A Novel Parellelly-fed Traveling Wave Photodetector with Integrated MMI Power Splitter

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1. Introduction

High-power, high-speed photodetectors are the key components for analog fiber-optic links to provide large bandwidth, reduce RF insertion loss, and increase spurious free dynamic range and signal-to-noise ratio [1]. The performance of analog fiber optic links is limited by the maximum linear photocurrent of the photodetector [2]. Conventional high-speed detectors have small absorption volume and therefore cannot achieve high saturation power. Velocity Matched Distributed Photodectors have shown excellent potential for high-speed high saturation current performance [3-4]. In these serially-fed VMDP's, the maximum linear photocurrent is often limited by the heat induced damage of the first detector of the chain [5].

We propose a solution to this problem through a parallely-fed distributed detection scheme with an integrated power splitter as shown in Fig. 1. In addition, we expect improved linearity of the device due to the fact that the maximum power seen by any single diode is reduced. Velocity

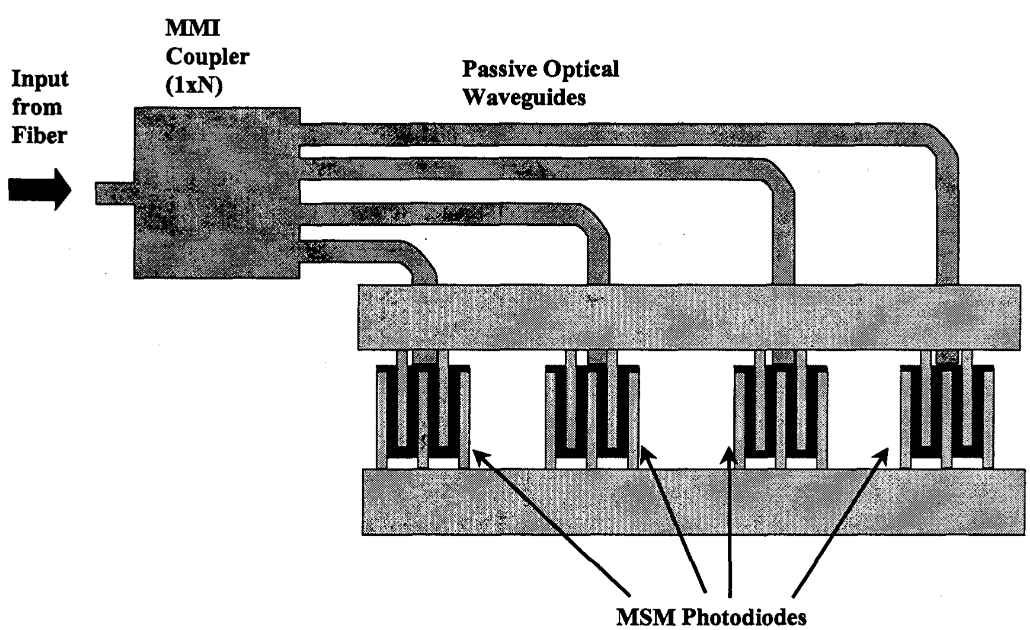

Fig. 1. Schematic of the Parallelly fed integrated MMI-VMDP.

Matching of discrete photodiodes with parallel optical feed has previously been demonstrated [6]. In this paper, we present a monolithically integrated scheme with the power splitter and detector fabricated on the same InP substrate. We chose a Multimode Interference (MMI) power splitter [7] because of its ease of fabrication, low losses and high fabrication tolerances compared to a Mach-Zender or Y-branch based splitter. The improvement in the saturation current scales in direct proportion to the number of output branches of the splitter.

2. Fabrication

The individual detectors are Metal Semiconductor Metal type detectors with a Schottky barrier enhancement layer of 660 Å. The absorbing region is InGaAs and the waveguide core and cladding layers are made of the InAlGaAs system. The core width is 0.5μm and the absorption region is 0.15μm wide.

The MMI waveguide was etched using a wet etching process. The waveguides are 0.4μm deep and the input and output waveguides of the MMI splitter are 6μm wide. The power splitting ratio is 1:8, with the splitter being 80μm wide and 1.805 mm long. The multimode section supports 51 modes. 2000 Å of Silicon Nitride was used for passivating the device. The Schottky Metal contact was made by evaporating 200 Å, 300 Å and 2000 Å of Titanium, Platinum and Gold respectively. The finger spacing was 1μm and the finger width was 1μm. The device was designed for optimum performance at a wavelength of 1.55μm. Fig. 2 shows the photograph of a fabricated device.

