Cost Effective VCSEL Array Based 80-Gb/s TOSA for NG-PON2

Eun-Gu Lee, Sil-Gu Mun, Sang Soo Lee, Jong Hyun Lee and Jyung Chan Lee
Electronics and Telecommunications Research Institute (ETRI)
218 Gajeong-ro, Yuseong-gu, Daejeon, 305-700, Korea, eungulee@etri.re.kr

***Abstract*— The 8×10 Gb/s TOSA based on a VCSEL array was successfully developed for NG-PON2 application. For the cost effectiveness, direct optical coupling without lens array was used to package the TOSA. We have found that an optical and electrical crosstalk was small enough not to effect on a transmission performance.**

Keywords—NG-PON2, WDM, VCSEL array, TOSA

I. INTRODUCTION

Rapid growth of wired and wireless data traffic, emergence of high capacity video contents and wide spread of smart-phone demand a larger traffic capacity of transmission system such as broadband optical access networks [1,2]. With the growth of the traffic capacity, data rate of optical access network is also steadily increased as 10 times per 10 years [3]. World widely deployed EPON and GPON utilizing time division multiplexing passive optical network (TDM-PON) method are developed into a 10GE-PON and a XG-PON via standard organization of IEEE and ITU-T, respectively[4,5]. As a result, downstream data rate of access network is evolved from 1G to 10G.

Since 2010, ITU-T is discussing NG-PON2 standard, for over 40G traffic capacity of downstream, through FSAN [6]. TWDM-PON and PtP WDM based on a tunable laser at subscriber side are among the standard subjects [7]. These two types of optical links utilize wavelength division multiplexing technique. To adapt WDM technique to access network, cost effectiveness is of primary importance. Single package using arrayed light source with a TEC will save not only foot print but also manufacturing cost.

In this work, we present 80-Gb/s TOSA based on a VCSEL array for NG-PON2 application at optical line terminal (OLT). To obtain more price competitiveness, we have eliminated lens array in optical coupling and used aligner instead of laser welder. Low operation current of VCSEL gives advantage of low power consumption.

II. PACKAGE OF VCSEL ARRAY BASED TOSA

The 4-channel VCSEL array based optical block is the key component of the TOSA . It is composed of FPCB, laser diode driver (LDD), CuW, Spacer, and VCSEL array as shown to left of . FPCB was used to change emitting direction of light from the VCSEL array to be orthogonal to the cross-section of wavelength multiplexer. This allows the TOSA package to fit within the CFP transceiver case.

To reduce the cost, we have utilized direct optical coupling technique without lens array. However, the multiplexer could not be physically contacted with the VCSEL array due to a wiring for current injection. To avoid a contact of the wire and the cross-section of multiplexer, we inserted a glass block as a spacer between CuW and multiplexer. The spacer maintained distance of 40 ~ 50 μm from VCSEL array to wavelength multiplexer, resulting in coupling efficiency of ~ 3 dB.

The back reflection at the cross-section of multiplexer caused the degradation of modulation performance. The reflection was reduced by an AR coating of 25~30 dB.

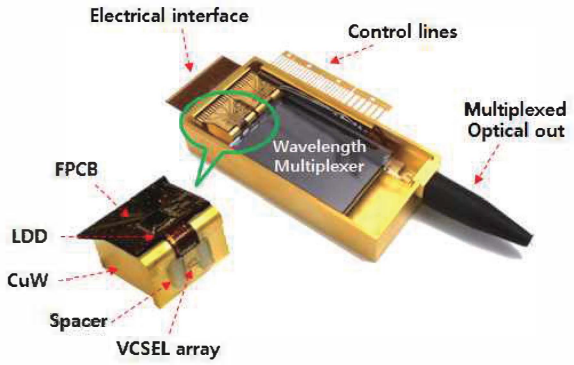

Fig. 1. Inset of packaged 80G TOSA (right) using 4ch VCSEL array based optical block (left)

A bandwidth from the electrical interface, outside of a case, to VCSEL array electrode is hardly affected by a wire length for connected point of each component. To guarantee a high electrical bandwidth, the wire length of each point was minimized by compactly integrating components as shown to right of Fig. 1. Furthermore, straight line path was used at electrical interface to avoid unwanted signal reflection [8].

III. RESULT & DISCUSSION

Electrical and/or optical crosstalk should be effectively suppressed in the integration of arrayed optical device. In the TOSA, electrical crosstalk was reduced by a ground plane between electrical signal lines of adjacent channels while the impedance of lines for each channel was kept constant and optical crosstalk was minimized by an AR coating.

Because a crosstalk is strongly depending on the physical distance of the channels [9], the total crosstalk of 2nd and 3rd channel of each optical block are expected to be the maximum. To investigate electrical and optical crosstalk, we

978-1-4799-6507-6/14/$31.00 ©2014 IEEE

have measured BER curve of a single channel (2nd channel) while sequentially turning on the adjacent channels (1st,3rd and 4th). The results show negligible power penalty as shown in . This proves that there was no optical and/or electrical crosstalk effect on the transmission performance.

