ISSN 2047-3338

Low Performance Characteristics of Optical Laser Diode Sources Based on NRZ Coding Formats under Thermal Irradiated Environments

Abd El–Naser A. Mohammed[1], Abd El-Fattah A. Saad[2], Ahmed Nabih Zaki Rashed[3*] and Hazem M. El-Hageen[4]

[1,2,3]Electronics and Electrical Communication Engineering Department
Faculty of Electronic Engineering, Menouf 32951, Menoufia University, Egypt
[4]Atomic Energy Authority, P.O. Box 29, Naser City, Cairo, Egypt

***Abstract*— The Vertical Cavity surface-emitting laser (VCSEL) is considered one of the most important devices for optical interconnects and local area networks (LANs), enabling ultra parallel information transmission in lightwave and computer systems. As well as active optoelectronic devices such as light emitting diodes, laser diodes (LDs), and photodiodes were evaluated for degradation under gamma and neutron irradiation. Total dose values and neutron fluences were chosen in such a way that we get estimates of the behaviour especially in space environments and nuclear engineering. The devices are designed for wavelengths from visible region to infrared region. LDs show a reduction of light output power and also a shift of threshold current after irradiation. This paper has proposed the study of the transmission bit rates and products of optical laser diode sources such as VCSEL under thermal irradiated environments. We have taken into account the performance characteristics of these devices such as the harmonic response transfer function, the resonance frequency, 3-dB bandwidth, damping frequency and the pulse rise time. These diodes affect the transmitted bit-rate in high-speed advanced optical communication systems. The effects of both ambient temperature, the injected current, power, and the dose of irradiation are deeply investigated. The pulse rise time and the resonance frequency as well as the transmitted signal bandwidth, transmitted bit rates and products based on non return to zero (NRZ) coding formats are the major criterions of the device speed.**

***Index Terms*— Optoelectronic Devices, VCSELs, Radiation Effects, Gamma Irradiation, Threshold Current, and Semiconductor Lasers**

I. INTRODUCTION

LASER diodes are semiconductor devices emitting coherent light. They are the most frequently used laser sources. Their small size, relatively low price, and their long lifetime make them an ideal component for multiple applications. Since their invention in 1963, the development of laser diodes has been pushed considerably, mainly due to the strong growth in the fields of telecommunication and optical data storage. These and other fields of application have led to important progress in laser diode size and reliability. Continuous development has resulted in laser diodes with shorter and shorter wavelengths, increasing output power, and an improved beam quality [1]. The diversity of laser diodes applications have grown dramatically in the last decade, as the technology matured and new devices enter the market: new wavelengths are available (i.e. blue-emitting diodes; narrow, spectroscopic-grade lasers); emitters have reached high-power, and in some situations they are fiber coupled; a wide span of tunable diodes is offered; and application-tailored devices are quite common. In the meantime, more simple, compact and easy to use laser drivers/ temperature controllers can be purchased. Apart from optical fiber and free-space communications, laser diodes became primary radiation sources in interferometer, proximity sensors, spectroscopy, material processing and surface treatment, replacing more bulky and expensive gas and solid-state lasers. Some of their characteristics (small size, long operating life, easy to use and maintain, great diversity, low price) recommend them for remote sensing and robotic applications. A challenge will be their operation in hostile environments [2], and more specific in nuclear ones (nuclear power plants, radioactive waist management sites, nuclear medicine, space-based instrumentation). Most of the investigations of laser diodes subjected to ionizing radiation were done in relation to their possible use in optical fiber communication links.

Although a considerable amount of radiation effects studies on individual devices, including optical fibers, light emitting diodes, laser diodes and photodiodes exposed to a variety of radiation conditions is reported in literature, only little information is available on the radiation tolerance at high total ionizing radiation dose and for a substantial neutron fluence. In this paper we therefore focus on the high dose radiation response of vertical-cavity surface-emitting lasers, which have already proven to exhibit an enhanced radiation tolerance compared to other types of optical emitters, e.g. LEDs [3]. Because of their structure and since they operate under very much different conditions than conventional edge-emitting lasers (EELs), VCSELs are more complex devices compared to EELs in the ways that affect the radiation response [4]. They are nevertheless considered as quite radiation tolerant, with the reticence that due to their non-constant slope efficiency, they can tolerate less particle radiation induced change in threshold voltage than conventional EELs. In addition, VCSELs have proven to be excellent candidates as optical sources for optical communication links in high-energy physics experiment [5].

Since several years, photonic technology is seriously considered for communication and monitoring applications in space-bone systems and nuclear projects. A major problem which arises when dealing with photonics in these environments is the presence of radiation fields. Space radiation includes mainly protons, electrons and heavy ions, whereas gamma and neuron radiation are a major concern around ground nuclear facilities. Two types of damage affect the electronic devices when they are exposed to the radiation [6]. The first one is ionization damage, it generates electron–hole pairs along the path of the incident particle charged inside the semiconductor. It is a transitory damage because it disappears shortly after the particle strikes. In contrast, displacement damages cause alterations in the periodicity of the lattice, generating energy levels located in the forbidden band of the semiconductor. Such damage is considered permanent. The lattice defects affect the behavior of the semiconductor. For several reasons, interest in high-temperature electronics develops fast. If these components are to be used in a radiation environment, knowledge about the degradation under high-temperature irradiation conditions is highly desirable [7].

In the present study, we have investigated deeply the performance characteristics of high speed laser diodes such as vertical cavity surface emitting lasers (VCSELs) under thermal-irradiated operating conditions over wide range of the affecting parameters. As well as a considerable amount of hard radiation effects studies on individual optoelectronic devices exposed to a variety of radiation conditions is deeply investigated, only little information is available on the radiation tolerance at high total dose and under neutron radiation. Optical fiber technology is seriously considered for applications in various radiation environments, including space, high-energy physics, nuclear power plants and future thermonuclear reactors.

II. SCHEMATIC STRUCTURE VIEW OF VCSEL

Emerging photonics technologies will be critical for next generation high performance spacecraft which may include sensor applications generating unprecedented amounts of data. For example, future high resolution multi-wavelength sensor systems will require intensive data transfer and routing on-board satellites. Optical based data busses will have higher performance (e.g. bandwidth, size, etc.), lower weight and power, and reduced sensitivity to electromagnetic effects than copper-based alternatives. A specific photonics technology that shows great promise for high speed intra-satellite data transfer applications is the VCSEL. It is a semiconductor device with light emission perpendicular to the chip surface. The vertical lasing cavity is produced by sequentially grown epitaxial semiconductor layers. As shown in Fig. 1 schematic structure view of VCSEL, the vertical resonant cavity confined by the two Bragg reflectors. The lasing current is laterally confined by the oxide layers. The active region generally consists of a number of quantum wells to achieve sufficient power. VSCELS exhibit very low threshold voltages. Different material systems are employed for various wavelength outputs [8].

