DESIGN PROBLEMS

Crystal Structures

12.D1 This problem asks that we determine the concentration (in weight percent) of InAs that must be added to GaAs to yield a unit cell edge length of 0.5820 nm. The densities of GaAs and InAs were given in the problem statement as 5.316 and 5.668 g/cm^3, respectively. To begin, it is necessary to employ Equation 12.1, and solve for the unit cell volume, V_C, for the InAs-GaAs alloy as

$$V_C = \frac{n' A_{ave}}{\rho_{ave} N_A}$$

where A_{ave} and ρ_{ave} are the atomic weight and density, respectively, of the InAs-GaAs alloy. Inasmuch as both of these materials have the zinc blende crystal structure, which has cubic symmetry, V_C is just the cube of the unit cell length, a. That is

$$V_C = a^3 = (0.5820 \text{ nm})^3$$

$$= (5.820 \text{ x } 10^{-8} \text{ cm})^3 = 1.971 \text{ x } 10^{-22} \text{ cm}^3$$

It is now necessary to construct expressions for A_{ave} and ρ_{ave} in terms of the concentration of indium arsenide, C_{InAs} using Equations 4.11a and 4.10a. For A_{ave} we have

$$A_{ave} = \frac{100}{\frac{C_{InAs}}{A_{InAs}} + \frac{(100 - C_{InAs})}{A_{GaAs}}}$$

$$= \frac{100}{\frac{C_{InAs}}{189.74 \text{ g/mol}} + \frac{(100 - C_{InAs})}{144.64 \text{ g/mol}}}$$

whereas for ρ_{ave}

$$\rho_{ave} = \frac{100}{\frac{C_{InAs}}{\rho_{InAs}} + \frac{(100 - C_{InAs})}{\rho_{GaAs}}}$$