B—3—6 MONOLITHIC INTEGRATED DEVICE FOR LIGHT AMPLIFICATION

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The object of this paper is to describe the fabrication technology and some characteristics of a semiconductor device for light amplification[1-3] which is considered to be an indispensable device for information processes in opto-electronics. The device structure is shown in Fig. 1 where an InGaAsP/InP heterojunction phototransistor (HPT) and a double heterojunction (DH) laser diode (LD) or a DH light-emitting diode (LED) are monolithically integrated on (100)-oriented n^+-InP substrate. The layers of InP and InGaAsP were grown on the substrate by a conventional slider-boat LPE technique.

At first, a discrete HPT (n-InP/p-InGaAsP) was fabricated and examined. A high-current and high-gain HPT is required to drive the DHLD or DHLED integrated on the substrate, so that it is of particular importance to precisely control the doping concentration and the width of p-type InGaAsP base region. The use of Cd as a p-type dopant for the quaternary base region in place of Zn allowed us to fabricate the excellent HPT whose characteristics are shown in Fig. 2. The collector current as high as 170mA was achieved with the incident optical power of 155μW and the bias voltage of 2V. The corresponding optical gain was about 1200 which is the highest one ever reported in InP/InGaAsP HPT's.

Then, the monolithic integrated device for light amplification, shown in Fig. 3, was fabricated under the growth conditions for the excellent HPT's. The light amplification

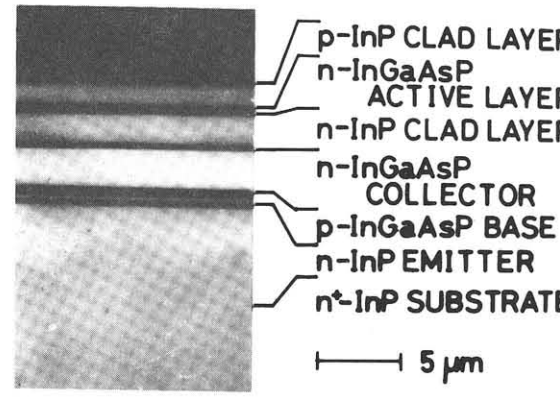

Fig. 1 Cleaved cross section of the monolithic integrated device fabricated by a LPE technique.

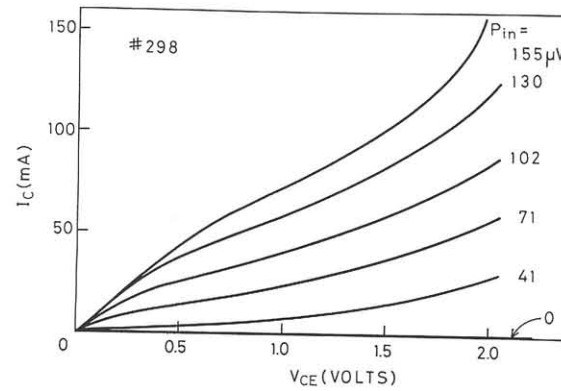

Fig. 2 Common-emitter current-voltage characteristics of an HPT with Cd-doped quaternary alloy base region.

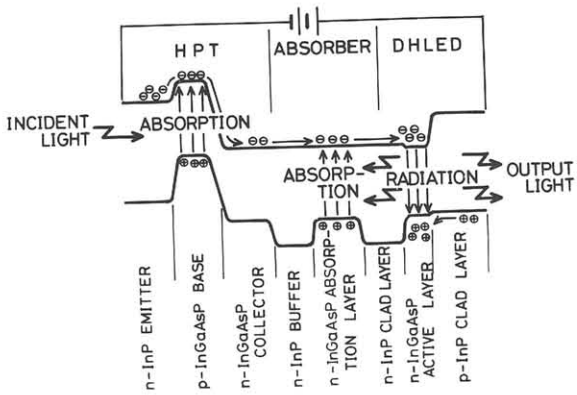

Fig. 3 Schematic illustration of the monolithic integrated device for light amplification.

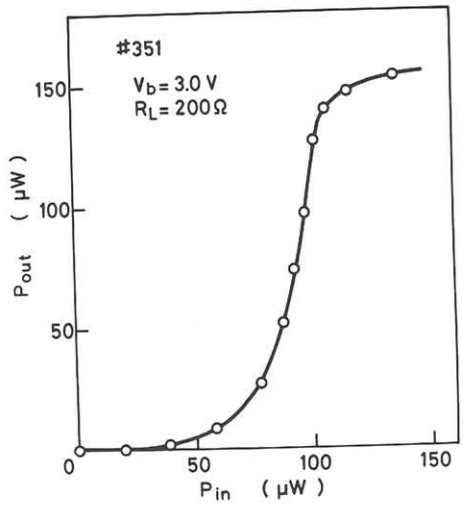

Fig. 4 Light amplification characteristics of the monolithic device.

characteristics are shown in Fig. 4 where a positive gain (>1) and a differential power gain of about 6 were achieved. In this device, in addition to the multi-layer structure shown in Fig. 1, an additional quaternary InGaAsP layer with a smaller band gap than that of the active layer of the DHLED was inserted between the collector layer and the confining layer in order to suppress or absorb the optical feedback from the DHLED to the HPT. Further, by controlling the feedback in the monolithic device without the absorber as well as by selecting a load resistance, we were able to obtain the optical switching or bistable characteristics, as shown in Fig. 5, which are greatly attractive to an optical signal process.

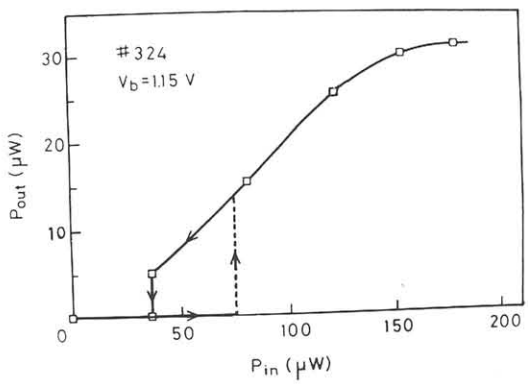

Fig. 5 Relationship between incident optical power (P_{in}) and output optical power (P_{out}) in the monolithic device with high optical feedback.

References :

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