

## LD-5-4

### ENHANCEMENT-MODE GaInAs MISFET'S WITH X-BAND OPERATION

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This paper reports a self-aligned gate enhancement-mode GaInAs MISFET which exhibited good DC characteristics and successful X-band operation for the first time.

GaInAs lattice-matched to InP is a very attractive material for high-frequency and high-speed devices, because of its high mobility and high velocity of electrons. Furthermore, GaInAs has favorable MIS interfacial properties, which allowed the formation of n-channel inversion or accumulation layers on p-type<sup>(1) (2)</sup> or n-type<sup>(3) (4)</sup> substrates.

In this work, enhancement-mode MISFET's with channel length of  $\sim 1 \mu\text{m}$  were successfully fabricated on a non-doped n-type ( $n \sim 1.5 \times 10^{16} \text{cm}^{-3}$ ) GaInAs layer, which was VPE grown on an Fe-doped semi-insulating InP substrate.

The MISFET structure is shown in Fig.1. An n-channel accumulation layer is formed at the surface of the GaInAs layer with the thickness  $d_0$  of  $\sim 1500 \text{\AA}$ .<sup>(4)</sup> A CVD  $\text{SiO}_2$  mask for etching the n GaInAs layer to form the channel region was successively used for the gate metallization.<sup>(5)</sup> The gate metal was Al and the gate insulator was  $1000 \text{\AA}$  thick CVD  $\text{SiO}_2$  film grown at  $350^\circ\text{C}$ .

Fabricated MISFET's exhibited good enhancement-mode characteristics. In Fig.2 are shown the current voltage characteristics of a fabricated MISFET measured by a curve tracer. Transconductance was typically  $100 \text{ mS/mm}$ , and the maximum transconductance of  $120 \text{ mS/mm}$  was obtained. This value is about four times higher than that so far reported in enhancement-mode GaInAs MISFET's. The average velocity of electrons in the channel region was estimated to be greater than  $2.5 \times 10^7 \text{ cm/s}$ .

Microwave performance was evaluated at the frequency of 4-12 GHz. Fig.3 shows drain-voltage dependence of maximum power gain at 4 GHz. A high power gain of 13.5 dB was obtained. The MISFET exhibited a successful X-band operation for the first time. A 5.6 dB gain was obtained at 12 GHz. The frequency dependence of power gain gave the extrapolated cut-off frequency of 24 GHz.

These characteristics described above demonstrate that enhancement-mode GaInAs MISFET's are very promising for use in high-speed and high-frequency applications.

This work is partly supported by the Ministry of International Trade and Industry of Japan.

#### References

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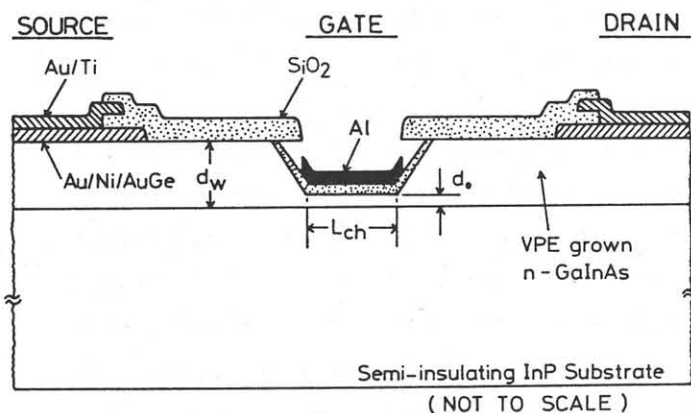


Fig.1. MISFET structure.

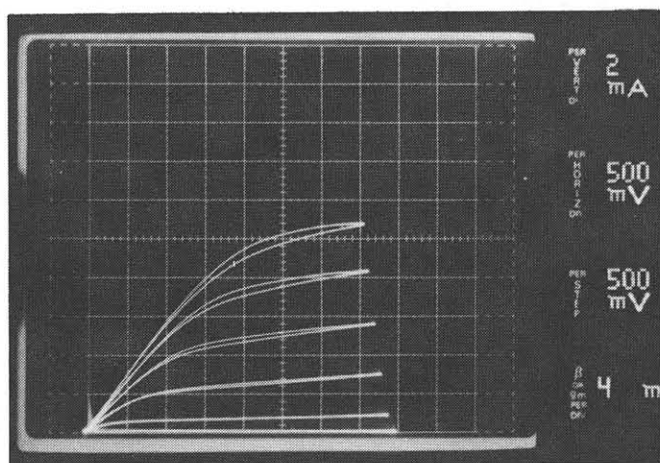


Fig.2. Current-voltage characteristics.

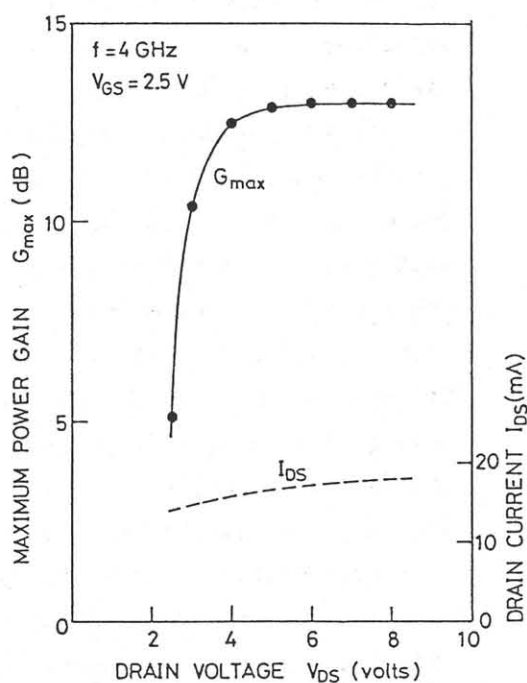


Fig.3. Drain voltage dependence of maximum power gain at 4 GHz.