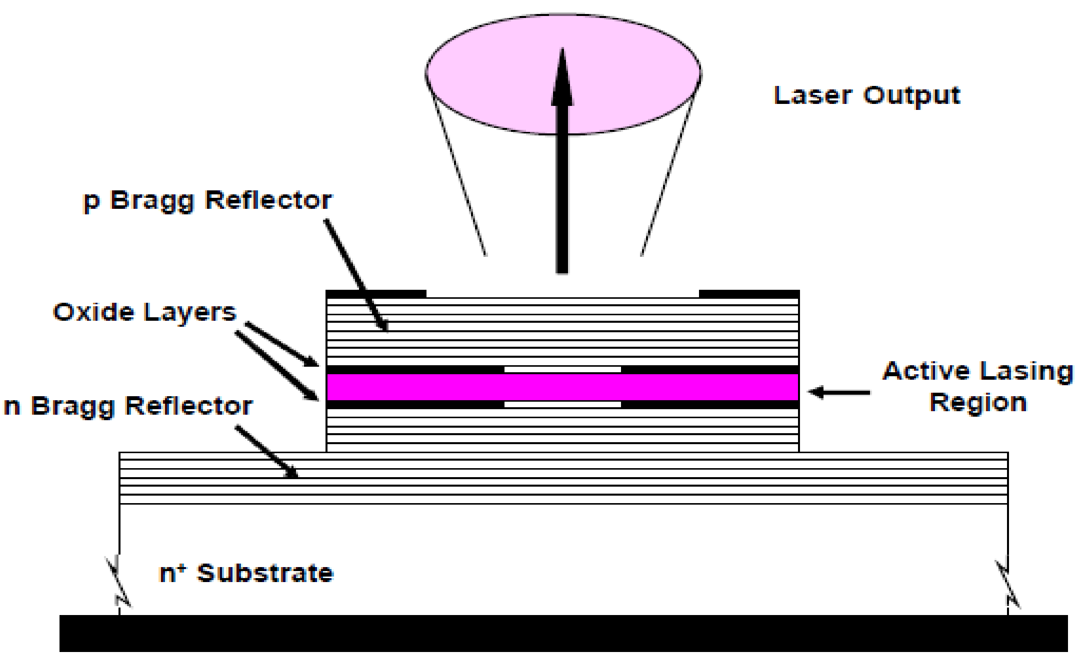

Fig. 1. Schematic view of VCSEL structure

VCSELs are becoming the component of choice for numerous applications, supplanting both LED- and edge-emitting sources, for diverse applications including data communication, optical interconnections and memory, sensors, etc. There are significant performance, producibility, and packaging advantages in the technology. For example, lower operating currents (mA’s) and power dissipation/emission (mW’s) at Gbit/s data rates; high reliability, wafer-level batch fabrication and on-wafer testability, and utilization of the existing LED infrastructure; increased fiber coupling efficiency (> 90% as a result of the uniform single mode beam profile), and simplified drive electronics, which translates into a significant cost advantage. Additionally, VCSELs are suitable for one and two dimensional array integration for parallel optical interconnects. There are both proton implant confined vertical cavity surface emitting lasers oxide confined VCSELs available commercially. An oxide confined VCSEL is desirable for 3.3 V (as opposed to 5 Volt) transceiver applications due to its higher slope efficiency and lower operating voltage compared to proton implant confined VCSEL [9]. Although reliability issues remain important for the longer wavelength lasers required in some long reach (>500 m) communications, satellite needs can be met with the more mature 0.85 μm technology [10].

III. MODELING ANALYSIS

When high-energy radiation falls on a semiconductor device, energy is deposited in the semiconductor via two mechanisms; atomic displacement or ionization [10]. The relative importance of these mechanisms in a semiconductor depends on the type of radiation and the nature of the device. The electrical resistance of semiconducting metals is very much more sensitive to radiation than that of typical metals because the radiation-induced defects may markedly alter the number of electrons available for conduction. Point defects (initially produced) can be produced by electron or gamma irradiation. It can be expressed as a single displaced atom and its associated vacancy called Frankel Defect. The interaction is simply described by the number of defects/cm^3 created, which is given by [11]:

$$N_t = \varphi\, a_d\, N_0 \quad , \qquad (1)$$

Where a_d is the displacement cross-section in cm^2, φ is the radiation fluence in n/cm^2, and N_0 is the number of lattice atoms/cm^3. The point defects result in the introduction of allowed energy states within the forbidden gap of the semiconductor. This energy states lead to the following: (a) Carrier removal is the majority carrier density is reduced by the radiation fluence, (b) Mobility degradation is the mobility was found to decrease with increasing the radiation fluence, (c) Conductivity modulation since the carrier concentration and mobility both decrease with radiation, then the conductivity will also decrease, and (d) Minority carriers lifetime can be defined as the degradation rate in minority carrier lifetime and can be expressed as:

$$\frac{d\tau}{d\varphi} = K_\tau \qquad (2)$$

Where K_τ is the carrier lifetime damage constant. The minority carrier lifetime τ will be reduced by [12]:

$$\frac{1}{\tau} = \frac{1}{\tau_0} + \sum_i v_{th}\, \sigma_i\, n_i \quad , \qquad (3)$$

Where τ_0 is the pre-irradiation minority carrier lifetime, υ_{th} is the average thermal velocity of the minority carriers, n_i and σ_i are the density and capture cross section, respectively, of the recombination centers of a given type i, and the sum extends over the different types of radiation induced defects. As long as there is no significant overlap of the defect regions produced by the individual incident particles, the initial defect density will be proportional to the particle fluence φ as the following expression:

$$n_i = c_i\, \varphi\, I \quad , \qquad (4)$$

Where the coefficient c_i stands for the density of particular defects per unit fluence. Defining a damage constant K_τ is:

$$K_\tau = v_{th} \sum_i c_i\, \sigma_i \quad , \qquad (5)$$

Equation 3 can then be written as the following formula:

$$\frac{\tau_0}{\tau} = 1 + \tau_0\, K_\tau\, \varphi \quad , \qquad (6)$$

K_τ is sensitive to many factors such as material, type of radiation, particle energy, flux, device temperature and electrical bias conditions. The ratio τ_0/τ of the minority carrier lifetime before and after the irradiation can be related to the relative light output after irradiation assuming that the total current density in the junction is dominated by diffusion currents as the following expression [13]:

$$\left(\frac{I_0}{I}\right)^{0.66} = \frac{\tau_0}{\tau} \quad , \qquad (7)$$

Where I_0 is pre-irradiation light output and I is light output after irradiation. Thus, the parameter k = $\tau_0 K_\tau$ can be calculated from the Relative Light Output (RLO) of the devices after the irradiation with a total particle fluence φ;

$$\left(\frac{1}{RLO}\right)^{0.66} = \left(\frac{I_0}{I}\right)^{0.66} = 1 + k\,\varphi \quad , \qquad (8)$$

Therefore, if the product kφ is significant compared to 1, the light output will decrease substantially. The presence of defects in the active region of the laser causes the threshold current to increase as a result of having to compensate for the injected charge that is lost through nonradiative transitions. A loss of output efficiency can also occur at high fluences when the nonradiative recombination lifetime τ_{nr} decreases to a comparable level to that of the (stimulated) recombination lifetime τ_{st} of the carriers, since the efficiency η is related to the lifetimes by [14]:

$$\eta = \frac{\tau_{nr}}{\tau_{nr} + \tau_{st}} \quad , \qquad (9)$$

Based on [tabour], the magnitude of the normalized harmonic response of VCSELs in the S-domain is given by:

$$G_n(S) = \frac{\omega_n^2}{S^2 - BS + \omega_n^2} \quad , \qquad (10)$$

Where ω_n is the device natural frequency, B is the damping coefficient, and S is the transformation due to Laplace transform. By solving the previous equation in the time domain, the obtained formula as:

$$g_n(t) = \left(1 - \left(\Gamma\, e^{-B/2}\right) \sin \omega_d\, t\right) u(t) \qquad (11)$$

