, the values of h, k, and l are determined using Equations 3.13a, 3.13b, and 3.13c as follows:

$$h = \frac{na}{A} = \frac{(1)a}{a/2} = 2$$

$$k = \frac{nb}{B} = \frac{(1)b}{b/3} = 3$$

$$l = \frac{nc}{C} = \frac{(1)c}{\infty c} = 0$$

Therefore, the B plane is a (230) plane.

3.36 *Explain why the properties of polycrystalline materials are most often isotropic.*

Solution

Although each individual grain in a polycrystalline material may be anisotropic, if the grains have random orientations, then the solid aggregate of the many anisotropic grains will behave isotropically.