Hall Mobility of Carriers in Impure Nondegenerate Semiconductors

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A discussion is given of the Hall mobility of carriers in nondegenerate semiconductors, taking into account scattering by lattice vibrations, ionized impurities, and neutral impurities. The study is confined to the case of low temperatures and high impurity concentrations, for which Sclar's theory of ionized impurity scattering is valid.

SODHA and Eastman[1] have discussed the drift mobility of carriers in nondegenerate semiconductors with high concentrations of ionized and neutral impurities, at low temperatures for which the scattering theories by Sclar[2] and Erginsoy[3] are valid. Since it is customary to study the Hall effect and electrical conductivity simultaneously, it is also necessary to investigate theoretically the dependence of Hall mobility on concentrations of ionized and neutral impurities, for a proper interpretation of data.

Using the same notation as in the previous paper,[1] the effective time of relaxation of a carrier is given by

$$\tau = la_1/(v+a_2/\sqrt{\lambda_0}). \tag{1}$$

The velocity distribution at low electric fields is given by

$$N(v)dv = Av^2\exp(-\lambda_0 v^2)dv. \tag{2}$$

The Hall mobility is given by[4]

$$\mu' = \frac{q}{m}\frac{\langle\tau^2 v^2\rangle}{\langle\tau v^2\rangle}. \tag{3}$$

From Eqs. (1), (2), (3), and expressions for μ_L and μ_N given in the earlier paper,[1] we obtain the zero-electric-field Hall mobility as

$$\mu' = \tfrac{3}{4}\pi^{\frac{1}{2}}a_1\mu_L\Psi(a_2) = \mu_N a_2\Psi(a_2), \tag{4}$$

where

$$\Psi(a_2) = \frac{2}{F(a_2)}\int_0^\infty \frac{u^4\exp(-u^2)}{(u+a_2)^2}du,$$

and

$$F(a_2) = 2\int_0^\infty \frac{u^4\exp(-u^2)}{(u+a_2)}du$$

is a tabulated[1] function.

Figure 1 gives the variation of $\Psi(a_2)$ and $a_2\Psi(a_2)$

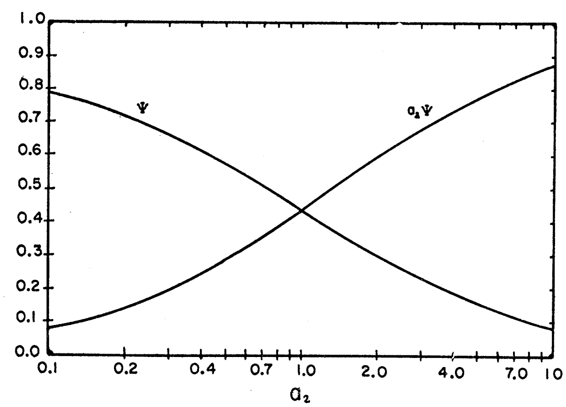

FIG. 1. Variation of $\Psi(a_2)$ and $a_2\Psi(a_2)$ with a_2.

with a_2 and, since μ_L can be calculated, can be used to evaluate either μ_I or μ_N if the other is known.

This investigation is subject to the limitations stated in the earlier paper.

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