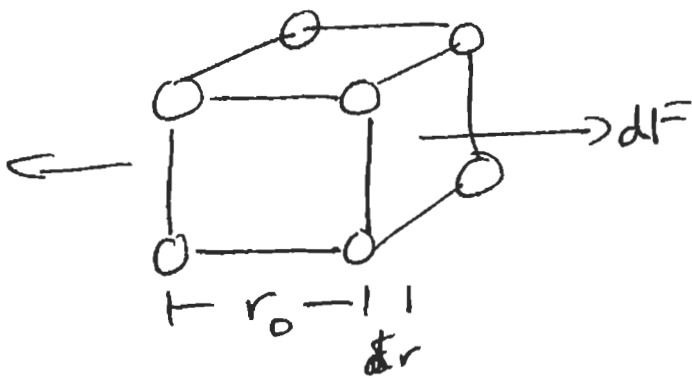


$$U = -\frac{A}{r^m} + \frac{B}{r^n} \quad (0)$$

long range
electrostatic
attraction

Short range repulsion
inner electron orbitals,
nuclei.

Cubic unit cell



Young's modulus

$$= \frac{dF}{A} \cdot \frac{dr_0}{dr} = \frac{dF}{dr} \frac{r_0}{r_0^2}$$

$$= \frac{1}{r_0} \frac{dF}{dr} = \frac{1}{r_0} \left. \frac{d^2U}{dr^2} \right|_{r=r_0} \quad (1)$$

$$\frac{dU}{dr} = MAr^{-(m+1)} - nBr^{-(n+1)}, \quad \frac{d^2U}{dr^2} =$$

$$\text{at } r = r_0 \quad \frac{dU}{dr} = 0$$

$$\Rightarrow B = \frac{m}{n} A r_0^{n-m} \quad \text{substitute into (0)}$$

$$\Rightarrow U = -Ar^{-m} + \frac{m}{n} A r_0^{n-m} r^{-n} \quad (2)$$

$$\therefore U(r_0) = -Ar_0^{-m} + \frac{m}{n} A r_0^{(n-m-n)} = Ar_0^{-m} \left(\frac{m}{n} - 1 \right) = Ar_0^{-m} \left(\frac{m-n}{n} \right)$$

From definition in question

$$-kT_m = A r_0^{-m} \left(\frac{m-n}{n} \right)$$

$$\therefore A = \frac{n}{(m-n)} kT_m r_0^m, \quad B = \frac{-m}{m-n} kT_m r_0^m \cdot r_0^{n-m} = \frac{m}{m-n} kT_m r_0^n$$

$$U = + \frac{n}{m-n} kT_m \frac{r_0^m}{r^m} - \frac{m}{m-n} kT_m \frac{r_0^n}{r^n}$$

$$\therefore \frac{dU}{dr} = - \frac{mn}{m-n} kT_m r_0^m r^{-(m+1)} + \frac{nm}{m-n} kT_m r_0^n r^{-(n+1)}$$

$$\frac{dF}{dr} = + \frac{(m+1)mn}{m-n} kT_m r_0^m r^{-(m+2)} - \frac{(n+1)nm}{m-n} kT_m r_0^n r^{-(n+2)}$$

$$\text{for } r=r_0, \quad \frac{1}{r_0} \frac{dF}{dr} = \frac{(m+1)mn}{m-n} kT_m r_0^{-m-2} \cdot r_0^{-1} - \frac{(n+1)nm}{m-n} kT_m r_0^{-n-2} \cdot r_0^{-1}$$

$$= \frac{mnkT_m}{(m-n)r_0^3} \left(+ (m+1) - (n+1) \right), \quad r_0^3 = \Omega$$

$$\therefore E = \frac{1}{r_0} \frac{dF}{dr} \Big|_{r=r_0} = \frac{mnkT_m}{\Omega}$$

The purpose of this question is to demonstrate intrinsic link between moduli & T_m . Diamond, Sic have high E high T_m , Polymers have low E , low T_m .