was chemically etched in order to obtain a pinch-off voltage of 3·5 V and an I_{DSS} of 35 mA, as can be seen on Fig. 2.

In this example, the transconductance is 12 mA/V, i.e. 60 mA/V/mm. This result can be considered as typical for a doping level of 10^{17} cm^{-3} and a full planar structure with the same gate length.

A voltage shift of 0·5 V is apparent in the characteristics (Fig. 2), due to the knee voltage of the Schottky diode.

Such transistors have also been measured under high drain voltage, and a typical example is given in Fig. 3. It can be seen that, near I_{DSS}, the breakdown voltage is about 25 V and a mean value of 30 V is obtained before irreversible breakdown. This voltage shows an improvement of about 15 V compared with a conventional planar MESFET device.

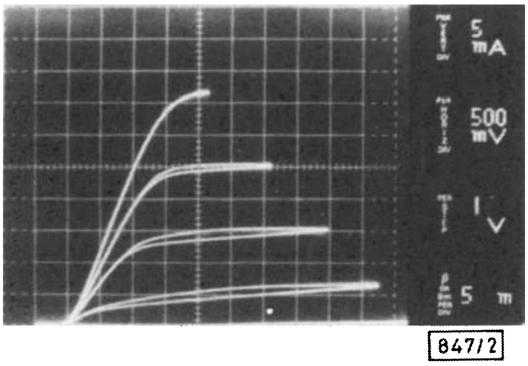

Fig. 2 *I/V characteristics of Schottky drain FET*

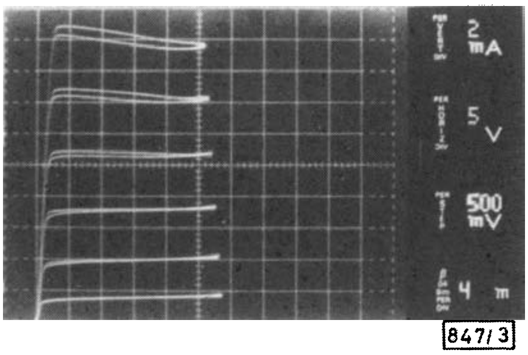

Fig. 3 *I/V characteristics for high drain voltage. First step is −1 V to limit thermal effects*

Near the pinch-off voltage, no excess current is observed until 29 V and irreversible breakdown occurs at 35 V.

Preliminary microwave measurements on such transistors have given a maximum gain of 9 dB and a minimum noise figure of 3·8 dB with 4·5 dB associated gain at 10 GHz.

The power behaviour of this new device has also been tested, with the transistor placed on a standard microstrip structure. We found that the output power increases with V_{DS} until 16 V and then saturates. This saturation is probably due to thermal effects. The maximum power at 1 dB gain compression for $V_{DS} = 16$ V was 50 mW, i.e. 250 mW/mm, with a linear gain of 6·3 dB at 6 GHz.

During the measurements the amplifier was power matched at $V_{DS} = 20$ V, and with high microwave input power levels no particular burn-out problems were observed.

Conclusion: In conclusion, a technology has been developed for the fabrication of GaAs Schottky drain FETs. Initial experimental results have shown this new device to be promising for high breakdown voltages. Further experiments will be carried out to reduce the gate length to improve the microwave performances.

Furthermore, Schottky drain devices with a fully recessed gate structure will be realised in order to increase the device transconductance.

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BURIED HETEROSTRUCTURE AlGaAs LASERS ON SEMI-INSULATING SUBSTRATES

Indexing terms: Semiconductor lasers, Integrated optics

Buried heterostructure (BH) AlGaAs lasers were fabricated on Cr-doped semi-insulating substrates. Low threshold current (8 mA/μm stripe width for cavity length of 300 μm), a high differential quantum efficiency (55%), and stable transverse mode operation were realised.

