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Comb generation using Multi Quantum Well (MQW) Passively Mode locked Laser for WDM systems

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ABSTRACT

Multi quantum well Semiconductor mode lock lasers are capable of generating ultra- short pulses in optical domain with extremely high bit rate transmission and generation of millimeter wave signals through mode beating process on high bandwidth photo detector. In this research paper comb generation using MQW passively mode locked laser has been demonstrated for wavelength division multiplexing. Four modes from multimode laser are filtered for this purpose and data streaming of 2.5Gb/s over these four individual channels is also demonstrated.

Keywords: Multi Quantum Well (MQW) Laser, Passive Mode locking, Comb generation, wavelength division multiplexing

1. INTRODUCTION

Semiconductor mode lock lasers are the light sources that can generate ultra- short pulses in optical domain. These lasers have unique features like their compactness, high repetition rates that can be as high as 500GHz and high power conversion efficiency and can generate pulses in femto second range[2[3][5][6].Due to these reasons mode locked laser are of great interest since they can easily be implemented in several applications ranging from high speed optical communication to all optical signal processing including optical sampling and clock recovery[1][6][7]. Moreover these lasers can be used to generate millimeter waves or terahertz waves through mode beating process on high bandwidth photo detector .They are also used for comb generation that can be exploited in wavelength Division Multiplexing WDM) transmission. There has been extensive study of Multi Quantum Well (MQW) semiconductor mode locked lasers for pulse signal generation and comb generation as they exhibit a periodic time variation of their output emission under dc-bias conditions [6][7][9].Passive mode locking can be achieved without any saturable absorber by exploiting nonlinear effects inside laser cavity like four way mixing. High frequency pulses can be generated at 40-GHz or beyond as they do not require any direct or external modulation [5][10].Pulse generation at 40Ghz and 100Ghz has already been demonstrated through these F-P lasers[4][6].The focus of this paper is to exploit above mentioned properties for generation of comb signal that can be used in WDM applications.

II. WDM transmission using comb generation

WDM transmission using comb generation in a passively mode locked based multimode laser has several advantages as compared to single mode lasers. In these lasers the channel spacing is determined by mode spacing of mode lock lasers. Once the mode spacing matches the to the channel spacing, no individual channel frequency control is needed [9]. Only single multimode laser can generate such comb for WDM applications. It is also cost effective and less complex system as now you are replacing N single mode lasers with only one multimode laser .One of the key points of WDM system is to generate error free transmission for WDM channels because each individual mode has level of relative intensity noise(RIN) much greater than that of total power or that of single mode laser[9].As MQW MLL laser has low relative intensity noise ,we successfully propagate 4 WDM channels over 25km of fiber at 2.5Gb/s with channel spacing of 1nm.This laser is cleaved to have length of 420um in order to achieve channel spacing of 100GHz.

III. Setup for 4-channel WDM system

Figure 1 shows schematically the setup for comb generation .The device under test is multi quantum well (MQW) passive mode lock laser that is stabilized on room temperature at 24C.The output power and applied bias current characteristics and voltage vs applied bias current characteristics are shown in figure 2 and figure 3 respectively. Figure 4 shows the optical spectrum of our Multi Quantum Well laser exhibiting four modes that are selected for comb generation. The output of the MQW laser passes through an arrayed waveguide grating (AWG) wavelength multiplexer. The AWG selects four channels with channel spacing of 1nm or 100GHz.After

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AWG, selected lasing modes with power level above -5dbm is amplified using EDFA amplifier. The amplified and filtered signal is modulated by Mach-zander Modulator operating 2.5Gb/s. This NRZ intensity modulated data signal is propagated over 25km long SMF .Figure 6 shows the selected four modes after AWG multiplexer apart 1nm from each other.

