$$E_v(x) = xE_v(AC) + (1-x)E_v(BC) + 3x(1-x)\left[-a_v(AC) + a_v(BC)\right]\frac{\Delta a}{a_\circ}$$

$\therefore$ $E_v(Ga_{0.7}In_{0.3}As) = 0.3E_v(InAs) + 0.7E_v(GaAs) +$

$3x(1\text{-}x)[-a_v(InAs) + a_v(GaAs)]\{(a_{InAs} - a_{GaAs})/[x\, a_{InAs} - (1-x)\, a_{GaAs}]\}$

$= -6.720$ eV.

Using linear interpolation, we found C_{11}(GaInAs) = 10.815 and C_{12}(GaInAs) = 5.124. Then

$$E_c(Ga_{0.7}In_{0.3}As) = E_v(Ga_{0.7}In_{0.3}As) + E_g(Ga_{0.7}In_{0.3}As) + 2a_c\varepsilon_1(C_{11} - C_{12})/C_{11}$$

where $\varepsilon_1 = \dfrac{a_{sub} - a_{epi}}{a_{epi}} = \dfrac{5.653 - 5.775}{5.775} = -0.0124$;

$a_c = -6.543$;

$E_g(Ga_{0.7}In_{0.3}As) = 0.36 + 0.505\times0.7 + 0.555\times(0.7)^2 = 0.9855$ eV.

$E_c(Ga_{0.7}In_{0.3}As) = -6.730 + 0.9855 + 0.147 = -5.587$ eV.

$\Rightarrow$ $\Delta E_C = -5.383 + 5.587 = 0.204$ eV.

The heavy-hole energy level in $Ga_{0.7}In_{0.3}As$ can be calculated as

$$E_{HH}(Ga_{0.7}In_{0.3}As) = E_v(Ga_{0.7}In_{0.3}As) + 2a_v\varepsilon_1\left(\frac{C_{11} - C_{12}}{C_{11}}\right) + b\varepsilon_1\left(\frac{C_{11} + 2C_{12}}{C_{11}}\right)$$

$= -6.720 - 0.0145 + 0.0418$

$= -6.6927$ eV.

$\Rightarrow$ $\Delta E_v = -6.807 + 6.6927 = -0.1143$ eV.

Therefore, the $Ga_{0.7}In_{0.3}As$/GaAs system has a type-I heterostructure.

6.5 Construction of Heterostructure Band Diagrams

Once the conduction band and valence band discontinuities are determined, we can proceed to construct the heterostructure band diagrams.

6.5.1. Anisotype *N-p* heterojunctions:

The band diagram construction method for a heterojunction is very close to the method for a doped homostructure, except we need to take account of the discontinuities ΔE_C and ΔE_V. Using an *N-p* heterojunction as an example, as shown in Fig. 6-14, one start with flat bands in each material as determined by Anderson's rule and the Fermi levels set by the doping on each side. To cancel out the effect of discontinuities temporarily, draw lines $E'_{C1} = E_{C1} - \Delta E_C$ and $E'_{V1} = E_{V1} - \Delta E_V$. Now the 'effective' band gap is the same on both sides.