Answer on Question #51561, Physics, Solid State Physics

Derive an expression for the velocity of the transverse wave in the [100] direction in a cubic crystal.

Solution

For cubic crystals, the equation of motion can be written as:

$$\rho\ddot{u}_x = c_{11}\frac{\partial^2 u_x}{\partial x^2} + c_{44}\left(\frac{\partial^2 u_x}{\partial y^2} + \frac{\partial^2 u_x}{\partial z^2}\right) + \left(c_{12} + c_{44}\right)\left(\frac{\partial^2 u_y}{\partial x \partial y} + \frac{\partial^2 u_z}{\partial x \partial z}\right) \quad (1)$$

where ρ is the mass density and u_x is the x component of the displacement $\vec{u}$. The corresponding equations of motion along y and z can be found by cyclic permutation.

The transverse wave in the [100] direction in a cubic crystal

$$v_T[100] = \sqrt{c_{44}/\rho} \quad (2)$$

Answer: $v_T[100] = \sqrt{c_{44}/\rho}$.