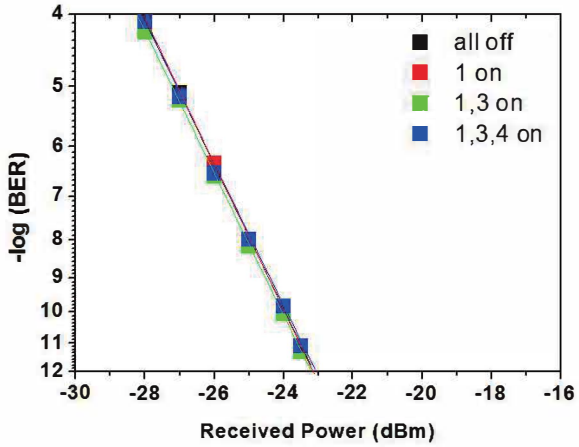

Fig. 2. Electrical and/or optical crosstalk measurement using power penalty with adjacent channels on/off condition.

Fig. 3 shows the spectra from a single TOSA. As shown in , the TOSA contains two optical blocks emitting a different wavelength and each have 4-channel VCSEL array. The 8 VCSELs in a TOSA are controlled by temperature and current to emit 8 different wavelengths with ~ 100 GHz channel spacing. The side mode suppression ratio (SMSR) was over 40 dB for all channels.

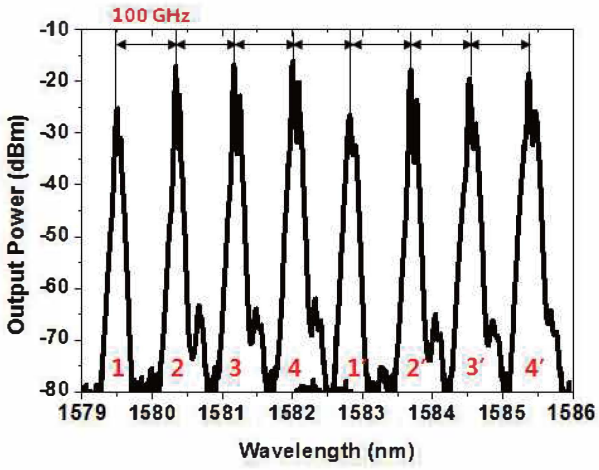

Fig. 3. Wavelength spectra from a VCSEL array based 80-Gb/s TOSA

We have measured BER curves of each of 8 channels from a single TOSA as shown in Fig. 4. Data rate of 10.3125 Gb/s with PRBS pattern length of 2^{31}-1was applied and the signal was transmitted over 40 km of SMF. An EDFA was used for optical signal amplification with dispersion compensation fiber (DCF) for compensating chromatic dispersion. Clearer eye-opening was obtained after 40 km transmission compared with that of back-to-back as shown in the inset of Fig. 4. This result was well matched with negative power penalty of BER curves between before and after transmission.

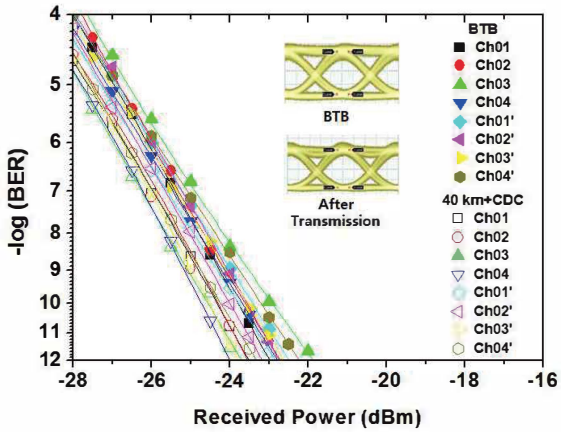

Fig. 4. Transmission performances of 8 channels from VCSEL array based 80-Gb/s TOSA

IV. CONCLUSIONS

We have successfully packaged 80-Gb/s TOSA utilizing two optical blocks based on 4-channel VCSEL array. For cost reduction, we have used a spacer instead of lens array in optical coupling to wavelength multiplexer.

No power penalty was observed by optical and/or electrical crosstalk. All the 100 GHz spaced 8 channels were successfully transmitted for 40-km SMF with data rate of 10.3125 Gb/s and PRBS pattern length of 2^{31}-1.

ACKNOWLEDGEMENT

This research was funded by the MSIP (Ministry of Science, ICT & Future Planning), Korea in the ICT R&D Program 2014.

REFERENCES

[1] A. Teixeira, “FSAN and the prepared path beyond NG-PON2: A system vender view”, Future network and mobile summit 2013, session 3, 2013.

[2] Y. Chun-hui *et al.*, “Research of CPRI protocol based on high-speed fiber link”, ITCS 2010, 336-339, 2010.

[3] J. C. Lee *et al.*, “A core device technology of next-generation optical access networks”, The Optical Society of Korea Winter Annual Meeting 2014, T2E-V2, 2014.

[4] IEEE 802.3av for 10 Gbit/s Ethernet, 09. 2009.

[5] ITU-T G.987.2 for XG-PON, 01. 2010.

[6] WDM PON for NG-PON2 Standardization, ADVA, Ericsson, ETRI, LG-Ericsson, NSN, and ZTE, endorsed by Fujitsu Semiconductor Europe, FTTH council, 2011.

[7] E-G. Lee *et al.*, “16-Channel tunable VCSEL array with 50-GHz channel spacing for TWDM-PON ONUs,” ECOC 2013, Tu.1.F.3, 2013.

[8] Sae-Kyoung Kang *et al.*, “A cost-effective 40-Gb/s ROSA module employing compact TO-CAN package”, ETRIJ., vol. 35, no. 1, 1-6, 2013.

[9] M. W. Maeda *et al.*, “Multigigabit/s operation of 16-wavelength vertical cavity surface-emitting laser array”, IEEE PTL., vol. 3, no. 10, 863-865, 1991.