

Millimeter wave operation of optical modulator using electro-optic polymer containing donor-electron enhanced FTC-based chromophore

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Abstract Electro Optic (EO) polymer modulators containing Donor-electron enhanced FTC-based chromophore were fabricated and evaluated. Phase modulators with 10 mm interaction length exhibited a wide bandwidth of 60GHz and a small half-wavelength voltage of 5.5 V. Mach-Zehnder (MZ) intensity modulators were also fabricated.

Keywords optical modulator, electro-optic polymer,

1. Introduction

EO polymer devices have been researched and developed actively in optical communications and electromagnetic sensing applications. Donor-electron enhanced FTC-based chromophore with large molecular hyper-polarizability is a promising material for high performance EO devices [1]. This paper reports developments of optical modulators using an EO polymer containing the chromophore.

2. Phase Modulator

Phase modulators of a normal structure with a reversed ridge waveguide and a microstrip line (MSL) electrode were fabricated [2]. Optical waveguides were formed by spin-coating and dry etching. Electrodes were formed by plating. A side-chain EO polymer and sol-gel derived silica films were used for a core layer and clad layers, respectively. Applied field and temperature of the following poling process were about 100 V/μm and 80 °C, respectively. To feed signal to the modulator die, connecting pads were formed in top surface as shown in the lower-left inset of Fig.1.

In this study, modulator dies were evaluated using micro-lensed fibers and GSG probes at the wavelength of 1550 nm. The right inset in Fig.1 shows optical spectrum modulated at 67 GHz. The first- and second-order sidebands were generated on both sides of the optical carrier. A -6dB electrical bandwidth and a half-wavelength voltage at 10 GHz of the modulator with 10 mm interaction length were 60 GHz and 5.5 V, respectively. The drive voltage will be reduced by optimizing the polling condition.

3. Mach-Zehnder Intensity Modulator

MZ intensity modulators which have Y-branch waveguides or directional couplers were also fabricated using same process. Evaluations of devices are on-going. The devices showed bandwidths of 60 GHz same as the phase modulator.

Fig.2 shows an opened eye- pattern of 10 Gbps NRZ signal.

4. Conclusion

EO polymer modulators using donor-electron enhanced FTC-based chromophore were fabricated and evaluated. With a wide bandwidth and a small half-wavelength voltage, these devices are ideally suitable for millimeter-wave photonic applications.

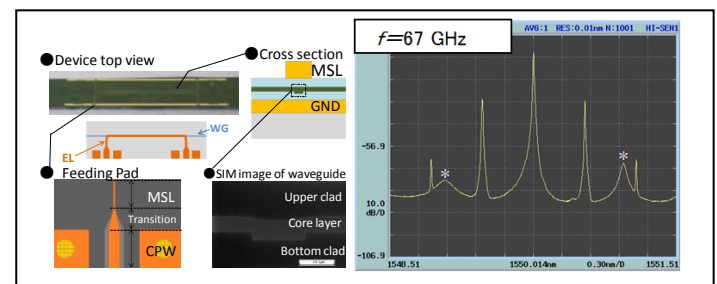


Fig. 1 Schematic Structure of Developed Phase Modulator and Optical Spectrum of Modulated Light. The peaks marked with "*" arise from the light source.

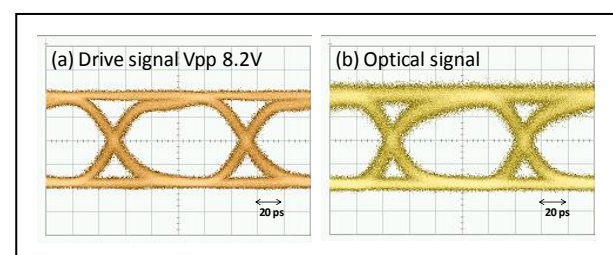


Fig. 2 10 Gbps NRZ Eye-pattern MZ modulator die (a) drive signal (b) optical signal

Acknowledgments

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References

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