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20 Gbps operation of the electro-absorption modulator in the COBRA generic integration platform

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Introduction: In recent years the generic InP photonic integration has drawn much attention as it allows for simplified, cost-reduced access to the state of the art photonic integrated circuit technology with integrated lasers, amplifiers and the most efficient electro-optic processes. In the COBRA integration platform [1], special attention is devoted to the design of the new building blocks, as they introduce increased functionality.

Electro-absorption modulators (EAMs) are attractive for high bandwidth optical communication systems due to their short length, an order of magnitude lower than phase modulators, and their high extinction ratio. Their integration with DFB lasers has been demonstrated and they are currently deployed in short reach data links [3]. However there has been little research into combining EAMs with the passive components required for more complex higher-performance integrated circuits.

In the present work we describe the development of an EAM designed for the COBRA platform. The device has been designed to have a small footprint, fabricated and characterized for high speed operation. This is our first demonstration of such a structure and our goal is to make it suitable for use in high speed transmitters.

Device characteristics: The electro-absorption modulator active region consists of quantum wells (QWs), with a bandgap wavelength around 1550 nm and exploits confined Stark effect when the QW region is reversely biased. The bandwidth of the device is influenced by the design of the transmission line for microwave, whose design is illustrated in Figure 1 (a) and gives an insight into the dynamic performance of the modulator.

The length of the modulator under test is 200 μm, which presents a good compromise between small footprint and high extinction ratio for a given optical overlap. For characterization, a tunable external laser source was used with variable detuning from the modulator's bandgap, in order to obtain the highest extinction ratio, see Figure 1 (b). The insertion loss from the external laser to the power meter at zero bias voltage is 9 dB, and includes in and out fiber-to-chip coupling, waveguide loss and the insertion loss of the modulator itself.

The use of the generic active layer stack for the modulator section leads to its high operation voltage. However, high extinction ratio of 16 dB has been achieved for –6 V bias voltage, which allowed us to obtain the open eye for high speeds.

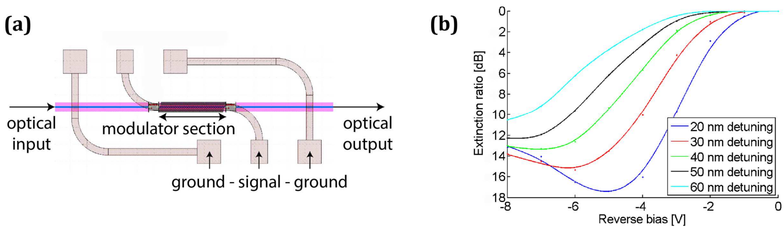

Fig. 64. (a) Top view of the designed transmission line. (b) Extinction ratio for a 200 µm long EAM and different detuning wavelengths.

Results: Dynamic, large signal modulation experiments have been performed to obtain the E/O bandwidth of the device. The optimal DC bias point for the chosen detuning wavelength is −3 V, taken from Figure 1 (b). Non-return-to-zero modulation has been used with PRBS sequence 2^7-1. An amplifier is used for the microwave signal, in order to reach ~5 V swing voltage. These values are chosen to obtain the maximum eye opening. The measured 3 dB bandwidth of the EAM is ~13.5 GHz, see Figure 2 (a), which allowed us to get an open eye up to 20 Gbps, see Figure 2 (b). The measured dynamic extinction ratio from a DC coupled receiver is around 7.7 dB.

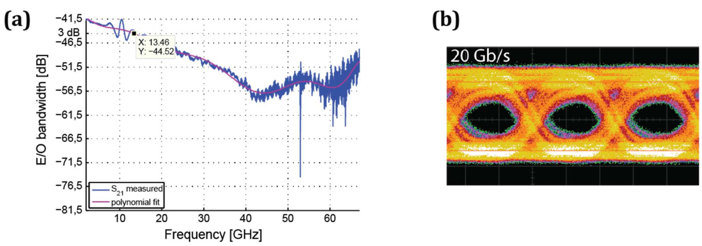

Fig. 2. (a) E/O bandwidth of the 200 µm long EAM. (b) Optical eye diagram at 20 Gbps.

Conclusion: An electro-absorption modulator in the COBRA generic integration platform has been designed, fabricated and characterized for the first time. A static extinction ratio of 16 dB is demonstrated for a 200 µm long structure. Opened eye under 20 Gbps non-return-to-zero modulation is obtained. The device's integration with passive structures and its small footprint makes it suitable for complex and densely packed circuits in the generic photonic integration platform.

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References

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