The integration of semiconductor based optical and electronic devices has gained considerable interest recently. Such integrated circuits would bring a significant simplification in long distance communication systems and also improvement of the high speed modulation characteristics. Semi-insulating (SI) GaAs crystals are the most suitable substrates for such devices wherever GaAlAs lasers are involved. We have recently demonstrated monolithic integration of GaAs-GaAlAs injection lasers with several electronic devices.[1] [3] One of the key factors in these devices is the fabrication of a reliable low threshold current laser. This is important in reducing the heat dissipation of the device which is necessary for long life operation. The beryllium implanted stripe geometry laser,[3] which has been monolithically integrated with a metal-semiconductor field effect transistor, and the transverse junction stripe laser,[4,5] can operate at relatively low current on GaAs SI substrates. Another attractive candidate is the buried heterostructure (BH) laser,[6] fabricated so far on conducting substrates only. In this letter we report on the fabrication of the BH laser on SI GaAs substrate, with characteristics comparable to the conventional BH laser on conducting substrates. The attractive features of this laser include low threshold current (approximately 8 mA/μm stripe width for 300 μm of cavity length), stable transverse mode operation, flat frequency response and linear light/current characteristics.

The cross-section of the device is schematically shown in Fig. 1. The laser is fabricated by two step liquid phase epitaxy. First, a 4 μm n^+-GaAs (2×10^{18} cm^{-3}) layer is grown on a Cr-doped SI GaAs crystal, followed by a growth of three layers: n-Ga$_{0·62}$Al$_{0·38}$As (thickness 1–1·5 μm), undoped Ga$_{0·95}$Al$_{0·05}$As (0·2–0·25 μm) and p-Ga$_{0·62}$Al$_{0·38}$As (1–1·5 μm). The n-GaAs layer serves as the laser cathode and as a buffer layer between the SI substrate and the double heterostructure (the introduction of a buffer layer reduces the amount of defects in the active region of the laser due to defects

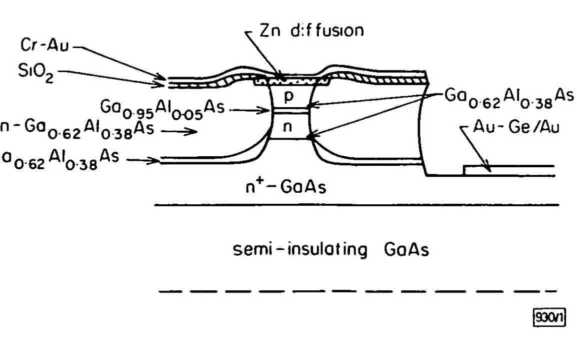

Fig. 1 *Schematic cross-section of buried heterostructure laser on semi-insulating GaAs substrate*

in the substrate). After etching mesa stripes down to the n^+-GaAs layer (stripe width 2-4 μm) with $H_2SO_4:H_2O_2:H_2O$ (1:8:8) in the $\langle 1\bar{1}0 \rangle$ direction (inverted trapezoidal shape), two burying layers are regrown over the wafer: p-$Ga_{0.62}Al_{0.38}As$ and n-$Ga_{0.62}Al_{0.38}As$. The wafer is covered with SiO_2 and after a shallow Zn diffusion into the p-GaAlAs layer on top of the mesa, Cr-Au is evaporated to form the p-contact. Then a second mesa is formed with the same etchant (1:8:8) down to the n^+-GaAs buffer layer, and, using a lift-off technique, the n-contact is formed by evaporation of Au-Ge and Au, followed by alloying. Since both the p and n contacts are on the upper side of the device, the lasers are indium mounted with junction up on a copper heat sink.

