Answer on Question #81500 - Physics - Mechanics – Relativity

Derive the expression for bulk modulus of cubic cryst

Solution

Bulk modulus is

$$K = \frac{\sigma}{\frac{dV}{V}},$$

where σ – tensile stress acting on the faces.

Consider a cubic crystal with side L, Young's modulus E and Poisson's ratio μ. Each side will suffer three mutually perpendicular strains:

$$\frac{\sigma}{E}, -\mu\frac{\sigma}{E}, -\mu\frac{\sigma}{E},$$

and the total strain of this side will be

$$\frac{dL}{L} = \frac{\sigma}{E} - -\mu\frac{\sigma}{E} - \mu\frac{\sigma}{E} = \frac{\sigma}{E}(1-2\mu).$$

Since $V = L^3$, we can write:

$$\frac{dV}{V} = \frac{dL^3}{L^3} = \frac{3L^2dL}{L^3} = \frac{3dL}{L}.$$

So

$$K = \frac{\sigma}{\frac{3\sigma}{E}(1-2\mu)} = \frac{E}{3(1-2\mu)}.$$

Answer

$$K = \frac{\sigma}{\frac{3\sigma}{E}(1-2\mu)} = \frac{E}{3(1-2\mu)}.$$