3.091 Fall Term 2004

Homework Quiz #5B

solution outline

(a) Green light, $\lambda = 518$ nm, shines on a crystal of gallium arsenide (GaAs), which has a band gap energy, E_g, of 1.34 eV. Is GaAs transparent to green light? Justify your answer with appropriate calculations.

To determine whether GaAs is transparent to green light, compare the incident photon energy to the value of the band gap energy. If $E_{incident} > E_g$, then electrons will be promoted across the band gap thereby absorbing the incident radiation.

$$E_{incident} = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.00\times10^{8}}{518\times10^{-9}} = 3.84\times10^{-19}\,\text{J} = 2.40\,\text{eV}$$

Clearly, $E_{incident} > E_g$, so green light is absorbed and GaAs is **not transparent** to this form of radiation.

(b) Aluminum arsenide (AlAs) is also a semiconductor. Do you expect the band gap of this material to be greater or less than the band gap of GaAs? Explain.

$E_g(\text{AlAs}) > E_g(\text{GaAs})$

the Al–As bond is stronger than Ga–As bond because although both Al and Ga are group 13, Ga is much larger than Al. This means that the valence electrons in Ga are more weakly held than those in Al, and hence the bonds that form with Ga are necessarily weaker than those that form with Al.