uniform field model of Kane. For reverse bias this may be expressed as

$$I = \frac{qm^*}{36\hbar^2}\,\text{A.P.}\left(\frac{\bar{E}}{2}\right)D \tag{1}$$

where

$$P = \exp(-\beta E_g^{3/2})$$

$$\beta = \pi m^{*1/2}/2\sqrt{2}\hbar qF$$

$$\bar{E} = \sqrt{2}\hbar qF/(\pi^2 m^* E_g)^{1/2}$$

$$D = qV + \left(\frac{\bar{E}}{2}\right)\left\{\exp\left(-\frac{2\delta_n}{\bar{E}}\right) + \exp\left(-\frac{2\delta_p}{\bar{E}}\right) - 2\exp\left(-\frac{qV+\delta_n+\delta_p}{\bar{E}}\right)\right\}$$

$$m^* = 2m_c m_v/(m_c + m_v).$$

The quantity P in equation (1) is the tunnel probability for an electron with zero transverse momentum. For a given junction structure β depends upon m^*, the dielectric constant, the doping concentrations and profile of the junction. $\bar{E}$ is a measure of the limiting energy of electrons having transverse momentum and an appreciable tunnel probability. For the junctions studied $\bar{E}$ is approximately 10 meV. The parameter D is a joint density of states function which may be approximated by qV for bias voltages much greater than $\bar{E}/2q$. In Kane's two band model m_c and m_v are isotropic effective masses for the conduction and light hole band respectively and δ_n and δ_p are the fermi energies in the n and p sides of the junction measured from the conduction and valence band edges respectively. The junction area is A, and F is the effective junction field. The other symbols have their usual meaning.

Approximating D with qV, we may express (1) as

$$I = CE_g^{-1/2}\exp(-\beta E_g^{3/2}) \tag{2}$$

where

$$C = \frac{\sqrt{2}m^{*1/2}q^2VFA}{72\pi\hbar^2}.$$

In addition to changes in the energy gap induced by stress, the constant energy surfaces are warped, and the valence band degeneracy at the Γ point is lifted. In the present study no evidence could be found for the splitting at the Γ point and it is assumed that the smearing of the band edges, arising from the heavy doping levels necessary, was sufficient to mask these effects. Such effects should be second order compared with the effects due to changes of E_g and we proceed in the manner suggested by Long and Hulme [7]. Fractional changes in tunnel current may then be expressed as

$$\frac{1}{I}\left(\frac{dI}{d\chi}\right) = -\frac{1}{2}[1+3\beta E_g^{3/2}]\frac{1}{E_g}\left(\frac{dE_g}{d\chi}\right). \tag{3}$$

In (3) χ is the stress and is negative for compression, and E_g and I are the energy gap and tunnel current in the absence of stress. From previous studies on these junctions [11] we find we may express

$$\beta E_g^{3/2} = (10 \pm 0{\cdot}5)(1 + 5{\cdot}88\,V)^{0{\cdot}63}.$$

The anisotropy in the fractional decrease in tunnel current with stress can be accounted for on the basis of the work of Bir and Pikus. At the centre of the Brillouin zone the change in energy gap with stress may be expressed in terms of the compliance coefficients, S_{ij}, and the deformation potentials. For stress parallel [010] it is given by

$$\frac{dE_g}{d\chi} = K - b(S_{11} - S_{12}). \tag{4}$$

Similarily for stress parallel [111]

$$\frac{dE_g}{d\chi} = K - \frac{d}{2\sqrt{3}}S_{44} \tag{5}$$

and for stress parallel [1$\bar{1}$0]

$$\frac{dE_g}{d\chi} = K + \tfrac{1}{2}\left\{b^2(S_{11}-S_{12})^2 + 3\left(\frac{dS_{44}}{2\sqrt{3}}\right)^2\right\}^{1/2} \tag{6}$$

where

$$K = (a + c)(S_{11} + 2S_{12}).$$

The quantities a, b, c and d are the deformation potentials. Deformation potentials a, and c describe rigid shifts in valence and conduction band edges respectively due to a volume change. The sum $(a + c)$ describes the change in the direct gap. Deformation potentials b, and d describe changes and splitting of the Γ_8 valency band energies for uniaxial stress parallel to the [010] and [111] directions respectively.

The compliance coefficients for InSb have been given by Potter[20]. At 100°K we have

$$S_{11} = 2{\cdot}26, \quad S_{12} = -7{\cdot}60, \quad S_{44} = 3{\cdot}19$$

in units of 10^{-12}cm^2/dyne.

If equations (4), (5) and (6) are used in turn in (3) for each of the principle stress directions, together with the measured values for the stress coefficients and the compliance coefficients we can deduce the deformation potentials. We find values of $(a+c)$, b, and d of -10, $-1{\cdot}3$ and $-7{\cdot}4$ eV respectively, with a probable error of ± 10 per cent. The value of the hydrostatic deformation potential $(a+c)$ is somewhat larger than reported value of $-7{\cdot}2$ from optical absorption[13], and piezoemission[14], but considerably less than -30 and -40 deduced from free carrier absorption[15], and plasma piezoreflectance[16]. Deformation potentials b, and d, are in fair agreement with the piezo-emission[14] data ($b = -2$ eV, $d = -6$ eV), piezobirefringence [17], ($b = -1{\cdot}8$ eV, and $d = -6{\cdot}4$ eV) and the magnetoreflection experiments[18]; ($b = -2{\cdot}0$ eV, and $d = -4{\cdot}9$ eV).

At higher values of stress the incremental change in current decreases with increasing stress. The explanation for this, we believe, lies in a more realistic calcuation of the change in tunnel current with stress taking into account the nonparabolicity of the bands, the stress induced change in the fermi-levels, and the deformation potential of the impurity levels.

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