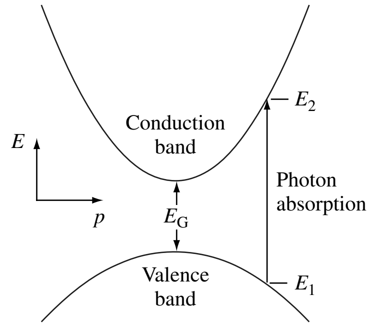

Figure 3.6 Photon absorption in a direct band gap semiconductor for an incident photon with energy $h\nu = E_2 - E_1 > E_G$

all possible transitions between states where $E_2 - E_1 = h\nu$ [9],

$$\alpha(h\nu) \propto \sum P_{12} g_V(E_1) g_C(E_2), \tag{3.24}$$

assuming that all the valence-band states are full and all the conduction-band states are empty. Absorption results in creation of an electron-hole pair since a free electron is excited to the conduction band leaving a free hole in the valence band.

In direct band gap semiconductors, such as GaAs, GaInP, CdTe, and Cu(InGa)Se_2, the basic photon absorption process is illustrated in Figure 3.6. Both energy and momentum must be conserved in the transition. Every initial electron state with energy E_1 and crystal momentum p_1 in the valence band is associated with a final state in the conduction band at energy E_2 and crystal momentum p_2. Since the electron momentum is conserved, the crystal momentum of the final state is the same as the initial state, $p_1 \approx p_2 = p$.

Conservation of energy dictates that the energy of the absorbed photon is

$$h\nu = E_2 - E_1 \tag{3.25}$$

Since we have assumed parabolic bands,

$$E_V - E_1 = \frac{p^2}{2m_p^*} \tag{3.26}$$

and

$$E_2 - E_C = \frac{p^2}{2m_n^*} \tag{3.27}$$

Combining equations (3.25), (3.26), and (3.27) yields

$$h\nu - E_G = \frac{p^2}{2}\left(\frac{1}{m_n^*} + \frac{1}{m_p^*}\right) \tag{3.28}$$