Extended Abstracts of the 22nd (1990 International) Conference on Solid State Devices and Materials, Sendai, 1990, pp. 1179-1180 **LN-D-15**

Monolithic Integration of a Lateral Current Injection Laser and a JFET Based on the Same Modulation Doped Structure

Y. Honda+, I. Suemune, and M. Yamanishi

Faculty of Engineering, Hiroshima University, Higashihiroshima, 724 Japan.

We have proposed a new type of laser with selectively-doped heterostructure lateral current injection (SDH-LCI) for optoelectronic integration[1]. The advantages of this laser are summarized as follows: (1) Structural compatibility with electronic devices employing two-dimensional electron gas (2DEG). (2) The fabrication process is simple. Only etching to form the ridge and metallization for ohmic contacts on the surface complete the process. Regrowth and diffusion processes are not necessary[2)3)]. In this paper, we demonstrate for the first time the monolithic integration of a modulation-doped (MOD) LCI laser and a JFET employing 2DEG. The static and modulation properties of this monolithically integrated device were studied.

Figure 1 shows the schematic structure of the monolithic integration of the MOD-LCI ridge waveguide laser and the JFET. The equivalent circuit of this structure is shown in the inset of Fig. 1. The layered structure was grown on a semi-insulating GaAs substrate by MBE. The main points of this structure are summarized as follows: (1) A 150Å GaAs quantum well was adopted for the active layer of the laser and for the channel of the JFET. (2) The optical guiding layer of AlGaAs consists of a 30Å-thick undoped spacer layer to increase the electron mobility, and a 'nin' structure to obtain the FET operation utilizing the 2DEG and to have large enough optical confinement. (3) A 20Å thick GaAs layer on top of the upper n-AlGaAs guiding layer was inserted for n-type ohmic contact to prevent the oxidation. In Fig. 1 , one ridge structure was used for a stripe of the MOD-LCI laser and the other for the pn junction gate of the FET. The stripe widths are about 3μm. The space from the n electrode to the ridge structure is about 1.5 μm. The cleaved cavity length is 630 μm.

The fundamental characteristics of this device under the CW operation at room temperature are summarized as follows. The threshold current of this laser is 22.5mA. The electron mobility and sheet electron concentration of 2DEG accumulated in the i-GaAs layer is $4100 cm^2/Vs$ and $1.76 \times 10^{12} cm^{-2}$, respectively. The tranceconductance g_m is still low at present, 6.3mS (10mS/mm), but the dark current of the FET remains the low value of 5nA at V_{gs}=-7V. Figure 2 shows the gate voltage control of the laser current and the light output. Figure 3 shows the waveforms of the input gate voltage and the optical output of this device. The gate voltage was modulated in rectangular-wave at the repetition frequency of 50MHz. The ON/OFF ratio of the light intensity was about 9. An outer resistance (506Ω) used for the control of the laser's bias current in the present experiment is not essential and will be eliminated by the further reduction of the laser threshold current with the reduced stripe width.

This is the first demonstration of the monolithic integration of LD and JFET which have the same device structure.

+ On leave from Matsusita Electric Works Ltd., Kadoma, Osaka, 571 Japan

References

1) N. Yasuhira et al., Appl. Phys. Lett. 56, 1391 (1990)
2) K. Shimoyama et al., Japan. J. Appl. Phys. 27, L2417 (1988)
3) O. Wada et al ., IEEE Photonics Technol. Lett. 1, 16 (1989)

