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$Ga_xIn_{1-x}Sb$ GUNN DIODES

K. Segawa, M. Otsubo, H. Miki, K. Shirahata and K. Fujibayashi*
Central Research Laboratory, Manufacturing Development Laboratory*,
Mitsubishi Electric Corporation. Mizuhara, Itami, Hygo, Japan.

A new material having a lower threshold field than GaAs is desired for a ultra-high-speed functional device using Gunn effect. The several authors[1-3] pointed out that it was possible to grow n-type $Ga_xIn_{1-x}Sb$ with a low carrier concentration, and that Gunn effect was observed in the composition range, covering the greater part of the theoretical one.[4] Systematic experimental data on microwave generation by $Ga_xIn_{1-x}Sb$ Gunn diodes were not reported except for a example (x = 0.4).[5]

This paper is a report on microwave generation by $Ga_{0.82}In_{0.18}Sb$ Gunn diodes.

Bulk diodes are prepared from single crystal ($n = 1.0 \times 10^{16} cm^{-3}$, $\mu = 7270$ cm^2/vs, at 300 K) grown on undoped (100) GaSb substrate by a conventional liquid phase epitaxial technique. The wafer is thinned to about 80 μm, after the substrate was lapped away. Tin layers containing 0.9 wt.% Te are vacuum coated on both faces and finally contacts are alloyed in hydrogen atmosphere at about 300 ℃ for 3 min. Crystals are then cleaved in small pellets (150 x 150 microns in cross sections), which are mounted in usual microwave packages.

The devices operate only in pulsed mode with 350 ns duration at a repetition rate of 340 Hz. The circuit consists of a coaxial tunable cavity with 2 or 3 slugs that could be varied in length, impedance and position. The bias voltage and current were detected with each probe.

Figure 1 shows typical I-V characteristics of $Ga_{0.82}In_{0.18}Sb$ at room temperature. Most of the samples showed the current drop at about 4 - 5 V (threshold field, E_T: 500 - 630 V/cm), and subsequent transition to the high bias voltage state, as was designated by broken lines in fig. 1. Then the further increase of bias voltage makes the increase of current, which sometimes exceeds the value of threshold current.

Figure 2 shows the spectrum of a pulsed oscillation with 1.9 GHz center frequency.

Maximum efficiency and peak output power of diodes are summarized in table 1. The data are obtained at biasing field of twice to three times threshold field. The highest values of maximum efficiency and peak output power are 8.7 % and 950 mW at 1.9 GHz, respectively.

Far more strict investigation of circuit conditions and process of diode fabrication would make the improvement in efficiency.

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References

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Table 1. Oscillation performance of $Ga_{0.82}In_{0.18}Sb$ Gunn diodes.

Sample No.	Frequency (GHz)	Peak output (mW)	Maximum efficiency (%)
1105-3-31	3.2	300	3.5
32	2.0	310	5.4
35	1.7	740	7.2
41	1.9	950	8.7
54	3.0	430	5.2

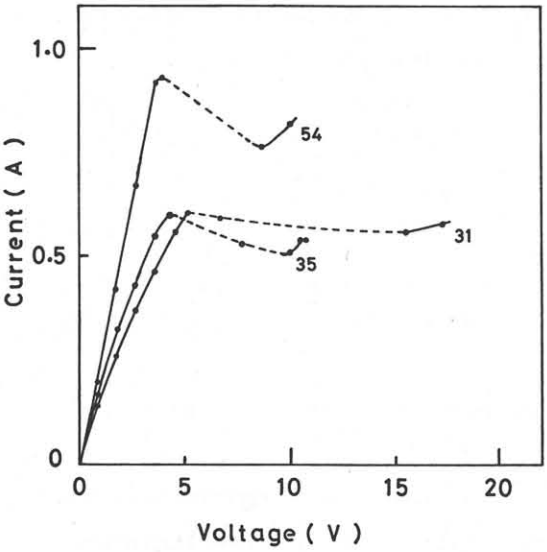

Fig. 1. I-V characteristics of $Ga_{0.82}In_{0.18}Sb$ at room temperature.

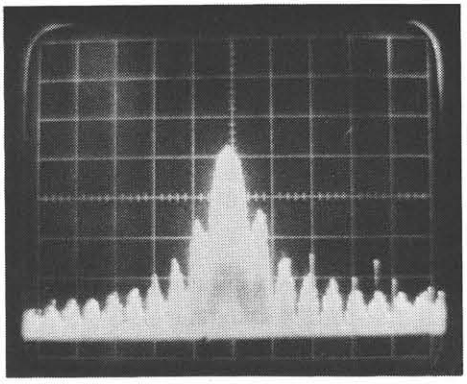

Fig. 2. Spectrum analyzer display. Center frequency: 1.9 GHz. Frequency scale: 5 MHz/div.