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 CONTRACTOR: Rockwell International/MRDC
 CONTRACT NO.: N00173-80-C-0485 CONTRACT AMOUNT: \$350,000
 EFFECTIVE DATE OF CONTRACT: 09/18/80
 EXPIRATION DATE OF CONTRACT: 11/17/81
 PRINCIPAL INVESTIGATOR: P. D. Dapkus
 TELEPHONE NO.: 805/498-4545
 SHORT TITLE OF WORK: Integrated Optical Transmitter and Receiver
 REPORTING PERIOD: 09/01/81 through 09/18/81

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A. DESCRIPTION OF PROGRESS:

1. Integrated Electronic Driver Development - -

Of the three start-up lots (2 wafers each) for the integrated electronic driver processing initiated last month, the first lot was completed. This included sulphur implanted/diffused planar TELD's and Si implanted FET's.

Sulphur doped TELD's were initiated as an alternative to achieving deep channels ($\sim 1 \mu\text{m}$ thick with carrier concentrations, $n \sim 5 \times 10^{16} \text{ cm}^{-3}$) by an implant/deep diffusion combination rather than using strictly deep implants with Si^{++} , since the latter approach was creating unexpected inherent ion-implantation problems. These included long turn-around times due to high dosages, high voltages required for Gunn device channel implants, and the low beam current, high voltage arcing problems associated with deep Si^{++} implants. The C-V implant profile for the first sulphur-diffused structures yielded $n \sim 10^{16}$ and a broad tail to $\sim 0.5 \mu\text{m}$. The TELD, as expected, did not show any DC current drops, since the product $nd < 10^{12} \text{ cm}^{-2}$. Some Gunn devices exhibited low MHz frequency oscillations indicative of trapping states, perhaps due to native centers such as EL2 associated with semi-insulating GaAs. For implants $n < 10^{16} \text{ cm}^{-3}$ into undoped semi-insulating GaAs, the Fermi level position may leave these native states unoccupied and promote field-assisted trapping. For the Gunn and FET channel dopings, we expect to use $n \sim 5 \times 10^{16} \text{ cm}^{-3}$,

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where such trapping effects into native centers would be eliminated. Further work remains in calibrating the sulphur-diffused channels for Gunn devices to obtain $n > 5 \times 10^{16} \text{ cm}^{-3}$ and diffusion depths $\sim 1 \mu\text{m}$.

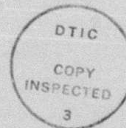
The Si implanted FET's had low electrical implant activation (high channel resistances) and poor contact resistance. Also, low yield in $1 \mu\text{m}$ Schottky gate metallizations was encountered, due to leaky Schottky barriers and shorted gates. It is expected that as experience is gained in the details of processing techniques, standard FET device performance should be reproduced.

Work continued on the high-speed transmitter packaging. The initial design is based on the GaAs IC and CCD techniques of using high frequency flat pack carriers in which the transmitter chips will be bonded, then inserted into a 50Ω microstrip package to facilitate quick, high-frequency measurement turn-around times. The GaAs IC group has demonstrated high-frequency tests using this packaging up to 2 GHz. The microwave package designed for the transmitter testing is very similar to the IC group's with slight modifications to facilitate laser light output using a fiber-optic pigtail or light pipe. For transmitter demonstrations up to 4 GHz, a modified package is being designed.

2. Laser Development

Further laser development await the servicing of the GaAlAs/GaAs MOCVD reactor (see section D).

During this period, work focused on continued high-speed measurements of narrow-diffused stripe laser structures grown by MOCVD, to be implemented into the integrated transmitter structure. The measurement technique for the high-frequency modulation utilized a comb frequency-generator (step recovery diode) to provide very short electrical pulses at a constant rate (100 MHz or 1 GHz). Figure 1 shows the electrical pulse generated at 100 MHz. The pulse width (P/2) is 170 psec. With 1 W input power at 100 MHz, the output pulse height is nearly 30 V into 50 ohms. The ringing is characteristic of an unmatched termination, with a period of 400 psec.



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This pulsed signal from the comb generator is attenuated by 10 to 30 dB and capacitively coupled to the laser. The d-c bias is fed through an inductive line or a high-impedance connection. Since the laser diode represents a low impedance to the pulsed input, the coupling efficiency of the electrical signal is poor. No current/light measurements can be made because of the unknown current. The optical signal changes with increasing bias are shown in Figure 2.

To avoid burning out the laser, the pulse power input was reduced each time the bias was increased. The ringing in Fig. 2(c) is due to relaxation oscillations in the laser cavity, rather than to electrical ringing. The unbiased pulse shows a slight secondary pulse, which is probably due to the electronic circuit. A similar noise appears in all of the laser pulse measurements made.

These measurements were made with an MOCVD-diffused stripe laser mounted on a 50-ohm microstrip line. The laser was operated both biased and unbiased, but the best pulse response was obtained with the laser unbiased. Figure 3 shows the pulse response with a pulse width of 220 psec. No relaxation oscillations were observed with these lasers as the bias current was increased. These lasers could be used at digital bit rates > 2 Gb/s without pattern effect interference.

B. CHANGE IN KEY PERSONNEL

No change.

C. SUMMARY OF SUBSTANTIVE INFORMATION DERIVED FROM SPECIAL EVENTS:

Nothing to report.

D. PROBLEMS ENCOUNTERED AND/OR ANTICIPATED

Work continued on isolating causes for growth control problems encountered last month on the GaAlAs/GaAs MOCVD system. These include inability to accurately tune the properties of the GaAlAs layer. The system is due for an overhaul to remove build up of contaminants in the flow lines and sources. Work has commenced on servicing the critical system components.



