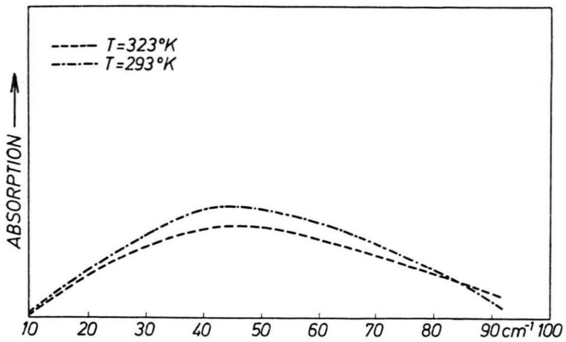

Fig. 3. The effect of the temperature on the absorption of CCl_4.

	Temperature interval (T in °C)	I.A. 1 (%)	B.S. (cm^{-1})
C_6H_6	27	4	2
CS_2	70	5	5
CCl_4	35	7	4

Table 1. The observed changes of the integrated absorption intensity (I.A. 1) and band shifts (B.S.).

be taken with caution because the moment analysis of bands may show that the calculated moments of inertia have not the same trend as the moments calculated from the geometry of the molecules.

The increase of the integrated absorption intensity with decreasing temperature is small but nevertheless only a part of this increase can be accounted for by the larger band width at higher temperature. This observation can be qualitatively explained by the assumption [6] that the absorption is not due to isolated molecules but is a result of the collective behaviour of the liquid.

The increase in half-width of the bands at higher temperatures supports the assumption that the absorption is of the resonance character. The temperature dependence of the band shift emphasizes the translational [7] character of the absorption.

The observed changes cannot be explained using the measurements in Ref. [1] with the assumption that only Debye relaxation absorption (below 10 cm^{-1}) is responsible for the observed changes.

Our measurements are consistent with the proposition [4, 5] that the absorption is of the resonance character with rotation-translation mechanism where the collective behaviour of the liquid is an important factor [6].

The authors are grateful to the Beckman-RIIC limited for making Fourier Spectrophotometer F 720 available to us.

[6] H. S. Gabelnick and H. L. Strass, J. Chem. Phys. **49**, 2334 [1968].
[7] D. R. Bosomworth and H. P. Gush, Can. J. Phys. **43**, 751 [1965].

The Effect of Carrier Concentration on Microwave Emission from n-Type Indium Antimonide

W. A. Porter and D. K. Ferry

Department of Electrical Engineering, Texas Tech University Lubbock

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The effect of carrier concentration on the threshold for microwave emission from InSb was determined. Threshold electric fields are lower for higher concentrations and the magnetic field dependence is reduced.

The influence of carrier concentration on the threshold values of the applied electric and magnetic fields required to stimulate microwave emission was determined by using otherwise similar samples in identical experiments. The power gain for samples of different carrier concentration was determined by comparing the percent change in applied electric field strength required to increase emission from the threshold level to an arbitrary higher level. Also the effect of diffused n^+ contacts on microwave thresholds was studied by first diffusing Sn to a depth of 30 μ and then removing this layer in stages and comparing the resulting threshold curves.

The samples used had carrier concentrations of $2\times10^{14}/cm^3$, $3\times10^{15}/cm^3$, and $1.9\times10^{16}/cm^3$ and mobilities of 6.5×10^5 cm^2/V-sec, 2.2×10^5 cm^2/V-sec, and 1.2×10^5 cm^2/V-sec, respectively. The InSb was cut into $.5\times.5\times5.0$ mm^3 bars and then polished in CP4. Ohmic contacts were applied using Sn and a $ZnCl_2$ flux. The samples were cooled to 77 °K in liquid nitrogen. The electric field was supplied in 10 μsec pulses and the perpendicular magnetic field by a $0-6$ kG electromagnet. A heterodyne microwave receiver with a sensitivity of -95 dBm tuned to 2 GHz detected the emission which had first been passed through a high pass filter to limit spurious signals. The output of this receiver was displayed on an oscilloscope.

