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Research Article

An Investigation of Optical Gain of Nanomaterial AlGaAsIn/InP under CTLSs in Optical Communications

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Abstract. The fundamental aim of this research paper has been to provide a critical role in the study of an investigation on optical gain enhancement of quaternary nanomaterial AlGaAsIn/InP under the CTLSs (*Compressive Type Longitudinal Strains*) in optical type telecommunication systems.

Keywords. Modal type gain intensity; Optical type gain intensity; CTLSs; AlGaAsIn; InP

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1. Introduction

Nowadays, the roles of heterogeneous type nanostructures are going too enhanced in the nanotechnological engineering and computational sciences due to their optical telecommunications type applications. As we know that the fundamental structures are homo type structures but these have not been used in optical communications due to their surface emitter type characteristics. Commonly, the combinations of multiple homo type junctions are known as homo type structures. But this type homo structure has various drawbacks so a substantial type structure has been used that is formed by collection of poly hetero type interfaces. The various types of hetero type nanostructures [1–3, 10, 12, 14, 15] like AlGaAsIn, AsAlPIn, AlGaAs have been utilized to emit the coherent type light and unidirectional light

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in the nanotechnological engineering and communications. There are two types of hetero type nanostructures. One is step index of refraction type nanostructure and second is graded refractive index type nanostructure. In step index refraction type nanostructure, the index of refraction changes abruptly while in the grade index type nanostructure, the index of refraction has been changed by computational techniques. The proposed type heterogeneous nanostructure AlGaAs/GaAs has been widely applied in the optical telecommunications through the fibre optic nanowires by the phenomenon of TI (*Total Internal*) reflection in the nano-technological engineering communications and computational sciences. In this paper, an innovative and computational study on yielding of modal type light of AlGaAs/GaAs has been computed and simulated by computational type nanotechniques in the technological engineering and telecommunications [13, 16, 18]. Section 3 of this article represents the graphical performance of peak type optical gain per cm and optical attenuation in optical type signals in dB/km with wavelength of light photons in nm. Moreover, in the study of spectral performance has been to found the peak value of optical type gain is achieved at the wavelengths of 1300 nm and 1550 nm. Both the wavelengths have very importance contributions in the fiber type optical telecommunications through the optical fiber nano-wires by the process of TI (Total Internal) Reflection phenomenon with negligible attenuations for the optical signals.

2. Theoretical Details

It has been clear that, now a day in the nano technological electronics and optical communication the yielding of optical gain [6, 8, 9, 11] has substantial role due its unique light properties. Commonly, the profit in optical light is given by yielding of light per unit original light intensity and per unit length of active region of structure. In the nano type optoelectronics optical type light yielding (gain) has been achieved when transitions of upward type are enhanced than transitions of downward type while in the equal condition of upward and downward transition the achieved yielding is negligible this type condition is termed as condition of transparent. When the power of absorption is higher than stimulated type emission then loss is obtained in the optical type light. An expression related with yielding of light gain as function of temperature and energy is give as below relation. This yielding gain equation is given by the ref. [5].

$$G(E) = \frac{e^2 h}{2nEm_0^2 \varepsilon_0 c}\left[1 - \exp\left(\frac{E-\Delta f}{k_b T}\right)\right] \sum_{nc,nv} \frac{|M_b|^2 f_c f_v}{4\pi^2 L_W} \frac{(h/2\pi\tau)dk_x dk_y}{\pi(\{E_{nc}+E_{nv}+E_{sg}\}-E)^2+(h/2\pi\tau)^2}.$$

The modal type confinement parameter has critical role in the computing of yielding of modal confinement light gain per cm in the nanotechnological optical communications. The fundamental equation of modal type confinement parameter is given as following type relations

$$\Gamma = \frac{\displaystyle\int_{-W/2}^{W/2} |\varepsilon(z)|^2 dz}{\displaystyle\int_{-\infty}^{\infty} |\varepsilon(z)|^2 dz}.$$

The combined effect of gain enhancement and modal confinement parameter generates the modal type gain. An essential expression of modal type gain in terms of modal confinement parameter and gain enhancement is given by following relation.

$$G_m(\hbar\omega) = \Gamma \times G(\hbar\omega).$$

The relation between change in modal type gain per unit carriers and index of refraction per unit carriers is expressed by parameter of anti-guiding. The parameter of anti-guiding is given by following equation

$$\alpha = 2K \cdot \left(-\frac{dn(E)}{dN}\right) \cdot \left(\frac{dG(E)}{dN}\right)^{-1}.$$

In above equation, the brief details of appropriate terms can be exhibited in refs. [4,7,17].