E. ACTION REQUIRED BY GOVERNMENT:

None.

F. FISCAL STATUS:

- (1) Amount currently provided on contract: \$350,000
- (2) Expenditures and commitments to date: 323,484
- (3) Funds required to complete work: 26,516

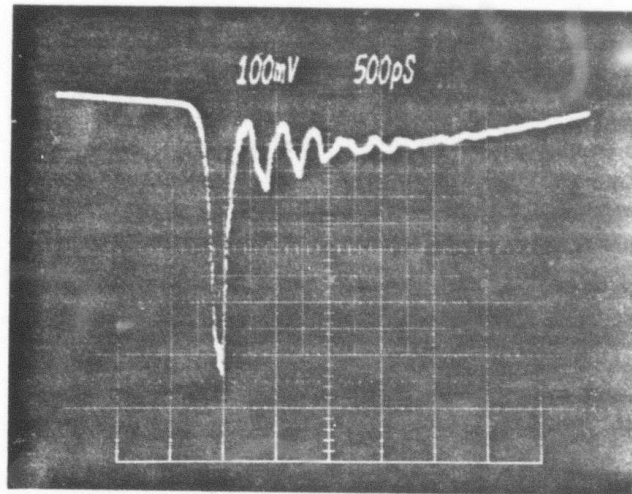
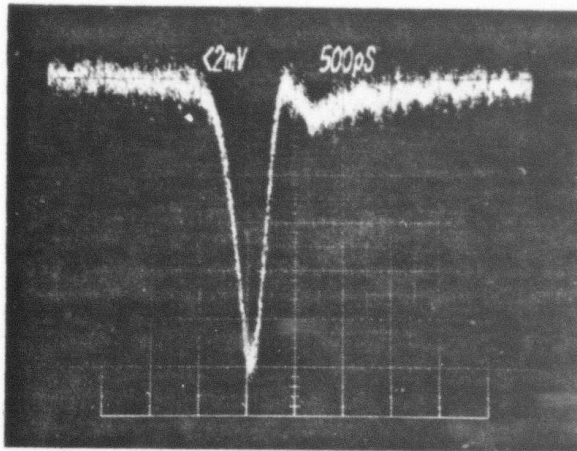
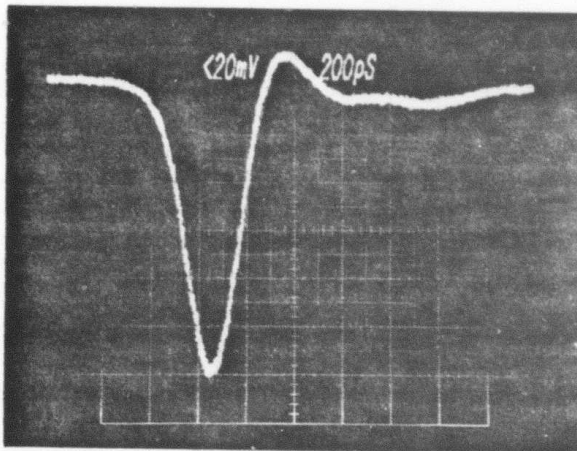


Figure 1. Electrical pulse generated at 100 MHz



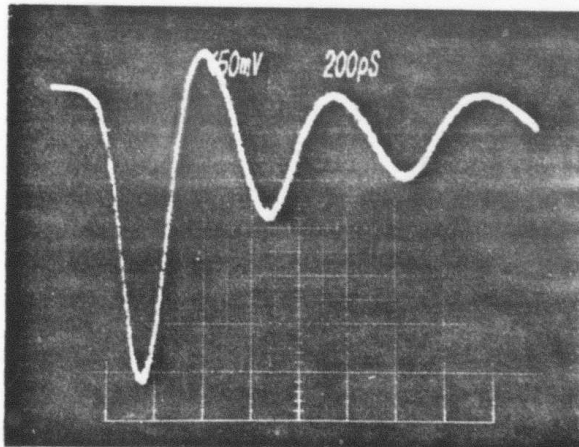
(a)

Zero Bias
10-V Pulse Input
380-psec Pulse Width (P/2)



(b)

Bias $I/I_{th} = 0.9$ (72 mA)
1-V Pulse Input
240-psec Pulse Width (P/2)



(c)

Bias $I/I_{th} = 1.1$ (90 mA)
0.5-V Pulse Input
200-psec Pulse Width with
1.9-GHz Ringing Due to
Relaxation Oscillation

Figure 2 Optical signal changes with increasing bias

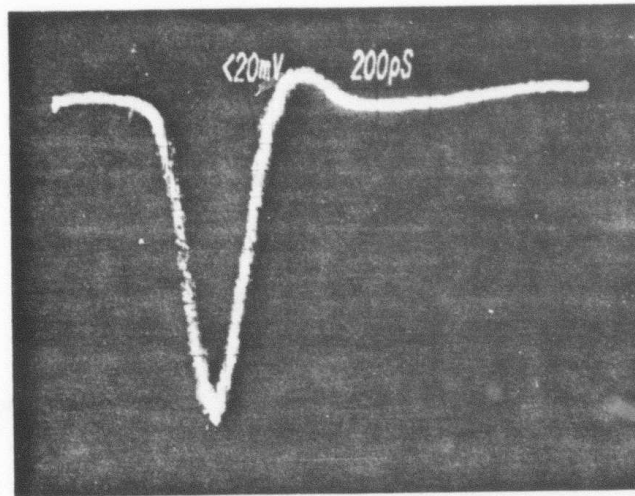


Figure 3. Pulse response of MO-CVD-grown Zn diffused striped laser