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A Novel Flattened Gain RAMAN-Photonic Crystal Quantum Dot Semiconductor Hybrid Optical Amplifier in U Band for Super Dense Wavelength Division Multiplexing System

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For the very first time, effect of RAMAN-PCQDSOA hybrid optical amplifier (HOA) in terms of flattened gain with noise figure has explored in this paper for 400x10 Gb/s super dense wavelength division multiplexing (SD-WDM) optical communication system with channel spacing of 100 GHz. Performance of proposed HOA has also compared with RAMAN-RAMAN, EDFA-EDFA and SOA-SOA HOA in terms of same features. Least variation of .05 dB ever recorded from RAMAN-PCQDSOA HOA for the flattened gain (30.1 dB to 18.22 dB) in the range of U-band from 1625 nm to 1675 nm. Further, proposed HOA has also declared to attain maximum gain of 30.1 dB with noise figure (NF) of -2.5 dB.

Keywords: Gain, Noise Figure, Hybrid Optical Amplifier (HOA), RAMAN, PC-QDSOA

1 Introduction

Revolutionary changes are going to occur in optical communication domain to maintain the high speed for long haul optical communication system. In recent years, the requirement of photonic crystal dielectric material has observed in optical domain due to its uniform characteristics to light confinement.[1] So Quantum Dot Semiconductor Optical Amplifier (PC-QDSOA) is the right candidate for linear amplification for super dense wavelength division multiplexing (SD-WDM) system.[2] The best characteristics of PC-QDSOA are come out in terms of high gain, high temperature stability, least effect of noise figure (NF), good rating output power, and wide gain bandwidth.[3-11]Most importantly, it is capable to amplify the signal capacity more than Tb/s data rate in super dense optical multiplexing system.[12] Controlling of signals transmission are much feasible in slow light transmission than fast light transmission.[13-14] Number of ways have presented in the literature for slow down the light to enhance the flat gain with minor effect of noise figure using photonic crystal waveguide (PCW), optical ring resonators (ORR)and by coupled resonator optical waveguide (CROW)respectively.[15-17] But impact of PCW is much impressive in optical amplifier in terms of reducing dispersion and nonlinearity.[18-22]

In this paper, we have archived good rating flattered gain using RAMAN and PC-QDSOA hybrid optical amplifier (HOA). For the first time, the best of our knowledge, no such work ever done in the literature to control the gain variation with proposed hybrid optical amplifier. Systematic arrangement of the paper is given as, basic introduction of technology followed by explanation of simulation model. Before a final summary of proposed model is made, the simulation results are analyzed.

2 Material and Methods

2.1 Simulation Model

In this paper, we are explored our extended work to achieve the flat gain using different set of optical amplifiers. The simulation model with proposed cascaded RAMAN- PC-QDSOA hybrid optical amplifier is shown in Fig. 1. Transmission of 400 optical signals are done with the rate of 10 Gbps at channel spacing of 100 GHz. Modulated signals are transmitted over DS-anomalous fiber.

A transmitter of 400 channels is arranged in compound component (CC). Each transmitter CC is made up of data source, NRZ electrical drive, Mach-Zehnder modulator and CW laser source. The

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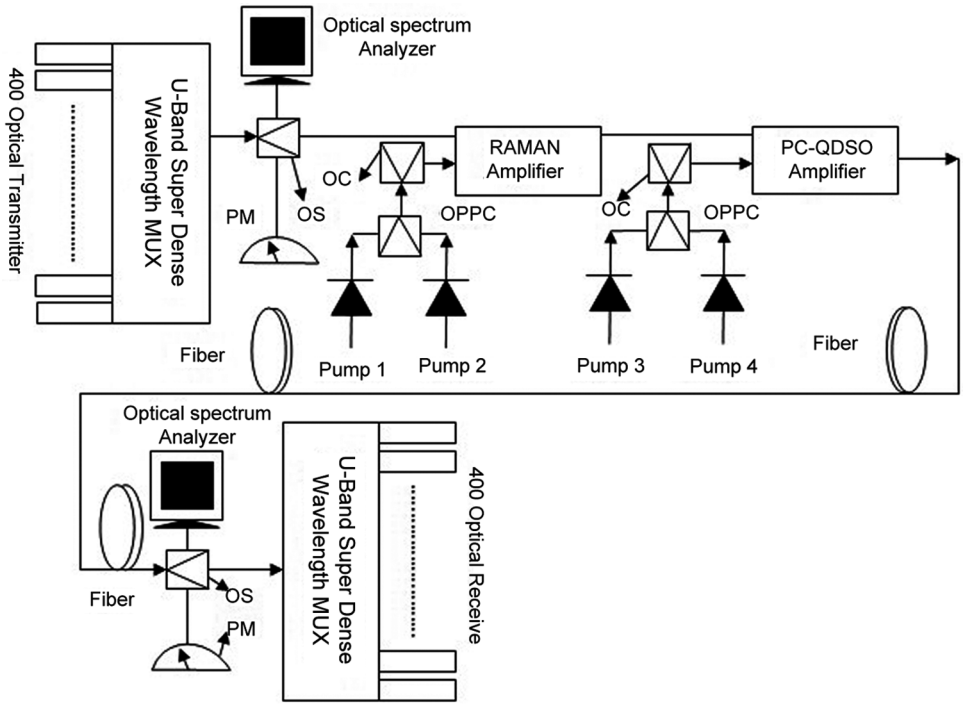

