Answer on Question #51564, Physics, Solid State Physics

In a one dimensional diatomic crystal, the velocity of sound is 1500 m/s and the lattice constant 4.0Å. The relationship between the mass of the atoms is M/m = 0.8. Calculate the gap in the frequency at the Brillouin zone boundary.

Solution

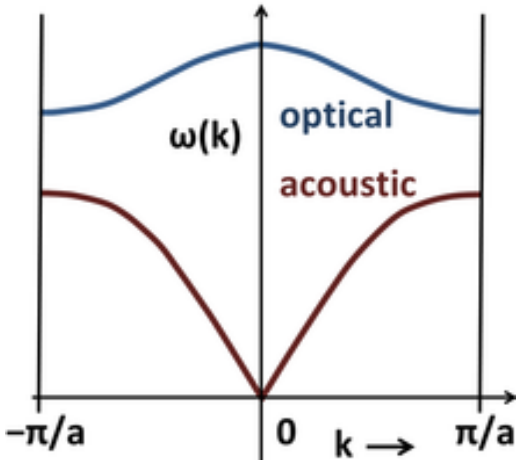

Fig.1

The gap in the frequency at the Brillouin zone boundary is given by Eq.(1) and (2).

$$\omega_1 = \sqrt{\frac{2\beta}{M}} \tag{1}$$

$$\omega_2 = \sqrt{\frac{2\beta}{m}} \tag{2}$$

The velocity of sound is $v = \sqrt{\beta / m}a$

Than

$$\omega_1 = \sqrt{2}\frac{v}{a}\sqrt{\frac{m}{M}} = \sqrt{2}\frac{1500}{4\cdot 10^{-10}}\sqrt{1/0.8} = 53.03\cdot 10^9\, rad/s$$

$$\omega_2 = \sqrt{2}\frac{v}{a} = \sqrt{2}\frac{1500}{4\cdot 10^{-10}} = 59.31\cdot 10^9\, rad/s$$

Answer:

The gap in the frequency is $\left[59.31\cdot 10^9\, rad/s;\ 59.31\cdot 10^9\, rad/s\right]$

If the frequency is expressed in Hertz ($f = \omega/2\pi$) $\left[8.44GHz; 9.44GHz\right]$