With the damping frequency $\omega_d = \sqrt{\omega_n^2 - 0.25\, B^2}$, u(t) is the unit step function and $\Gamma = \frac{\omega_n}{\omega_d}$. One normalized electric bit of duration T_d and pulse width t and its optical output power are shown above. Both t_2 and t_1 are the solutions of $g_n(t_2)=0.9$, and $g_n(t_1)=0.1$. A special software is designed to handle both formulas to find both t_2 and t_1 and consequently the rise time t_r where $t_r=t_2-t_1$. An important application in high-speed optical interconnection in thermo-irradiated field is the effect of both the ambient temperature T and the irradiation fluence φ. Based on the investigation of [15], the derived the following: The resonance frequency ω_r, and the 3-dB bandwidth $\omega_{3\text{-dB}}$ can be obtained as:

$$\omega_r = 2\pi f_r = \sqrt{\omega_n^2 - 0.5 B^2} \quad , \tag{12}$$

$$\omega_{3-dB} = 2\pi f_{3-dB} = \omega_r \sqrt{1+\sqrt{1+3\left(\omega_n^2/\omega_r^2\right)^2}} \quad , \tag{13}$$

The power forward current voltage curves of different types of VCSEL devices were given in [16], with remarkable nonlinearly while in [17] it depicted in linear fashion. Based on the data of [18], the following nonlinear thermal relations for the set of the selected device were carried out:

$$P(I,T) = p_0 + p_1 I + p_2 I^2 , \quad \text{mWatt} \tag{14}$$

$$V(I,T) = v_0(T) + v_1 I + v_2 I^2 , \quad \text{Volt} \tag{15}$$

Where the set of parameters {p_0, p_1, p_2, and v_o} are polynomial functions of T.

$$p_0 = 0.73 - 0.00169\ T + 0.000345\ T^2 , \tag{16}$$

$$p_1 = 2.5 - 0.0072\ T + 0.0002\ T^2 , \tag{17}$$

$$p_2 = -7.3 - 0.002\ T + 0.000065\ T^2 , \tag{18}$$

$$v_0 = 0.58 - 0.000015\ (T - 300), \tag{19}$$

Where the set of the coefficients of v_1=2.95, and v_2=-1.07. The power forward current and bias voltage of VCSEL under the effects of irradiation can be expressed in the following formulas [19]:

$$P(I,T,\varphi) = P(I,T)\, F_p(\varphi) \quad , \tag{20}$$

$$V(I,T,\varphi) = V(I,T)\, F_v(\varphi) \quad , \tag{21}$$

Where both $F_p(\varphi)$ and $F_v(\varphi)$ are functions of the irradiation fluence φ, can be expressed as follows [20, 21]:

$$F_p(\varphi) = 1 + \alpha_1 \varphi + \alpha_2 \varphi^2 \quad , \tag{22}$$

$$F_v(\varphi) = 1 + \beta_1 \varphi + \beta_2 \varphi^2 \quad ,$$

Where the set of the coefficients of α_1=0.0005, α_2=-0.001, β_1=0.023, and β_2=0.0054. Based on the data published by [22, 23], the obtained the offset current I_{off} (T) under irradiation under the form:

$$I_{off}(T,\varphi) = I_{off}(T)\left(\Psi_0 + \Psi_1 \varphi + \Psi_2 \varphi^2\right) \tag{23}$$

Where the set of the coefficients of ψ_0 =0.023, ψ_1=-0.0195, and ψ_3=-0.00287. As well as the VCSEL rise time is given in terms of the data rate for non return to zero pulse code by the expression [24-26]:

$$B_R\,(NRZ) = \frac{0.7}{t_r} , \tag{24}$$

Moreover the transmission bit rate-distance product within the optical laser diode device is given by:

$$P_R(NRZ) = B_R \,.\, L \quad , \quad \text{Gbit.m/sec} \tag{25}$$

Where L is the transmission VCSEL laser diode reach.

IV. SIMULATION RESULTS AND DISCUSSIONS

We have investigated transmission bit rates and bandwidth transmission reach products of VCSEL devices under the effects of the thermo-Irradiated environments under the assumed set of the operating parameters and ranges as: irradiation fluence φ=2x10^{14}–50x10^{14} n/cm^2, Ambient temperature T=290 K–330 K, applied threshold current I=2 mA–10 mA, room temperature T_0=300 K, spectral linewidth of the optical source Δλ= 0.2 nm, signal power Pso=2 mWatt, Operating signal wavelength λ_s=0.85 μm, relative refractive index difference Δn= 0.005, initial device gain, g_0=8.5x10^5, thermal rate R_{th}=0.85, transmission laser diode reach L=50 m–500 m, N_0=1.3x10^6. It is necessary to stress that the major generator of features is the irradiation fluence due to the damage which causes dislocations; and radiation-induced defects is the band gap. Based on the above model and the series of the operating parameters variations of the set of five causes {3-dB signal transmitted bandwidth $f_{3\text{-dB}}$, resonance frequency f_r, damping frequency f_d, device rise time t_r, device transmission bit rates and products} against the variations of a set of effects {irradiation fluence φ, ambient temperature T, applied threshold current I} are displayed in the series of Figs. (2-15):

i) As shown in the series of Figs. (2-4) have assured that as ambient temperature increases, this leads to decrease in device bandwidth, damping frequency, and resonance frequency after or before irradiation. But we have observed that values of device bandwidth, damping frequency, and resonance frequency are very low after irradiation compared to that values before irradiation.

ii) Fig. 5 has indicated that as threshold current increases, this results in increasing of device bandwidth after or before irradiation. But we have demonstrated that device bandwidth is very low after irradiation compared to that values before irradiation.

iii) As shown in Fig. 6 has proved that as ambient temperature increases, this leads to increase in pulse rise time after or before irradiation. But we have indicated that pulse rise time is very high after irradiation compared to that values before irradiation.

iv) As shown in Fig. 7 has assured that as ambient temperature increases, this leads to decrease in transmission bit rate after or before irradiation. But we have indicated that transmission bit rate is very low after irradiation compared to those values before irradiation.

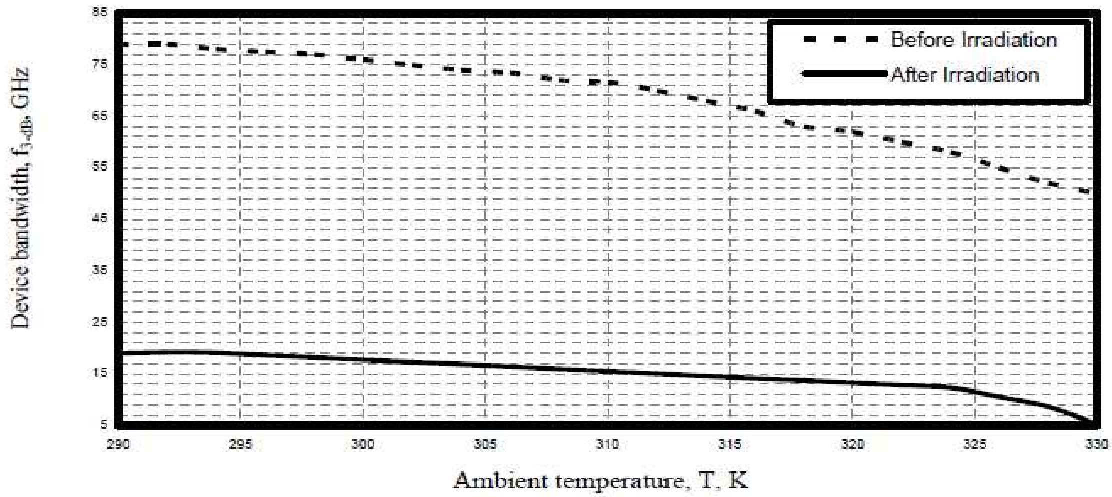

Fig. 2. Variations of the device bandwidth against ambient temperature at the assumed set of the parameters.