The appropriate equation of optical attenuation of signals of light in terms of optical power and fiber length is given by below expression

$$A = \left(-\frac{10}{L}\right) \times \log_{10}\left(\frac{P_o}{P_i}\right).$$

3. Results and Discussions

In nano type optoelectronics, the optical type light yielding (gain) has been achieved when transitions of upward type are enhanced than transitions of downward type while in the equal condition of upward and downward transition the achieved yielding is negligible this type condition is termed as condition of transparent. When the power of absorption is higher than stimulated type emission then loss is obtained in the optical type light.

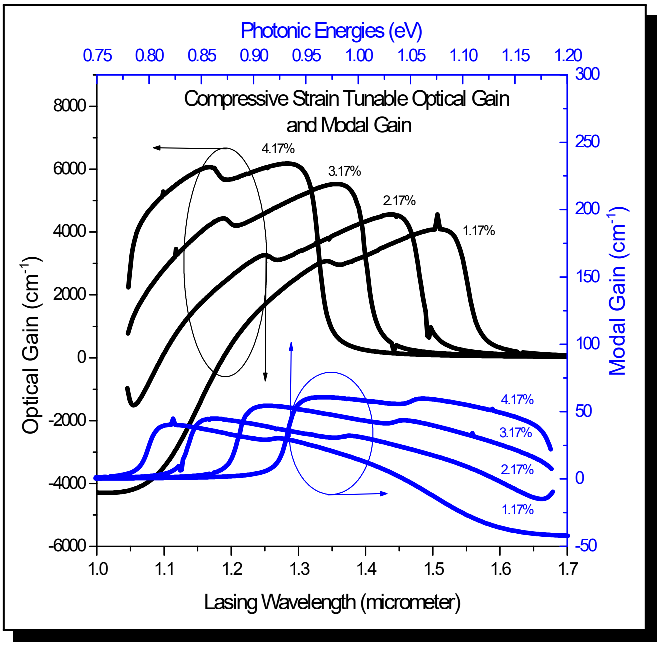

Figure 1. Spectral behaviours of optical gain and modal gain with wavelengths and energies of photon respectively

The spectral type behaviors of intensity of optical type gain and modal type gain with wavelengths of light photons and energies of photons respectively for various percentage longitudinal compressive strains for nano material AlGaAsIn/InP in optical communications has been illustrated in Figure 1. The peaks optical gain spectra tend to lower value of lasing type wavelength from higher value of it when the value of percentage longitudinal type compressive strain is enhanced from 1.17% to 4.17%, and the value of peak optical type gain enhances from ~ 4000 per cm to ~6000 per cm at the ranges of wavelengths (~1500 nm to 1200 nm). This range of length is mostly utilized in the NIR and SWIR applications. Moreover, the achieved optical type gain of wavelengths (1310 nm and 1550 nm) for lasing phenomenon have an essential contribution in current days for the applications of EM radiations (SWIR and NIR) as well as these type wavelengths have also been useful in the fiber optic telecommunications through the FOWCs (*Fiber Optic Wire Cables*) by the method of TI (*Total Internal*) Reflection without attenuations in dB/km of light signals due to much minimal scattering and absorptions.

Next, the graphical behaviors of optical loss attenuation and peak optical gain with wavelengths of light photon in nm for AlGaAsIn/InP have been shown in Figure 2. It has been cleared by Figure 2 that the maximum value of optical loss occurs at the wavelength of 1400 nm while the lowest value of optical type loss achieved at the wavelengths of 1300 nm and 1500 nm. At these wavelengths the values of absorptions and scattering take place minimum. The peak value of optical type gain is reduced as increase in wavelength of lasing process. Figure 3 represents the graphical and computational performances of antiguiding parameter and peak type leakage current per unit cross section area with compressive type percentage longitudinal strains for nanomaterial AlGaAsIn/InP in optical communications. The range of antiguding parameter is a substantial parameter in the semiconducting nanomaterial because it supports the performances of optical and modal type light gains in optoelectronics. The Range of antiguiding parameter has reciprocal behavior with the percentage longitudinal type compressive strains but the peak value of per unit area leakage current has proportional behavior with the percentage longitudinal type compressive strains.