Fig. 1 — Simulation model for RAMAN-Photonic Crystal Quantum Dot Semiconductor Hybrid Optical Amplifier.

modulated signals are fed to different combination of HOA as shown in Fig. 1. The received optical signals are further converted in electrical domain with the help of PIN diode at the receiver side.

PC-QDSOA is activated with electrical dual pumping from pump3 and pump4 and RAMAN is activated optical dual pumping from pump 1 and pump 2 respectively.

3 Results and Discussion

Dual ports SD-WDM analyzer is used for observing the flat gain and noise figure for different combinations of hybrid optical amplifiers. Here, outcome of RAMAN-RAMAN, EDFA-EDFA and SOA-SOA hybrid optical amplifiers arealso observed with the proposed RAMAN-PCQDSOA hybrid amplifier to compare the best performance in U-Band for SD-WDM system in Fig. 2, Fig. 3 and Fig. 4 respectively. Maximum gain (30.1 dB) with noise figure (-2.5 dB) at 1625 nm is recorded among the others HOAs from RAMAN-PCQDSOA HOA. Further, it decreases almost linearly till 1675 nm with least variation of (.05 dB). In this way, we attain the flattened gain from (30.1 dB to 18.22 dB). Minor variations are recorded from 1640 nm to 1655 nm due to slightly effect nonlinearity and crosstalkof hybrid amplifier. This can be settling down by adjusting the input power level.

However recorded values of gain and noise figure for other sets of HOA are given as flattened gain from 25.1dB to 13.22 dB with NF 3.5 dB for RAMAN-RAMAN HOA, flattenedgain from 20.1 dB to 8.22 dB with NF 4.5 dB for EDFA-EDFA, and flattenedgain from 15.1 dB to 7.22 dB with NF 5.5 dB for SOA-SOA HOA respectively. Moreover, the effect of different combinations of HOAs is also evaluated for different range from 1620nm to 1670 nm for U-Band in Fig. 3. And it is observed that the effect of gain and noise figure minutelyaffected which is also acceptable value for optical SD-WDM system.

Further, eye diagrams from different combination of hybrid optical amplifiers are also explored from Fig.4 to Fig.7 to observe the effect of each HOA. Observed values are considered as eye opening .000123 a.u, eye closed 0.11 dB with bit error rate of 1x 10-2 for RAMAN-PCQDSOA, eye opening .00023 a.u, eye closed 0.231 dB with bit error rate of 1x 10-20 for RAMAN-RAMAN, eye opening .000567 a.u, eye closed 0.67 dB with bit error rate of 1x 10-34 for EDFA-EDFA, and eye opening .000456 a.u, eye closed 0.89 dB with bit error rate of 1x 10-45 for SOA-SOA respectively. Furthermore, it is clearly observed that representation RAMAN-PCQDSOA, HOA is most impressive for super dense wavelength division multiplexing optical communication with least