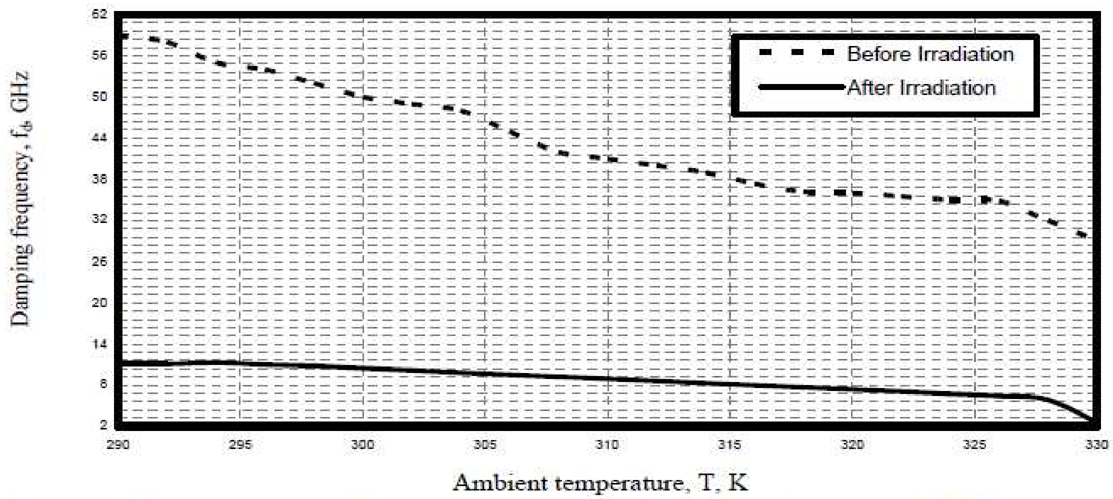

Fig. 3. Variations of the damping frequency versus ambient temperature at the assumed set of the parameters.

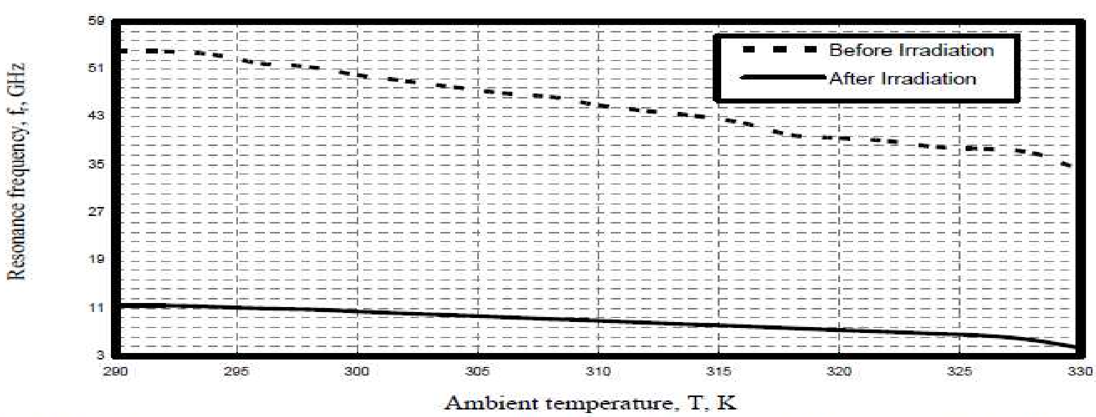

Fig. 4. Variations of the resonance frequency against ambient temperature at the assumed set of the parameters.

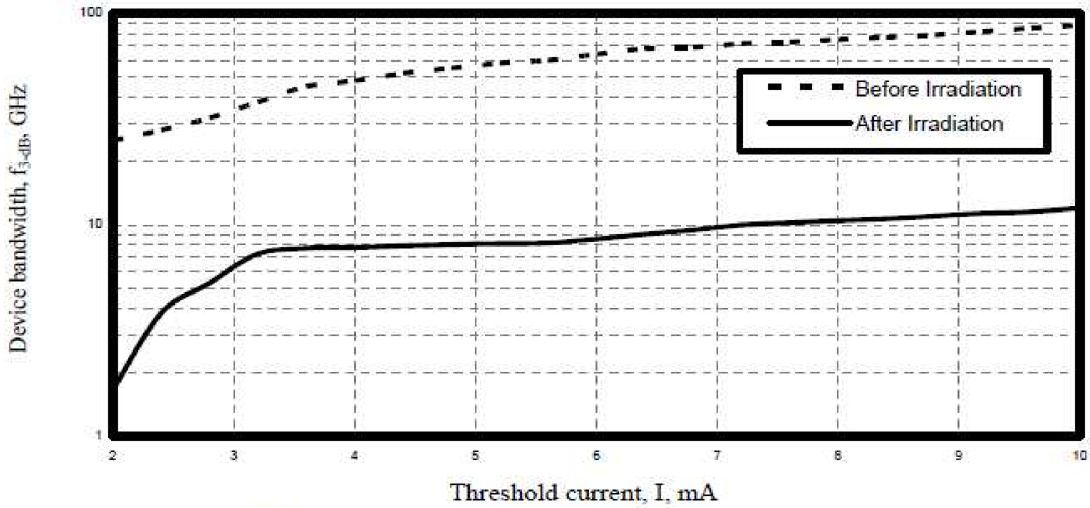

Fig. 5. Variations of the device bandwidth against threshold current at the assumed set of the parameters.

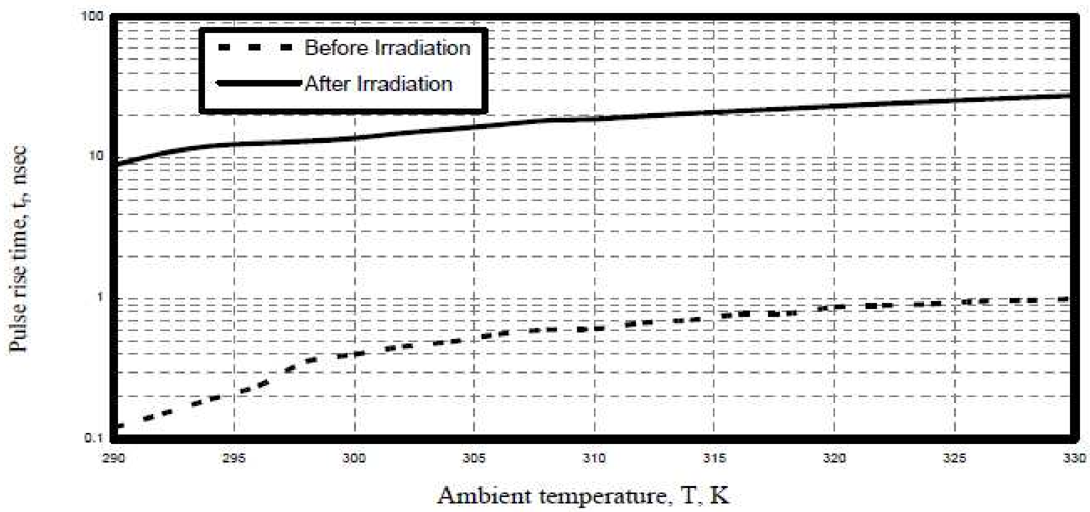

Fig. 6. Variations of the pulse rise time against ambient temperature at the assumed set of the parameters.

