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Analysis of Physics of Novel Light-Emitting Diode for Holographic Imaging

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***Abstract*—The paper focuses on the analysis of the physics of a novel light-emitting diode for holographic imaging. The research problems in this study are based on the specific challenges that were discussed in the introduction. The solution for this research problem is accomplished with two approaches such as (i) device modeling, physics of LEDs, and characteristics of LEDs under the theoretical analysis and (ii) fabrication of LEDs, PL and FTIR measurement, performance check, and performance comparison under the experimental studies. The specific objectives of this research are to advance the LED design for optical transmission in 5G communication systems, to recognize the semiconductor material for LED structure, and to approach theoretical and numerical calculations for LED. In these analyses, there are two main approaches for solving the performance of the novel light-emitting diodes. The first one is to develop the effective structure for light emitting diode and the other is to develop the energy diagram design of III-V and II-VI compound-based LED. The simulation analyses were carried out with the help of MATLAB language. The results confirm that the numerical analyses of these two developments could be supported to estimate the outcomes of experimental studies without using real equipment in the laboratory.**

***Index Terms*— Holographic Imaging, Novel Light Emitting Diode, Physics of Semiconductor**

I. INTRODUCTION

MICRODISPLAYS have received much attention as the main display engines of augmented reality/virtual reality (AR/VR) devices due to their small size and high resolution. There are many types of microdisplays such as liquid crystal display (LCD)-based microdisplays that use high-temperature polysilicon (HTPS) technology, liquid crystal on silicon (LCoS), digital micromirror device (DMD), Inorganic light-emitting diode-based microdisplays including quantum dot-based microdisplays, and microLED-based microdisplays. LCoS and DMD have already been used in various applications such as projectors, projection TVs, night vision for military use, and AR/VR glasses. LCoS microdisplays have high luminance and simple fabrication processes, but low response time, low contrast ratio, and relatively large volume and weight due to their external lighting sources. DMD microdisplays have a complex fabrication process and need additional light sources. Advanced technologies are required for high-resolution and low-cost full-color quantum dot-based and microLED-based microdisplays [1-4].

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Although non-flat displays are being marketed, the currently available commercialized displays are mostly bent displays whose shape cannot be changed. The next-generation display, by contrast, will be transformable into various forms. Smart glasses and/or smart lenses will enable augmented reality, displaying information additively over the natural scene behind the glasses or lens. It will be possible to display vital signs (e.g., blood pressure, pulse, respiration rate, and body temperature) or other health information measured by a wearable sensor in real-time through smartwatches. LEDs fabricated in the form of yarns can be woven into fabric and cloth for wearable displays. Ultrathin displays will be attached to the human skin in the form of electronic tattoos. Bendable displays can be utilized as foldable tablets whose screen sizes are tunable. Moreover, transparent flexible displays can be used for smart windows or digital signage, which can display digital information overlapped on the background view [5-8].

In 2018, telecommunication providers began deploying fifth-generation (5G) networks to meet growing demands for data from consumer and industrial users. 5G networks are expected to enable providers to expand consumer services (e.g., video streaming, virtual reality applications), support the growing number of connected devices (e.g., medical devices, smart homes, Internet of Things), support new industrial uses (e.g., industrial sensors, industrial monitoring systems), perform advanced data analytics, and enable the use of advanced technologies (e.g., smart city applications, autonomous vehicles) [9].

The three research challenging issues are given. (1) Effective Novel LEDs Designed for high data rate optical transmission in 5G Telecommunication Systems are essential challenges in real-world applications. (2) High-performance design of the Hybrid System-based LED fabrication process is important in photonic device modeling. (3) Luminescence Intensity and defects would be disturbed to the design of LEDs with decreasing quantum efficiency (internal or external) [10-13].

The research objectives are as follows:

- To advance the LED design for optical transmission in a 5G communication system
- To recognize the semiconductor material for the LED structure
- To approach theoretical and numerical calculation for LED

II. MATERIALS AND METHODS

A. Proposed LED Model Structure

Fig. 1 shows the proposed LED structure for high-speed telecommunication systems with III-V and II-VI compound materials.