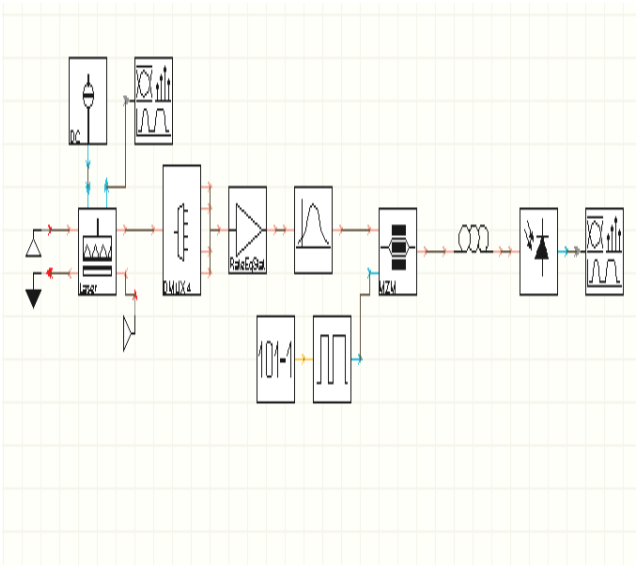

Figure 1: Setup for comb generation

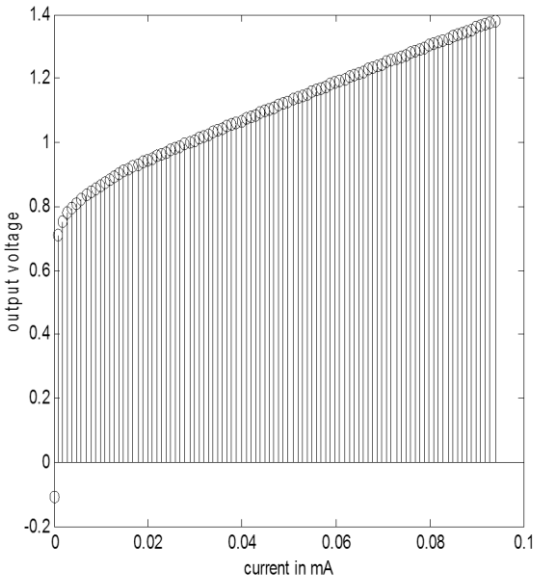

Figure2: Output voltage vs current characterization of MQW laser under test

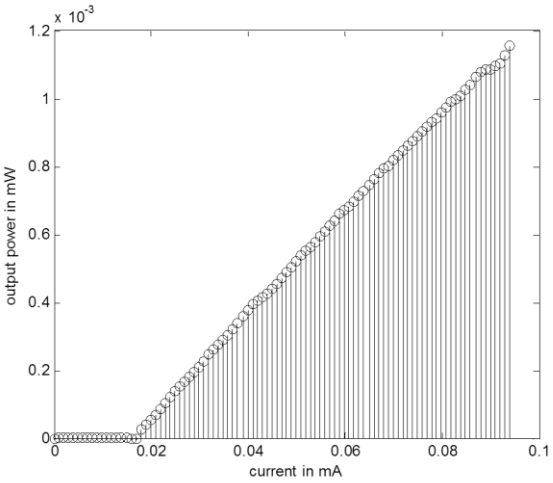

Figure 3: output power vs current characterization

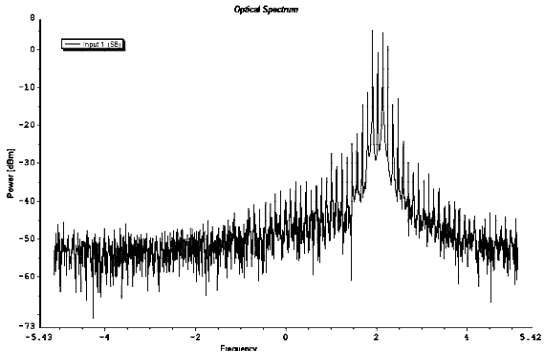

Figure 4: Optical spectrum of MQW laser

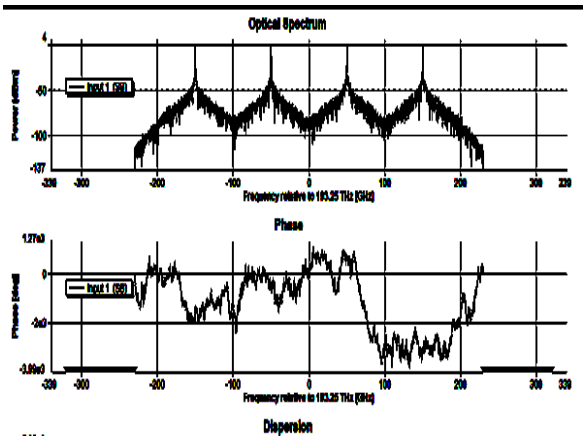

Figure 6: Four filtered modes

Figure 7 shows the output after data modulation on each of four channels. These four WDM channels are propagated over the length of 25km and detected over high speed photo detector that converts the optical signal to electrical one .Figure 8 shows the resultant electrical signal after photo