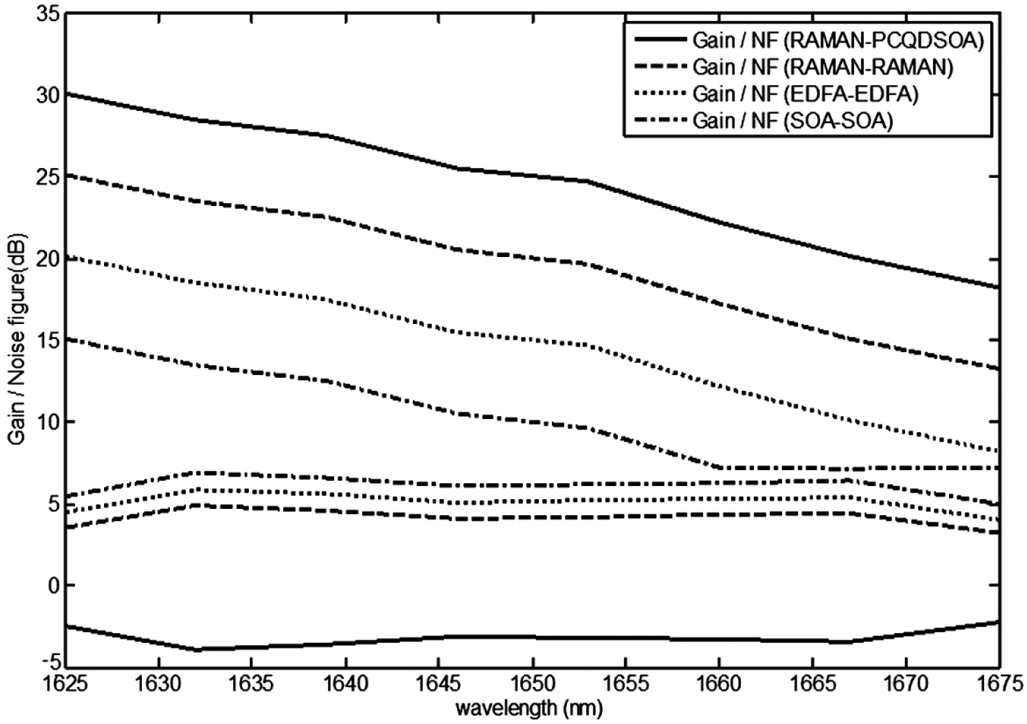

Fig. 2 — Gain and noise figure versus channel wavelength for U-Band.

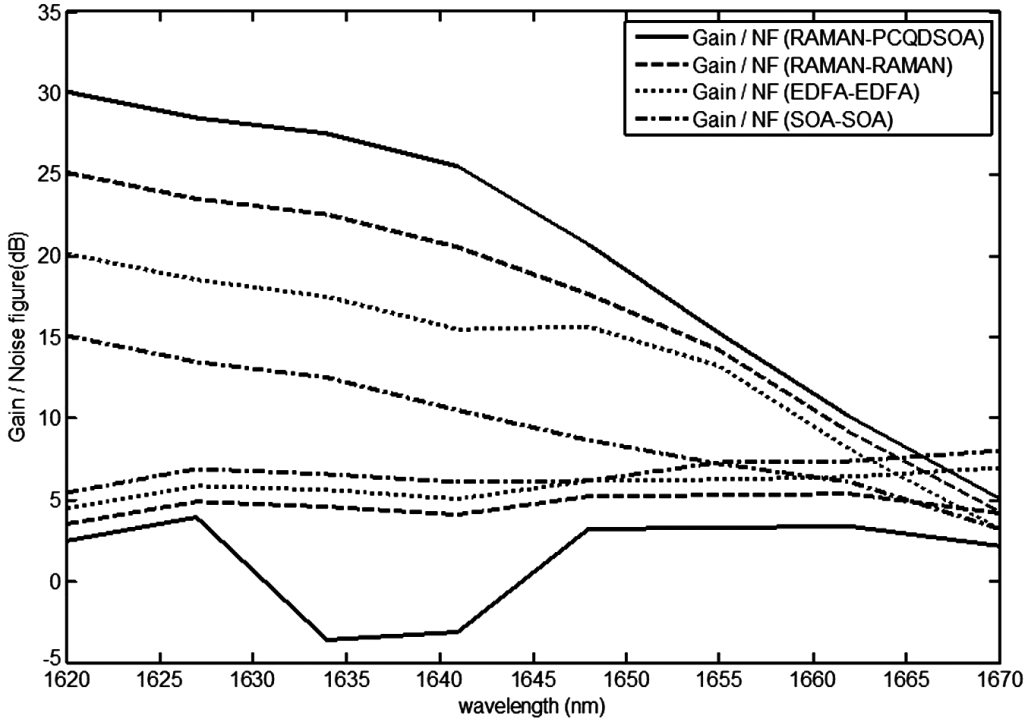

Fig. 3 — Gain and noise figure versus with displacement of channel wavelength for U-Band.

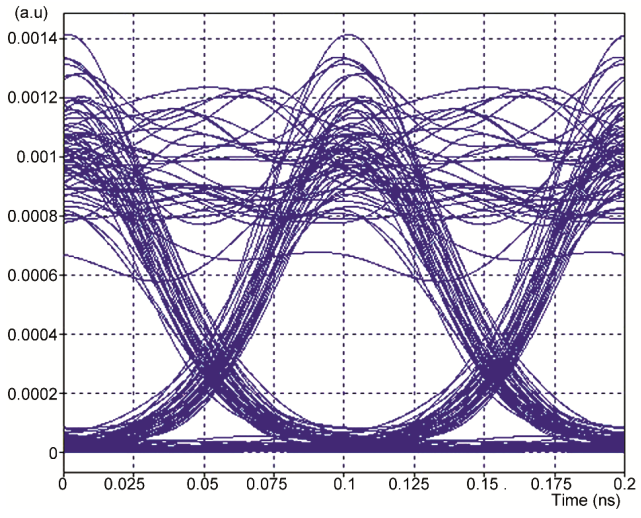

Fig. 4 — Eye diagram of RAMAN-PCQDSOA, HOA.

