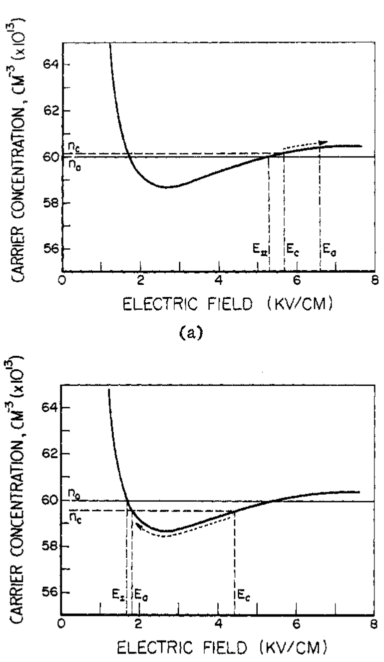

(a)

(b)

Fig. 2. (a) Solution (dotted line) for a slightly injecting cathode contact. (b) For a slightly blocking cathode contact. E_c: cathode field. E_a: anode field.

Slightly Injecting Contact

The solution is of the type shown in Fig. 2(a). Because the starting point is very close to the singular point II, in physical space the solution will have a sizeable region in which $E \simeq E_{II}$, i.e., a stationary cathode domain. With increasing x, the domain will be followed by an accumulation layer ending at a somewhat higher field, as determined by the applied voltage. When the cathode domain is long enough, disturbances will grow sufficiently so that the accumulation layer will break up into dipole domains, which grow as they propagate along the sample. As the applied voltage is increased, the cathode domain extends further into the sample; therefore, the domain transit time decreases and the oscillation frequency increases. The description above accounts for most features of the Type 1 oscillations.

If the sample is long enough, the field associated with the growing domain becomes large enough to ionize electron-hole pairs across the energy gap. The ionization occurs at the anode, where the field is higher. Fluctuations in the generation rate of electron-hole pairs give rise to noise. This explains the features observed in Type 2 oscillations.

Slightly Blocking Contact

The solution is of the type shown in Fig. 2(b). The field in the cathode region is close to E_{II}. With increasing x, the high-field domain is followed by a depletion region ending at the anode, with $E \simeq E_I$. As in the first case, this depletion region breaks up into domains that grow as they travel along the sample. However, now the anode field is lower than the threshold field; as the solution goes through E_p, the threshold field, the traveling domains start to decay and finally die without reaching the anode. As the voltage is increased, the domains move further along the sample; therefore, the domain transit time increases and the oscillation frequency decreases. This explains the features observed in Type 3 oscillations.

Conclusions

The difference in boundary conditions at the cathode was seen to explain the difference in the observed characteristics of oscillations in germanium when all the other parameters (temperature, carrier concentration, orientation) are identical. McGroddy–Nathan samples, both "short" and "long", exhibit the high anode field characteristic of a slightly injecting cathode contact. Due to this high field at the anode, the measured threshold field is high and the domains grow as they propagate from the cathode, until they reach the anode ("short" samples) or start to generate electron-hole pairs by impact ionization ("long" samples). In contrast, Guion–Ferry samples are characterized by the low anode field associated with a slightly blocking cathode contact. As a consequence, the measured threshold field is low and the domains are extinguished before they reach the anode.

The difference in the mechanism by which the domains are created and extinguished also explains why the McGroddy–Nathan samples and the Guion–Ferry samples show the opposite frequency dependence on the applied voltage.

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Erratum

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One of the figures in the correspondence "LSA Operation of a Gallium Arsenide Device in Microstrip"[1] is incorrectly labeled. Fig. 2(b) should be labeled 2(c) and Fig. 2(c) should be labeled 2(b).

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