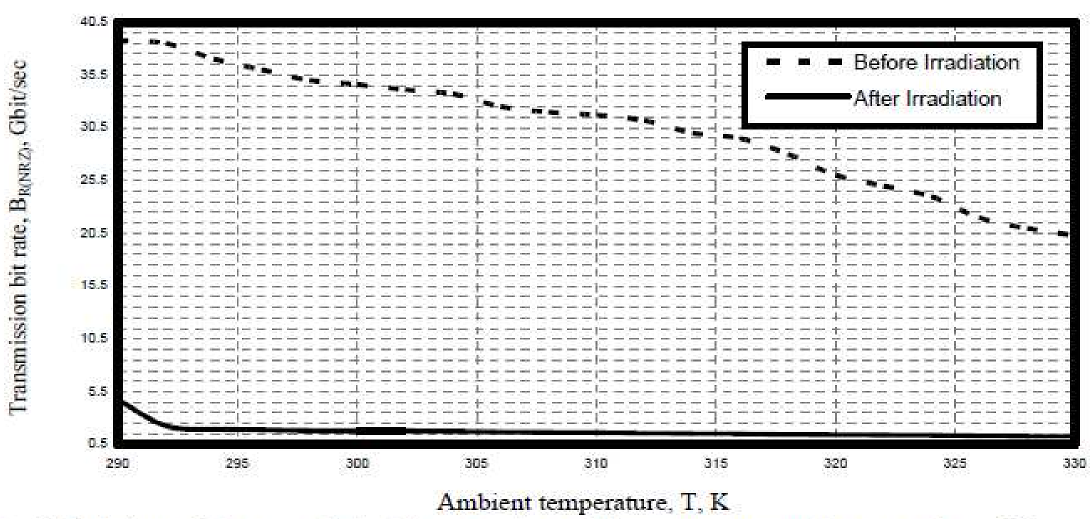

Fig. 7. Variations of the transmission bit rate against ambient temperature at the assumed set of the parameters.

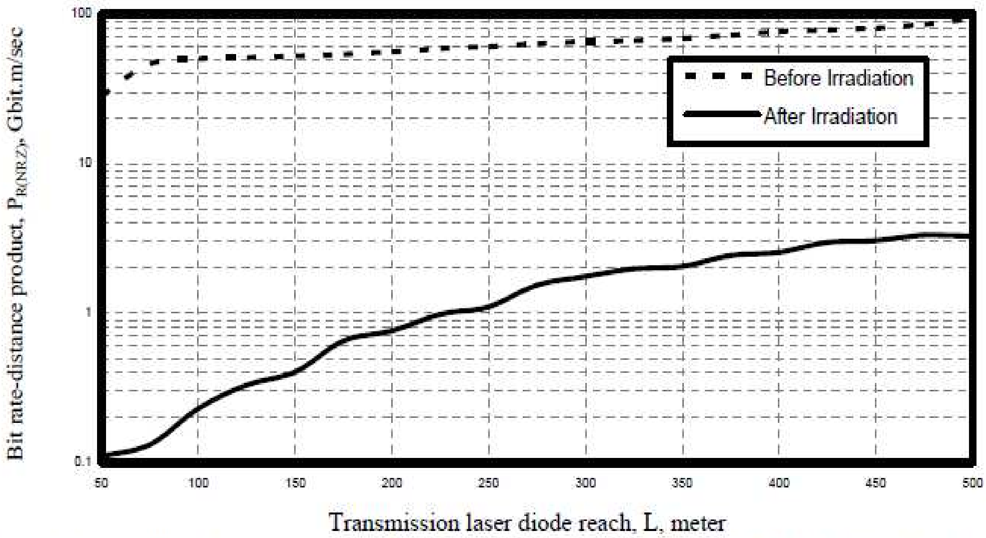

Fig. 8. Variations of the transmission bit rate-distance product against transmission laser diode reach at the assumed set of the parameters.

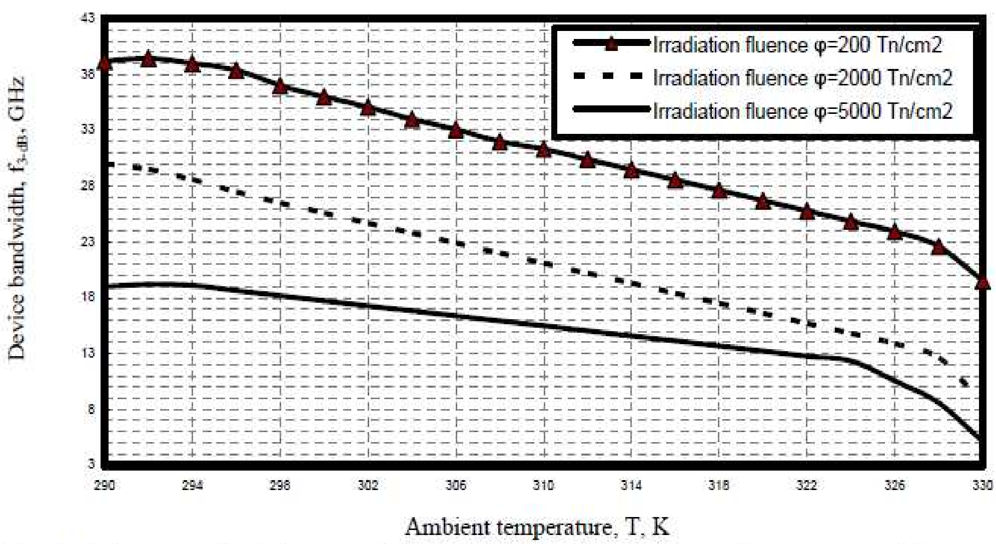

Fig. 9. Variations of the device bandwidth against ambient temperature at the assumed set of the parameters.

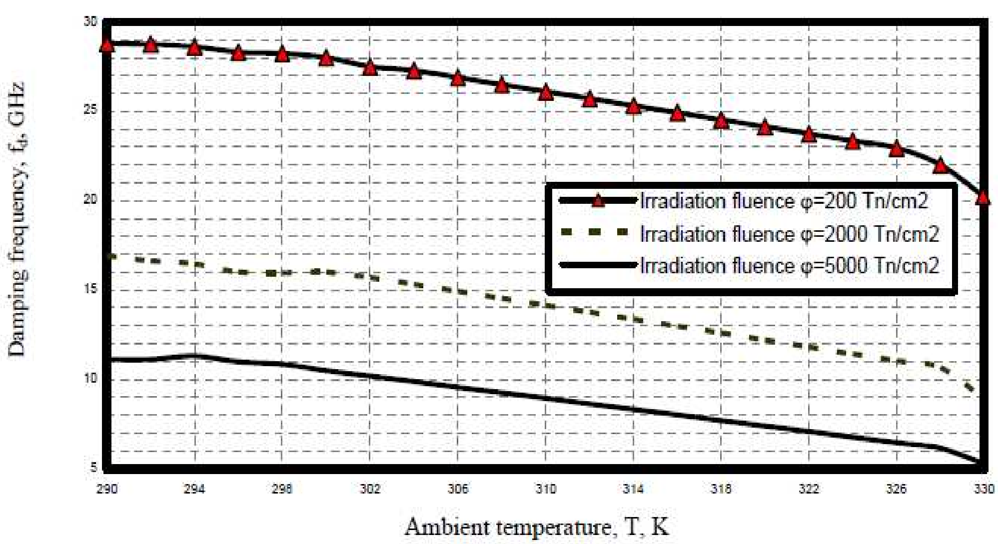

Fig. 10. Variations of the damping frequency versus ambient temperature at the assumed set of the parameters.