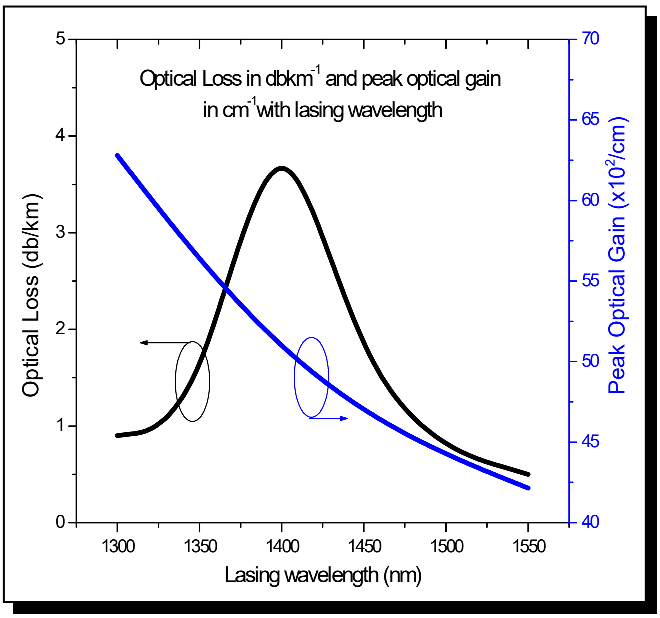

Figure 2. The graphical behaviours of intensity of optical loss and peak optical gain with wavelengths of light photon in nm

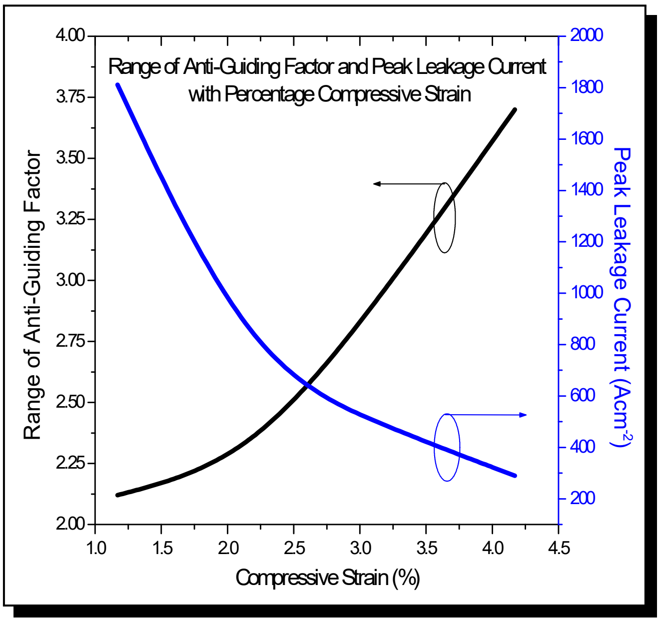

Figure 3. The graphical and computational performances of antiguiding parameter and peak leakage current with compressive type percentage longitudinal strains

4. Conclusions

Under the CTLSs in optical telecommunication systems the fundamental objective of this research paper provides a critical role in the optimized investigation on NIR gain enhancement of AlGaAsIn/InP type heterogeneous nanostructure. In this paper the spectral performances of NIR optical gain with wavelengths and modal NIR gain intensity with energies of light photons for proposed nanostructure have been calculated mathematically, and the graphical and computational performances of antiguiding parameter and peak type leakage current per unit cross section area with compressively percentage longitudinal strains for AlGaAsIn/InP have also been computed. Hence in the results, the achieved peak value of intensity of optical NIR gain of wavelengths (1310 nm and 1550 nm) for lasing phenomenon have an essential contribution in recent and future time for the SWIR and NIR applications. These wavelengths have also been useful in the fiber optic telecommunications through the FOWCs by the method of TI Reflection without attenuations in of optical signals.

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Competing Interests

The author declares that he has no competing interests.

Authors' Contributions

The author wrote, read and approved the final manuscript.

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