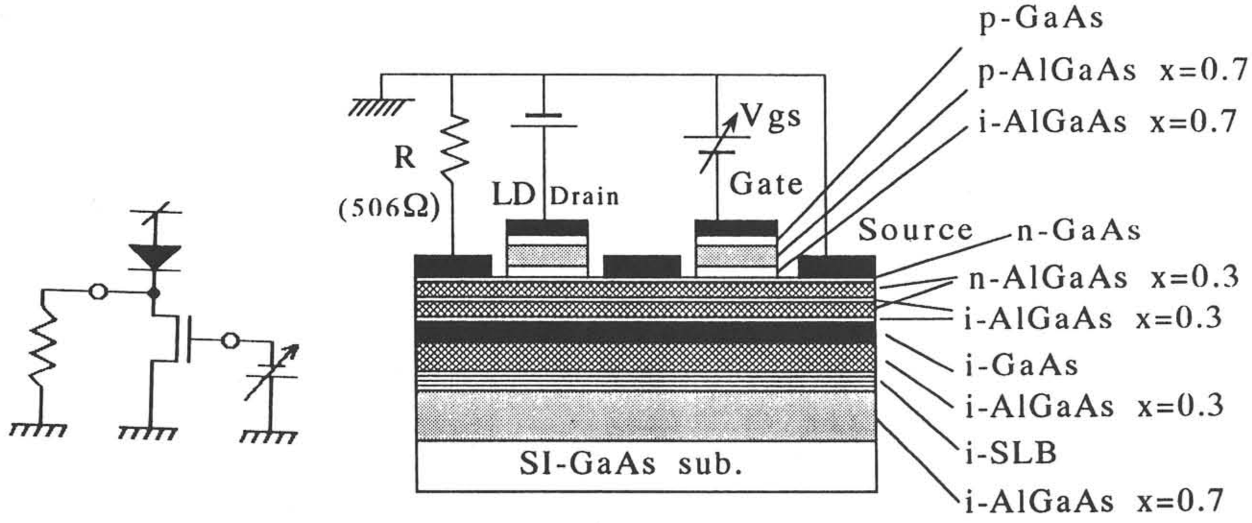

Fig. 1. Schematic cross-sectional view of monolithic integration of LCI laser with JFET used in the experiments.

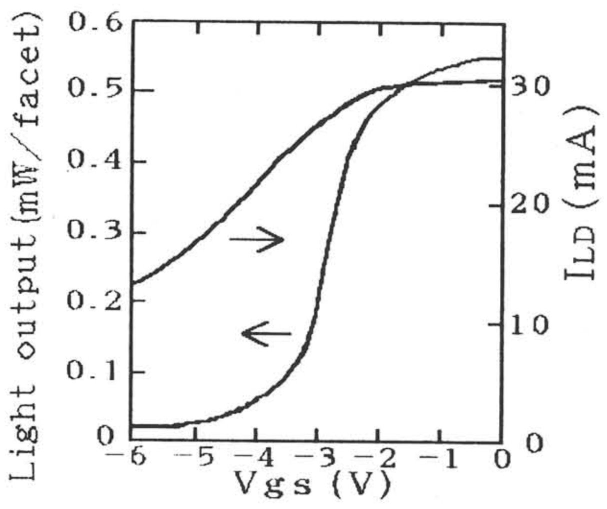

Fig. 2. Laser current versus gate voltage characteristic and light output versus gate voltage characteristic under the CW operation at room temperature.

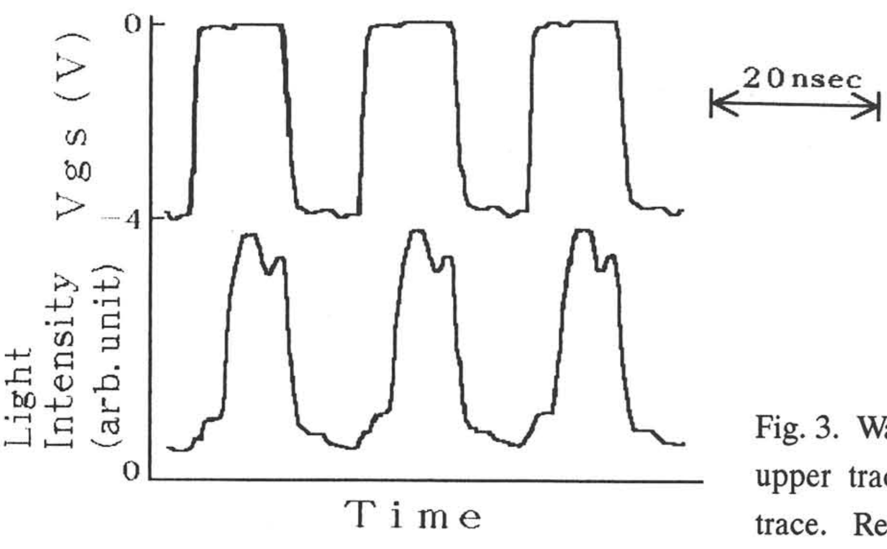

Fig. 3. Waveforms of input gate voltage upper trace and laser output lower trace. Repetition frequency is 50MHz.