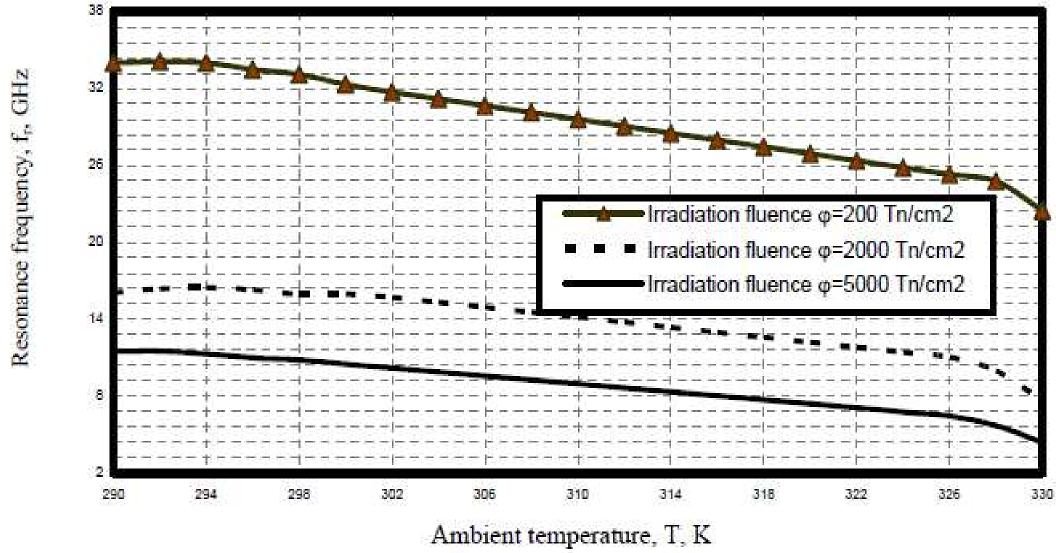

Fig. 11. Variations of the resonance frequency against ambient temperature at the assumed set of the parameters.

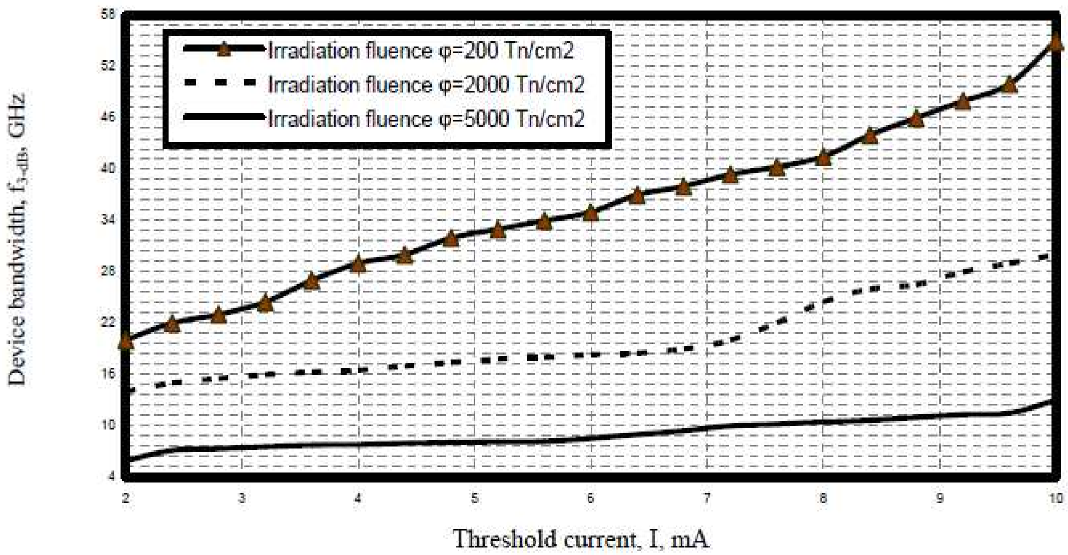

Fig. 12. Variations of the device bandwidth against threshold current at the assumed set of the parameters.

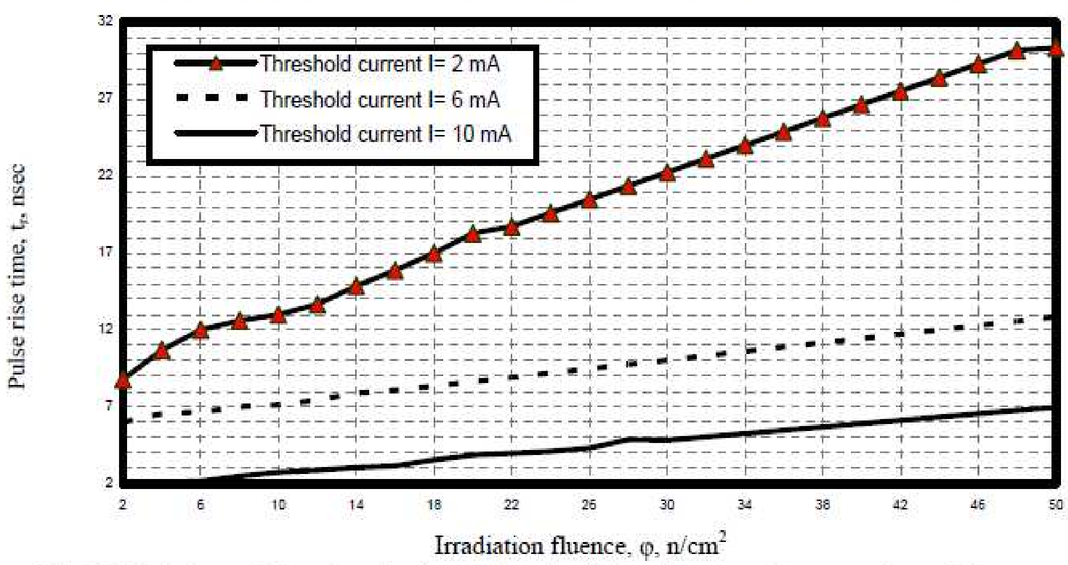

Fig. 13. Variations of the pulse rise time against irradiation fluence at the assumed set of the parameters.

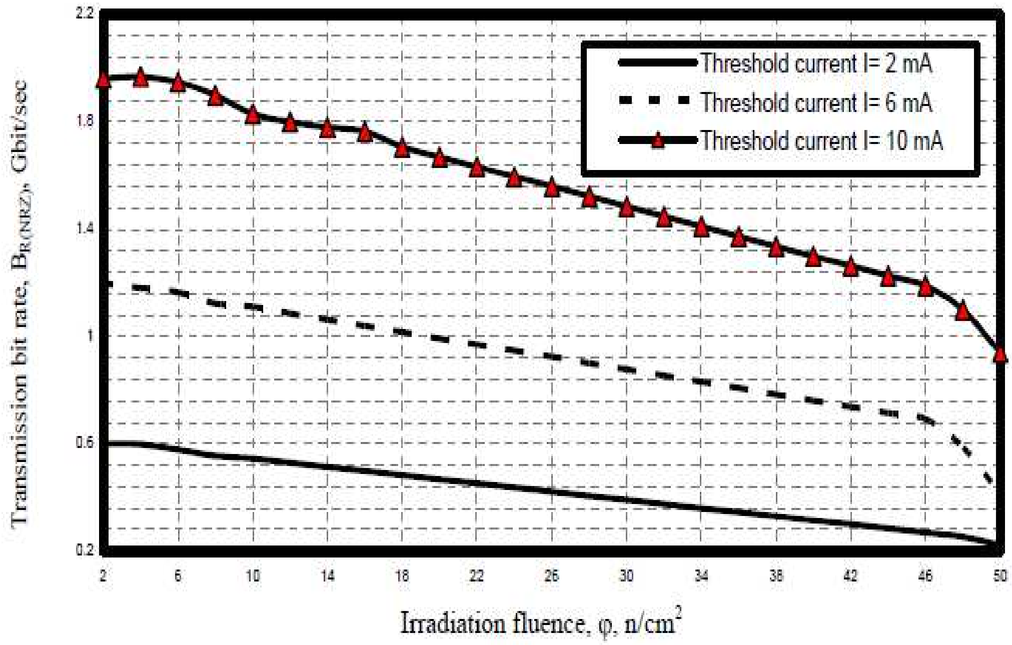

Fig. 14. Variations of the transmission bit rate against irradiation fluence at the assumed set of the parameters.