For the lowest carrier concentration, the threshold for emission was similar to that reported earlier [1], the required electric field increasing sharply as the magnetic field was decreased as shown in Fig. 1. Samples of the intermediate concentration behaved quite differently with the required electric field being approximately constant at 12 V/cm and emission persisting as B was reduced toward zero. For the highest concentration, the required electric field strength was only 3 V/cm.

[1] D. K. Ferry and W. A. Porter, Microwave Emission and High Frequency Oscillations in n-Type InSb, IBM Journal **13**, 621 [1969].

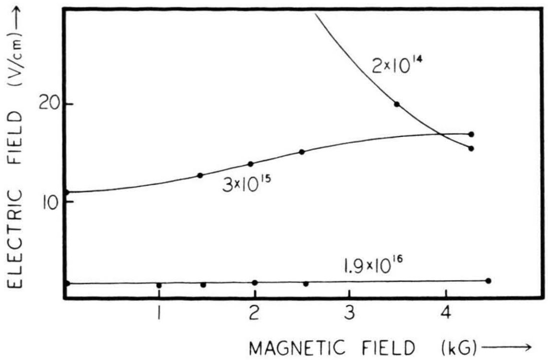

Fig. 1. Microwave emission threshold curves for different concentration samples.

Again the magnetic field had essentially no effect on the threshold electric field. It is evident that the influence of the magnetic field decreases with increase in carrier concentration and that emission from samples of the highest concentration show a virtual independence of the magnetic field.

When the electric field required for an arbitrary emission level is compared with that required for the initiation of emission at a fixed magnetic field strength, the power gain for a sample can be determined. Shown in Fig. 2 are data for samples of the different concentrations, where the applied electric field has been normalized to threshold electric field value (E_t). It can be seen that the samples of higher carrier concentration exhibit a larger power gain for $B=3.5$ kG. That is, the same arbitrary power level was reached for a lower normalized electric field. At higher magnetic fields (e. g. 4.6 kG) all concentrations had approximately the same gain.

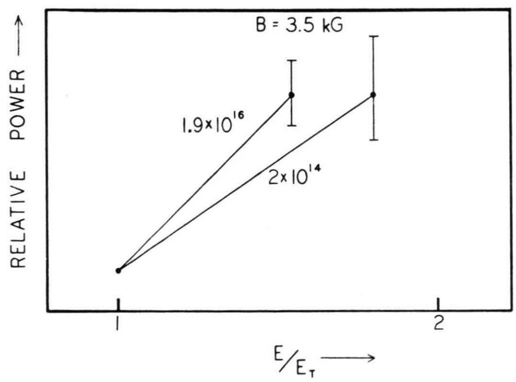

Fig. 2. Power gain for different concentration samples.

Tin was diffused into the contact area of some samples ($n=2.5\times10^{14}\,\mathrm{cm}^{-3}$) to a depth of 30 μ to form n+ diffused contacts. The threshold for microwave emission was determined as the diffused layer was etched away in stages by dilute CP4. For low etch times, in which very little of the contact is removed, the threshold is similar to that observed for the highest concentration samples used above. For longer etch times (70 sec) the threshold increased and approached that observed for samples of the lowest concentration, i. e. the concentration of the bulk material.

Several mechanisms have been advanced as explanations of the microwave emission. Effects in the contact region are frequently mentioned and the data reported here tend to confirm this. The results of the contact studies would indicate that the emission is beginning in the high concentration contact regions at a lower threshold than the bulk, so that the emission is dominant in the contact region. We do not feel, however, that field constriction near the contact [2], is the key mechanism, particularly since the threshold appears relatively independent of magnetic field at higher carrier concentrations. If field constriction were the cause, samples with n-plus diffused contacts would be expected to exhibit higher, rather than lower, emission thresholds since lower electric field gradients would result at the contacts.

[2] A. H. THOMPSON and G. S. KINO, Noise Emission from InSb, IBM Journal 13, 616 [1969].