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detection and transmuting after 25km length of SMF .The difference of power between propagated modes and received modes is around 4 to 5 dB due to losses inside fiber and relative intensity noise of modes itself.

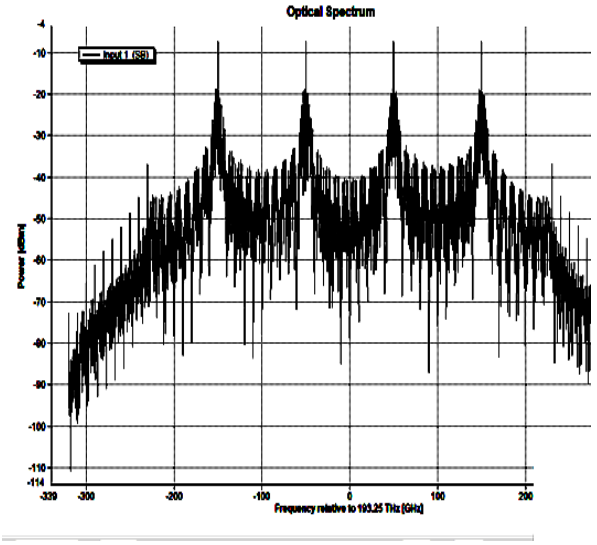

Figure 7:Ouput after MZM modulator

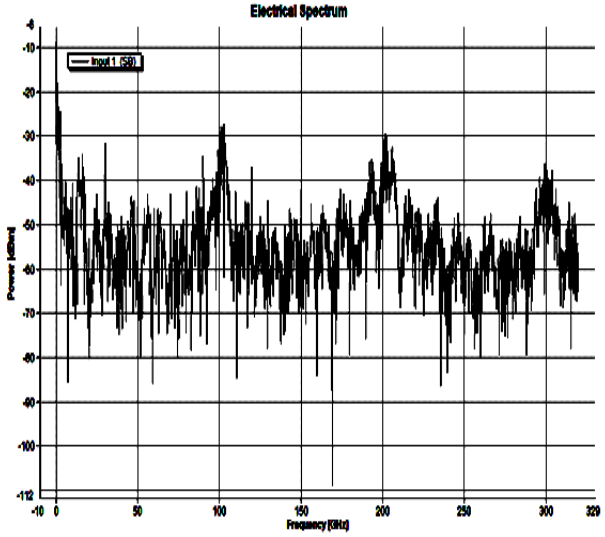

Figure 8: Electrical Signal detected at photo detector

Conclusion

4-channel WDM system is demonstrated and error free transmission over 25km is achieved by using MQW mode lock laser at 1550 nm window. Power penalty of around 3-4 db as compared to use external cavity CW laser is absorbed.

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