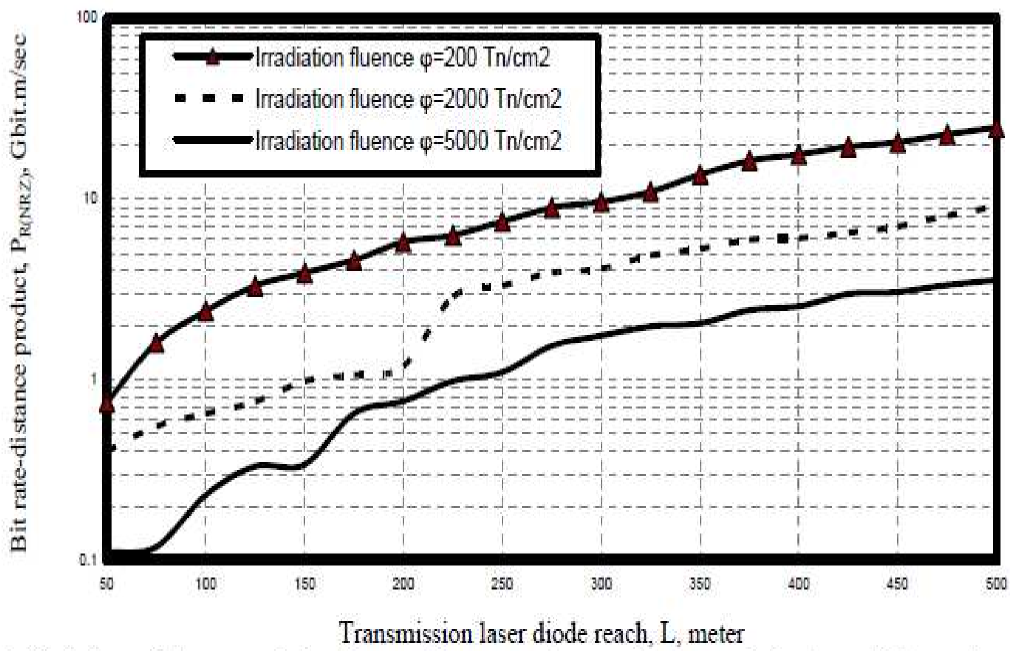

Fig. 15. Variations of the transmission bit rate-distance product against transmission laser diode reach at the assumed set of the parameters.

v) Fig. 8 has proved that as transmission laser diode reach increases, this results in increasing in transmission bit rate distance product after or before irradiation. But we have demonstrated that transmission bit rate distance is very low after irradiation compared to that values before irradiation.

vi) As shown in the series of Figs. (9-11) have indicated that as both irradiation fluences and ambient temperature increase, this results in decreasing in device bandwidth, damping frequency and resonance frequency.

vii) Fig. 12 have proved that as applied threshold current increases and irradiation fluence decreases, this leads to increase in device bandwidth.

viii) As shown in Figs. 13 has indicated that as irradiation fluence increases and applied threshold current decreases, this results in increasing of pulse rise time.

ix) Fig. 14 has demonstrated that as irradiation fluence increases and applied threshold current decreases, this results in decreasing of transmission bit rate based on NRZ coding formats.

x) As shown in Fig. 15 has assured that as transmission laser diode reach increases and irradiation fluence decreases, this results in increasing of transmission bit rate distance product at room temperature.

V. CONCLUSIONS

In a summary, we have investigated deeply the transmission bit rates, products and performance characteristics of VCSEL under thermal irradiated environments. It is theoretically found that the decreased both ambient temperature and irradiation fluences, this leads to the increased in the device bandwidth, damping frequency and resonance frequency. Moreover it is also indicated that the increased applied threshold current, and the decreased irradiation fluences, this results in the increased device bandwidth. As well as the decreased of both ambient temperature and irradiation fluences, this leads to the increased transmission bit rates and products based on NRZ coding formats and the decreased pulse rise time. Also in the same way, the increased transmission laser diode reach at room temperature, this results in the increased transmission bit rate distance product. Finally we can say that the highest of both temperature effects and irradiation fluences (especially neutrons) are the major serious problems that has bad effect on the device performance characteristics and high speed device operations.

REFERENCES

[1] Yu. K. Akimov, "Silicon Radiation Detectors (Review)," Instruments and Experimental Techniques, Vol. 50, No. 1, pp. 1–28, 2007.

[2] J. R. Srour, C. J. Marshall and P.W. Marshall, "Review of Displacement Damage Effects in Silicon Devices," IEEE Trans. on Nucl. Sci., Vol. 50, No. 3, pp. 23-33, 2003.

[3] K. Gill, S. Dris, R. Grabit, R. Macias, E. Noah, J. Troska and F. Vasey, "Radiation Hardness Assurance and Reliability Testing of InGaAs Photodiodes for Optical Control Links in the CMS Experiment," Submitted for presentation at the RADECS 2004 Workshop, Madrid, Spain, Sep. 2004.

[4] K. Takakura, K. Hayama, D. Watanabe, H. Ohyama, T. Kudou, K. Shigaki, S. Matsuda, S. Kuboyama, T. Kishikawa, J. Uemura, E. Simoen and C. Claeys, "Radiation Defects and Degradation of Si Photodiodes Irradiated by Neutrons at Low Temperature," Physica B, Vol. 3, No. 1, pp. 376–377, 2006.

[5] S. M. Khanna, D. Estan, L. S. Erhardt, A. Houdayer, C. Carlone, A. Ionascut-Nedelcescu, S. R. Messenger, R. J. Walters, G. P. Summers, J. H. Warner, and I. Jun, "Proton Energy Dependence of the Light Output in Gallium Nitride Light Emitting Diodes," IEEE Trans. Nucl. Sci., Vol. 51, No. 2, pp. 2729–2735, Oct. 2004.

[6] Abd El-Naser A. Mohammed, Gaber E. S. M. El-Abyad, Abd El-Fattah A. Saad, and Ahmed Nabih Zaki Rashed, "High Transmission Bit Rate of A thermal Arrayed Waveguide Grating (AWG) Module in Passive Optical Networks," IJCSIS International Journal of Computer Science and Information Security, Vol. 1, No. 1, pp. 13-22, May 2009.

[7] A. Kalavagunta, M. Neifeld, H. Barnby, and R. Schrimpf, "Impact of Proton Irradiation on A grating Demultiplexer," IEEE Trans. Nucl. Sci, Vol. 51, pp. 3595–3602, Dec. 2004.

[8] Abd El-Naser A. Mohammed, Gaber E. S. M. El-Abyad, Abd El-Fattah A. Saad, and Ahmed Nabih Zaki Rashed, "Low Loss A thermal Arrayed Waveguide Grating (AWG) Module for Passive and Active Optical Network Applications," International Journal of Communication Networks and Information Security (IJCNIS), Vol. 1, No. 2, pp. 27-34, August 2009.

[9] J. H. Warner, R. J. Walters, S. R. Messenger, G. P. Summers, S. M. Khanna, D. Estan, L. S. Erhardt, and A. Houdayer, "High Energy Proton Ieffects in GaAs Devices," IEEE Trans. Nucl. Sci., Vol. 51, pp. 2887–2895, Oct. 2004.

[10] T. F. Miyahira and A. H. Johnston, "Trends in Optocoupler Degradation," IEEE Trans. Nucl. Sci., Vol. 49, pp. 2868–2873, Dec. 2002.

[11] Sh. M. Eladl, "Modeling of Photons Trapping Effect on the Performance of HPT-LED Optoelectronic Integrated Device (OEID)," Semiconductor Physics, Quantum Electronics & Optoelectronics Journal, Vol. 12, No. 3, pp. 255-259, 2009.