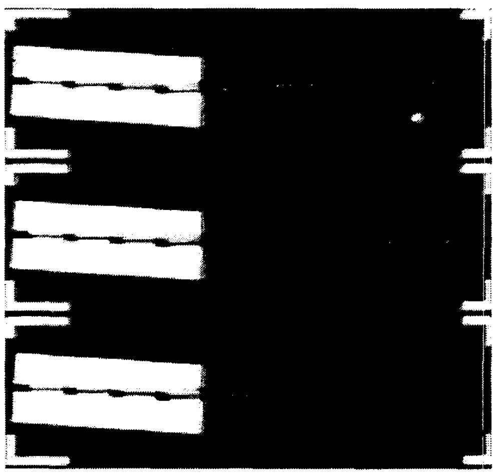

Fig. 2. Photograph of fabricated devices.

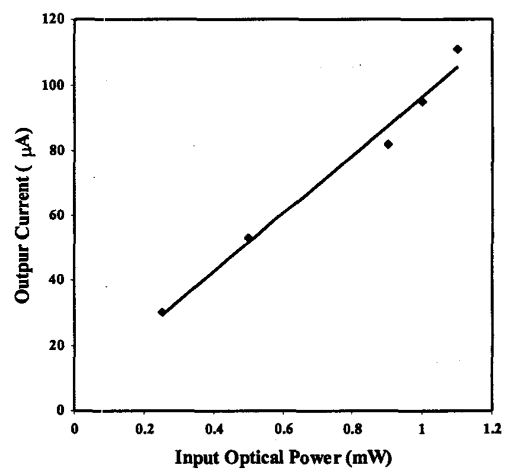

Fig. 3. Resposivity measurement at 1V bias.

3. Measurement

The photoresponse of the device was measured using a Photonetics tunable external cavity semiconductor laser and a HP4145B. The devices show a responsivity of .095 A/W. The responsivity curve of the device is shown in Fig. 3. The device has a bandwidth of 7.2 GHz (Fig. 4) at a bias voltage of 5V and a DC current of 2mA, when measured with a frequency sweep using a HP8510C Network Analyzer and a HP83420A Lightwave test set. The dark current of the device was measured to be 4μA at 5V . The breakdown voltage of the device is about 7V.

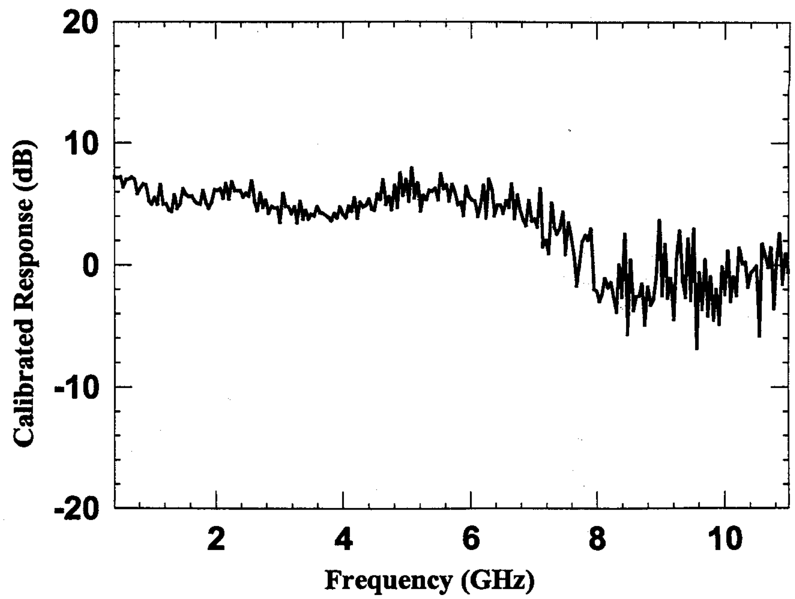

Fig. 4. Bandwidth measurement of the MMI-VMDP at a bias voltage of 5V and a DC current of 2mA.

4. Discussion

The saturation current was measured to be 3mA. This limit is from the EDFA output saturation and not from the device itself. The device had a lower efficiency in the wavelength range of the EDFA used in the saturation power measurement (the device had highest efficiency at 1.57μm due to processing variations) which caused the EDFA output to saturate before the device limit could be reached.

The low responsivity of the device is mainly due to uneven undercut of the waveguides of the MMI splitter due to H_2O_2 based etchant attacking the Photoresist etchmask. We expect the responsivity of the photodetector to increase with improvement in the processing steps.

5. Conclusion

We have proposed a novel parallelly-fed Distributed Photodetector with an integrated MMI power splitter. Successful operation of the devices has been demonstrated. Optimization of the fabrication process would definitely improve the efficiency of the device and enable testing to the maximum photocurrent limits.

5. References

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