Taper Line Distributed Photodetector

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Summary: Velocity Match Distributed Photodetector (VMDP) attracts lots of attention due to their high electrical bandwidth and high saturation power [1]. However in VMPD structure, in order to absorb the reverse traveling microwave, additional dummy load and D.C. blocking capacitance in the input end are needed, which will sacrifice one half of the quantum efficiency and the low frequency part in the response. Taper line structure is one of the ways that can solve the reverse wave problem in distributed amplifier circuit [2]. The most challenge in the design of this structure is high impedance line in the first taper section. In this paper, we propose a novel type of distributed photodetector: "Taper Line Distributed Photodetector (TLDP)". The top view of proposed device and the cross sectional diagram of its active region is shown in figure 1 (a) and 1 (b) respectively. We adopt the low temperature grown GaAs (LTG-GaAs) based self-align metal-semiconductor-metal traveling wave photodetector structure (MSM TWPD) as the active photo-absorption region in each taper section for its high speed and high efficiency characteristics [3] (Fig. 1(b)). The fabricated device can be transferred to glass substrate, which has low dielectric constant and the capacitance of interconnect line can be reduced significantly. Thus, without huge radiation loss, high impedance line in first taper section can be achieved easily by this method [4]. The velocity match between optical wave and microwave in VMPD is replaced by phase match in each taper section of this novel structure, which can avoid the difficulty in the design of velocity match high impedance line. As shown in figure 1 (a), the routing interconnects CPW line is due to higher speed of microwave than optical wave. Different air gap in each taper section represented different characteristics impedance which is 200Ω, 100Ω, 66.67Ω, and 50Ω respectively. The simulated frequency response is shown in figure in 2, which shows a 400GHz bandwidth. We calculate the net 3-dB bandwidth by multiplying each frequency response of bandwidth limiting factor, as shown in different traces of figure 2. Trace A, B, C, D, E represents carrier-trapping time of LTG-GaAs (250fs) and cut-off frequency of each self-aligned MSM TWPD, Bragg cut-off frequency in synthetic transmission line [5], dispersion of microwave loss and the net frequency response, respectively. We neglect the effect of phase/velocity mismatch between microwave and optical wave in bandwidth calculation due to the careful design in the length of both kinds of

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waveguide. The detail simulation and newest measurement results of fabricated device will be presented in the conference.

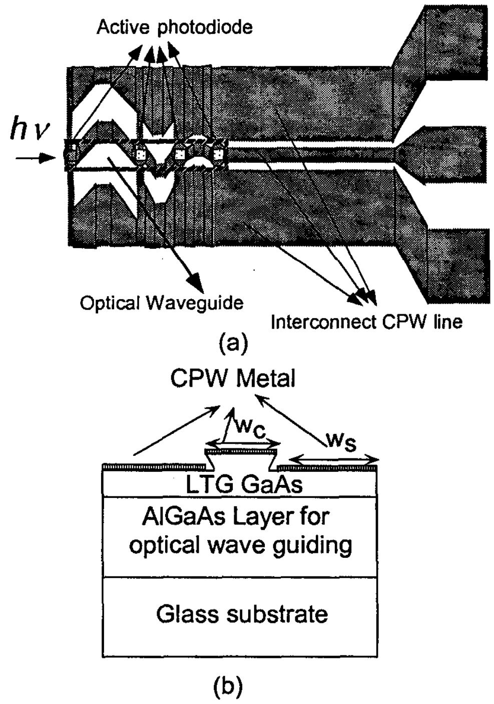

Figure 1 (a) (b). Top view (a) and cross-sectional diagram (b) of proposed TLDP, and its active region, respectively.

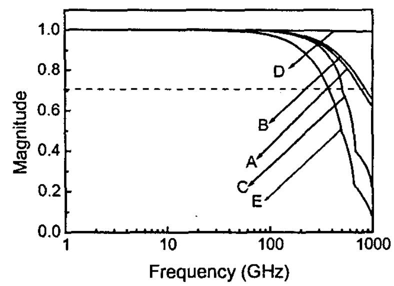

Figure 2. The simulated frequency responses of TLDP. Each trace represents different bandwidth limiting factor

Reference:

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