[12] M. V. Raghavendra, and P. L. H. Vara Prasad, "Estimation of Optical Link Length for Multi Haul Applications," International Journal of Engineering Science and Technology, Vol. 2, No. 6, pp. 1485-1491, 2010.

[13] F. Semond, I. R. Sellers, F. Natali, D. Byrne, M. Leroux, J. Massies, N. Ollier, J. Leymarie, P. Disseix, and A. Vasson, "Strong Light–Matter Coupling at Room Temperature in Simple Geometry GaN Microcavities Grown on Silicon," Appl. Phys. Lett., Vol. 87, pp. 1–3, 2005.

[14] Abd El-Naser A. Mohammed, Mohamed M. S. El-Halawany, Gaber E. M. El-Abyad and Mohammed S. F. Tabbour "Performance Characteristics of High Speed Laser Diodes Under Thermal Irradiated Operating Conditions," Journal Media and Communication Studies, Vol. 2, No. 5, pp. 127-132, May 2010

[15] R. Butt´e, G. Christmann, E. Feltin, J.-F. Carlin, M. Mosca, M. Ilegems, and N. Grandjean, "Room Temperature Polariton Luminescence from A bulk GaN Microcavity," Phys. Rev. B, Vol. 73, pp. 1–4, 2006.

[16] G. Christmann, R. Butt´e, E. Feltin, J.-F. Carlin, and N. Grandjean, "Impact of Inhomogeneous Excitonic Broadening on the Strong Exciton Photon Coupling in Quantum Well Nitride Microcavities," Phys. Rev. B, Vol. 73, pp. 15–19, 2006.

[17] S. Kako, C. Santori, K. Hoshino, S. G¨otzinger, Y. Yamamoto, and Y. Arakawa, "A gallium Nitride Single Photon Source Operating at 200 K," Nat. Mater., Vol. 5, pp. 887–892, 2006.

[18] S. Christopoulos, G. von H¨ogersthal, A. Grundy, P. G. Lagoudakis, A. V. Kavokin, J. J. Baumberg,G.Christmann, R. Butt´e, E. Feltin, J.-F. Carlin, and N. Grandjean, "Room Temperature Polariton Lasing in Semiconductor Microcavities," Phys. Rev. Lett., Vol. 98, pp. 1–4, 2007.

[19] S.-H. Park, J. Kim, H. Jeon, T. Sakong, S.-N. Lee, S. Chae, Y. Park, C.-H. Jeong, G.-Y. Yeom, and Y.-H. Cho, "Room Temperature GaN Vrtical Cavity Surface Emitting Laser Operation in an Extended Cavity Scheme," Appl. Phys. Lett., Vol. 83, pp. 21–23, 2003.

[20] T. Tawara, H. Gotoh, T. Akasaka, N. Kobayashi, and T. Saitoh, "Low Threshold Lasing of InGaN Vertical Cavity Surface Emitting Lasers With Dielectric Distributed Bragg Reflectors," Appl. Phys. Lett., Vol. 83, pp. 830–832, 2003.

[21] E. Feltin, G. Christmann, J. Dorsaz, A. Castiglia, J.-F. Carlin, R. Butt´e, N. Grandjean, S. Christopoulos, G. Baldassarri, H. von H¨ogersthal, A. J. D. Grundy, P. G. Lagoudakis, and J. J. Baumberg, "Blue Lasing at Room Temperature in an

Optically Pumped Lattice Matched AlInN/GaN VCSEL Structure," Electron. Lett., Vol. 43, pp. 924–926, 2007.

[22] J.-T. Chu, T.-C. Lu, H.-H. Yao, C.-C. Kao, W.-D. Liang, J.-Y. Tsai, H.-C. Kuo, and S.-C. Wang, "Room-Temperature Operation of Optically Pumped Blue Violet GaN Based Vertical Cavity Surface Emitting Lasers Fabricated by Laser Lift Off," Jpn. J. Appl. Phys, Vol. 45, pp. 2556–2560, 2006.

[23] J.-T. Chu, T.-C. Lu, M. You, B.-J. Su, C.-C. Kao, H.-C. Kuo, and S.-C. Wang, "Emission Characteristics of Optically Pumped GaN Based Vertical Cavity Surface- Emitting Lasers," Appl. Phys. Lett., Vol. 89, pp. 1–3, 2006.

[24] C.-C. Kao, T. C. Lu, H. W. Huang, J. T. Chu, Y. C. Peng, H. H. Yao, J. Y. Tsai, T. T. Kao, H. C. Kuo, S. C. Wang, and C. F. Lin, "The Lasing Characteristics of GaN Based Vertical Cavity Surface Emitting Laser With AlN–GaN and Ta2O5 – SiO2 Distributed Bragg Reflectors," IEEE Photon. Technol. Lett., Vol. 18, No. 7, pp. 877–879, 2006.

[25] S.-C. Wang, T.-C. Lu, C.-C. Kao, J.-T. Chu, G.-S. Huang, H.-C. Kuo, S.-W. Chen, T.-T. Kao, J.-R. Chen, and L.-F. Lin, "Optically Pumped GaN Based Vertical Cavity Surface Emitting Lasers: Technology and Characteristics," Jpn. J. Appl. Phys., Vol. 46, pp. 5397–5407, 2007.

[26] T.-C. Lu, C.-C. Kuo, H.-C. Kuo, G.-S. Huang, and S.-C. Wang, "CW Lasing of Current Injection Blue GaN Based Vertical Cavity Surface Emitting Laser," Appl. Phys. Lett., Vol. 92, pp. 1–3, 2008.

[27] E. Petrolati and A. D. Carlo, "The Influence of Mobility Unbalance on GaN Based Vertical Cavity Surface Emitting Lasers," Appl. Phys. Lett., Vol. 92, pp. 15–18, 2008.

Dr. Abd-Elnaser A. Mohammed

Received Ph.D degree from the faculty of Electronic Engineering, Menoufia University in **1994**. Now, his job career is Assoc. Prof. Dr. in Electronics and Electrical Communication Engineering department, faculty of Electronic Emgineering, Menoufia university, EGYPT. Currently, his field and research interest in the passive optical communication Networks, digital communication systems, and advanced optical communication wireless access networks. Analog communication systems, Optical filters and Sensors, digital communication systems, Optoelectronics devices, and Advanced material science, Network management systems, Multimedia data base, Networks Security, Encryption and optical computing systems.

Dr. Ahmed Nabih Zaki Rashed

was born in Menouf city, Menoufia State, Egypt country in 23 July, 1976. Received the B.Sc., M.Sc., and Ph.D. scientific degrees in the Electronics and Electrical Communications Engineering Department from Faculty of Electronic Engineering, Menoufia University in 1999, 2005, and 2010 respectively. Currently, his job carrier is a scientific lecturer in Electronics and Electrical Communications Engineering Department, Faculty of Electronic Engineering, Menoufia university, Menouf, postal menouf city code: 32951, EGYPT. His scientific master science thesis has focused on polymer fibers in optical access communication systems. Moreover his scientific Ph. D. thesis has focused on recent applications in linear or nonlinear passive or active in optical networks. His interesting research mainly focuses on transmission capacity, a data rate product and long transmission distances of passive and active optical communication networks, wireless communication, radio over fiber communication systems, and optical network security and management. He has published many high scientific research papers in high quality and technical international journals in the field of advanced communication systems, optoelectronic devices, and passive optical access communication networks. His areas of interest and experience in optical communication systems, advanced optical communication networks, wireless optical access networks, analog communication systems, optical filters and Sensors, digital communication systems, optoelectronics devices, and advanced material science, network management systems, multimedia data base, network security, encryption and optical access computing systems. He is a reviewer member in high quality scientific research international journals in the field of Electronics, Electrical communication and advanced optical communication systems and networks.