EAM modulated DBR laser array for TWDM-PON applications

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Abstract

4 channel DBR laser arrays are fabricated for use in optical line terminals of TWDM-PON systems. These combine 1.4Q InGaAsP material in the DBR with EAMs using the identical active layer design. A tuning range ~10 nm and extinction ratio of >27 dB are measured.

Introduction

To meet the rapid bandwidth growth of optical access networks, 10 Gb/s PON systems, including XG-PON and 10G EPON, have been standardized and are ready for large scale deployment in the near future. In the longer term, TWDM-PON, which can provide 40 Gb/s capacity, has been selected by the FSAN (Full Service Access Network) community as a key solution for broadband PON systems delivering higher speed [1]. In the TWDM-PON system, the use of wavelength tunable transmitters in the optical line terminal (OLT) leads to enhanced network performance, including an incremental upgrade of the total bandwidth and flexible load balancing [2, 3]. In this paper we report a monolithically integrated EAM modulated 4 channel DBR laser array for use in OLTs of future TWDM-PON systems.

Device structure and fabrication

An optical micrograph of a fabricated four channel DBR laser array is shown in Figure 1. Each of the DBR lasers in the chip consists of a 250 µm long rear DBR section, a 100 µm long phase matching section, a 300 µm long gain section, a 50 µm long front DBR, a 300 µm long SOA section and a 150 µm long EAM section. An MMI coupler is used to combine the light from different lasers into the output waveguide. The device is fabricated by a three step MOCVD process described in detail in [4]. A 400 nm thick 1.4Q InGaAsP layer is butt-jointed to form the waveguide core of the combiner, the DBR and the phase matching sections. In contrast to the device reported in reference [5] which uses 1.25Q InGaAsP as the passive waveguide core, the use of longer bandgap wavelength 1.4Q InGaAsP in the DBR section can enlarge the wavelength tuning range of the DBR lasers [4]. The light from each laser is modulated by an EAM, which has the advantages of compact size when compared with the MZM modulator used in reference [5]. The EAM is integrated into the device by the identical active layer technique [6], which is considerably more straightforward than other approaches such as the SAG technique and the butt-joint technique, helping to increase the yield and lower the cost of the device. The size of the chip is 700×2600 μm^2.

Measurement results

The chip was mounted on a heatsink and measured at room temperature. Figure 2(a) shows the wavelength tuning properties of the device. The emission wavelength is around 1.58 µm, and the wavelength tuning range (for a tuning current of 150 mA) lies between 8.85 nm and 9.93 nm for the DBR lasers in the array. The tuning range is similar to the 9 nm tuning range of the DBR lasers reported in reference [5], and is noticeably smaller than those of DBR lasers which also have 1.4Q InGaAsP as the DBR material (13.8 nm) [4]. In the present fabrication procedure, the waveguide is formed by dry etching and is trapezoidal in shape, which lowers the wavelength tuning efficiency of DBR current. By adopting a reverse mesa ridge waveguide structure [4], the tuning range can be enlarged effectively. Figure 2(b) shows typical spectra obtained from one channel of the device, all having a SMSR larger than 38 dB.

The static extinction curves of the integrated EAM are shown in Figure 3(a). During the measurements, the currents injected to the gain and SOA sections were both 200 mA and the extinction ratio (ER) was measured using light coupled into a single mode fiber. The EAM provides an ER of 27–31 dB over the wavelength range 1586 to 1578 nm at 4.5 V reverse voltage. A 50 GHz network analyzer was used for the measurements of the small signal frequency response of the EAM. As shown in Figure 3(b), the measured 3 dB frequency bandwidths are around 8 GHz, which is sufficient for modulation beyond 10 Gb/s. The bandwidth can be further increased by fabricating polymer spacers under the electric pads of the EAMs.

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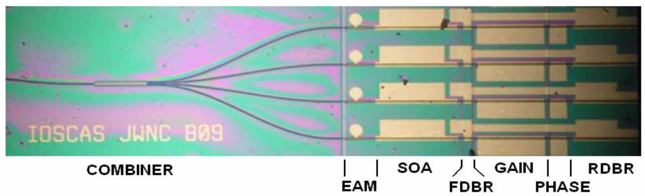

Fig. 1. Optical micrograph of a fabricated four channel DBR laser array

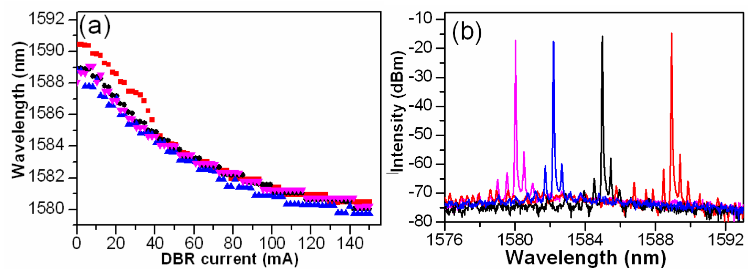

Fig 2. Wavelength tuning properties of the device and typical laser spectra

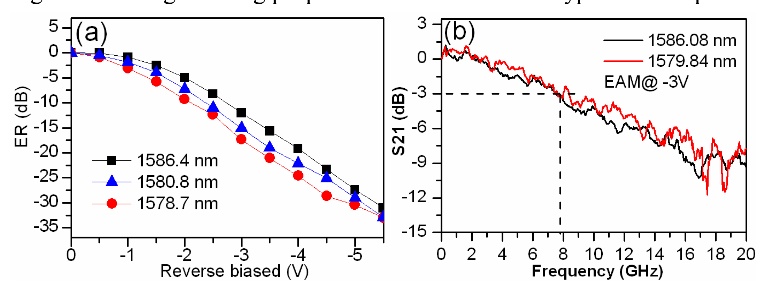

Fig 3. Static extinction ratio and small signal frequency response of the EAM

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