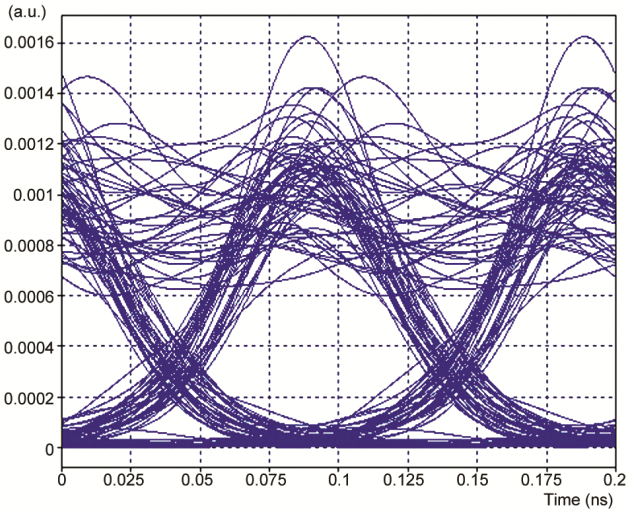

Fig. 5 — Eye diagram of RAMAN-RAMAN, HOA.

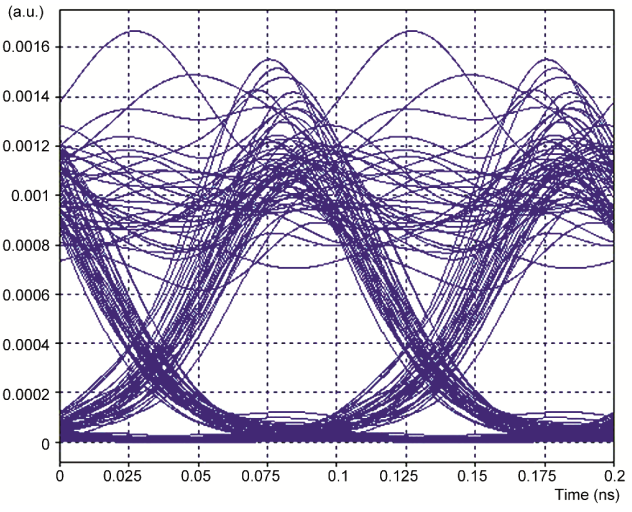

Fig. 6 — Eye diagram of EDFA-EDFA, HOA.

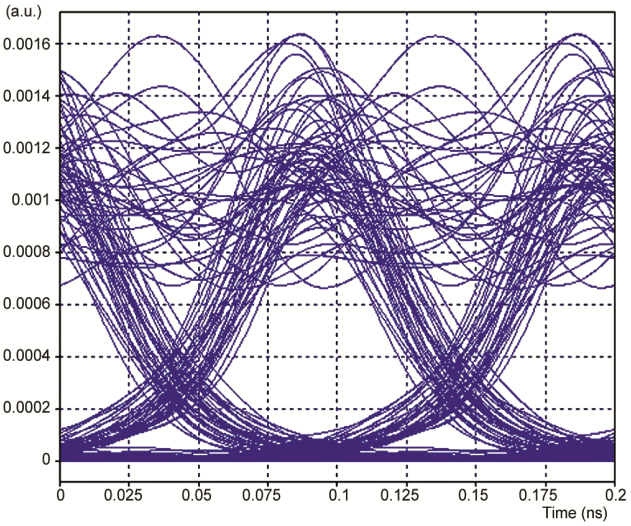

Fig. 7 — Eye diagram of SOA-SOA, HOA.

variations in gain and minor effect of noise figure which is also acceptable.

4 Conclusion

For the very first time, the flattened gain and noise figure are investigated using (RAMAN-PCQDSOA) hybrid optical amplifier for 400 x 10 Gb/s SD-WDM system with channel spacing 100 GHz in this paper. Best rating flattened gain (30.1 dB to 18.22 dB) for the range of U-band from 1625 nm to 1675 nm with minor variation of (.05 dB) are recorded from RAMAN-PCQDSOA. The performance of proposed HOA is also good in terms of NF (-2.5 dB) than the other HOAs.

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