The threshold current is approximately 8 mA/μm stripe width for 300 μm cavity length. These values are in agreement with the results reported for BH lasers on conducting substrates.[7] The light/current characteristics are linear up to average power levels of 10 mW, with differential quantum efficiency of 55%. A stable fundamental transverse mode was essentially found in the lasers with stripe width of 2 μm, while higher order modes appear in the wider stripe lasers. These values are somewhat better than those predicted by theory.[7] The far field patterns of two devices are shown in Fig. 2. No significant asymmetry was observed in the light patterns. The series resistance of the devices was 15 Ω compared to 10 Ω for vertical BH lasers (on conductive substrates) but, due to the low operating current, this gives rise only to a small increase in heat dissipation (~ 10%).

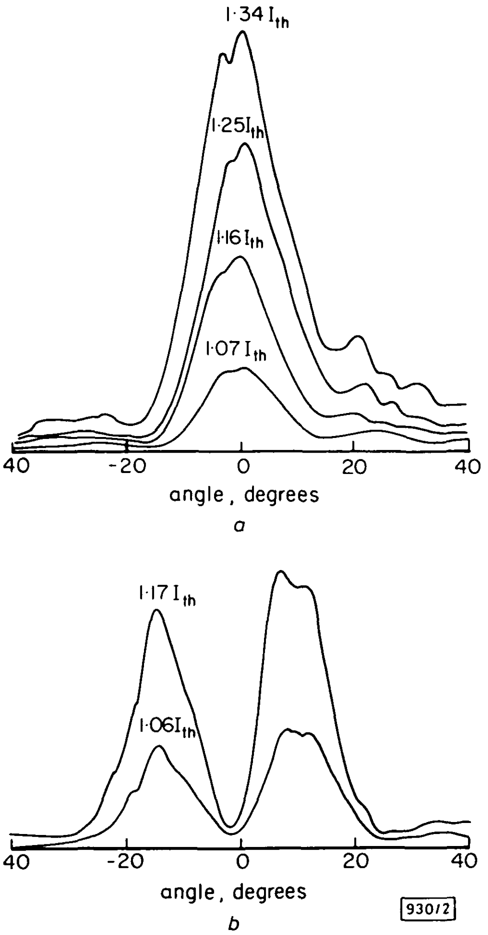

Fig. 2 *Typical far-field patterns of buried heterostructure laser on SI GaAs substrate*

(*a*) 2 μm stripe width
(*b*) 3 μm stripe width
Vertical scale in arbitrary units

The main advantage of fabricating the laser on SI GaAs substrate is that other parts of the substrate can be used for the fabrication of electronic devices, e.g. photodetectors or field effect transistors, which are necessary for optoelectronic circuits like transmitters and repeaters. The low operating currents will lead to a small power dissipation. The realisation of the buried optical guide BH laser[8] on SI substrate can be achieved similarly, thus leading to higher optical powers with only a small increase of the threshold current.

In conclusion, buried heterostructure lasers on semi-insulating GaAs substrate have been fabricated with properties such as low threshold current, stable transverse mode operation and linear light/current characteristics. These characteristics are comparable to those of conventional BH lasers on conductive substrates. These make this laser a potentially important light source for integrated optoelectronic applications.

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DFT PROCESSING OF VARIABLE LENGTH SEQUENCES

Indexing terms: Fast Fourier transforms, Image processing

A method is presented for the frequency domain digital processing of signals of various lengths using a transform processor or program designed for a particular length. The proposed system employs a transform processor based on any algorithm and a shift register with a few feedforward connections. The method is especially useful in digital processing applications that involve two-dimensional signals. It can be applied for the processing of signals using the conventional discrete Fourier transform or number theoretic transforms.

Introduction: Frequency domain techniques are widely used in many digital signal processing applications (e.g. digital filtering). The transform processor required for this purpose is usually designed for a particular length using an efficient algorithm (e.g. a power of 2, using the FFT). The signals to be processed can, however, occur with arbitrary lengths. In this letter an efficient technique is presented for the processing of a signal of arbitrary length using a fixed length transform processor or program. This method offers considerable savings in the memory and computational requirements, especially in the processing of 2-D signals.

Method: 1-D sequences: Consider the frequency domain