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Substrate : Sapphire Substrate
p-type : Gallium Nitride
Active Layer : Zinc Oxide
n-type : MgxZn1-xO
Electrodes : Alloy Materials

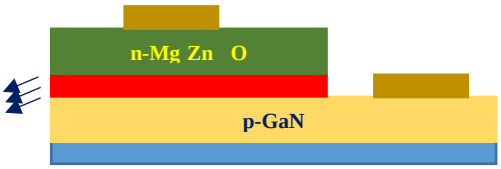


Fig. 1. Proposed LED Structure

B. Hybrid System for Optical Properties Analysis

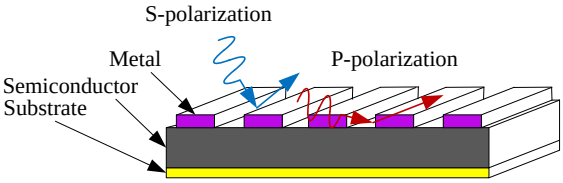


Fig. 2. Measurement Model for Hybrid System

1. Analysis based on Rate Equations
Steady-state Analysis could be observed as

$$\frac{dN}{dt}=\frac{dS}{dt}=0$$

Rate equations take the form of

$$\eta_i \frac{I_0}{qV}-\frac{N_0}{\tau}-v_g g(N_0)S_0=0$$

$$\Gamma v_g g(N_0)S_0-\frac{S_0}{\tau_p}+\Gamma\beta_{sp}R_{sp}=0$$

If in the last equation, we neglect the small spontaneous emission term, we obtain an expression for a photon lifetime

$$\frac{1}{\tau_p}=\Gamma v_g g(N_0)$$

2. Small-signal Analysis with the Linear Gain Model
When neglecting spontaneous emission and using a linear gain model where the gain is given by $g = a\,(N–N_{tr})$, one obtains

$$\frac{dN}{dt}=\eta_i\frac{1}{qV}-\frac{N}{\tau}-v_g a\left(N-N_{tr}\right)S$$

$$\frac{dS}{dt}=\Gamma v_g a(N-N_{tr})S-\frac{S}{\tau_p}$$

3. Small-signal Analysis with Gain Saturation
Let us remind ourselves of the rate equations which were established in the previous section:

$$\frac{dN}{dt}=\eta_i\frac{1}{qV}-\frac{N}{\tau}-v_g g\left(N\right)S$$

$$\frac{dS}{dt}=\Gamma v_g g(N)S-\frac{S}{\tau_p}+\beta_{sp}R_{sp}$$

4. Large-signal Analysis

Large-signal analysis based on rate equations for semiconductor lasers has been reported extensively. The main equations without spontaneous emission are

$$\frac{dN}{dt}=\eta_i\frac{1}{eV}-\frac{N}{\tau}-v_g g\left(N\right)S$$

$$\frac{dS}{dt}=\Gamma v_g g(N)S-\frac{S}{\tau_p}$$

A generalize the gain model to include saturation as follows:

$$g(n)=\frac{g_0+g(N-N_0)}{1+\varepsilon S}$$

III. IMPLEMENTATION

A. *Flowchart for Wave Equation*

Fig. 3 shows the Flowchart for Wave Equation.

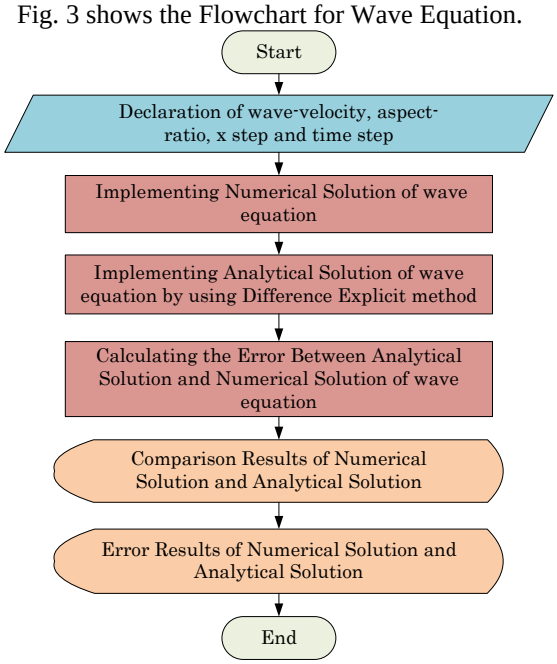


Fig. 3. Flowchart for Wave Equation

B. *Flowchart of Schrödinger Equation Solver*

Fig. 4 shows the Flowchart of Schrödinger Equation Solver.

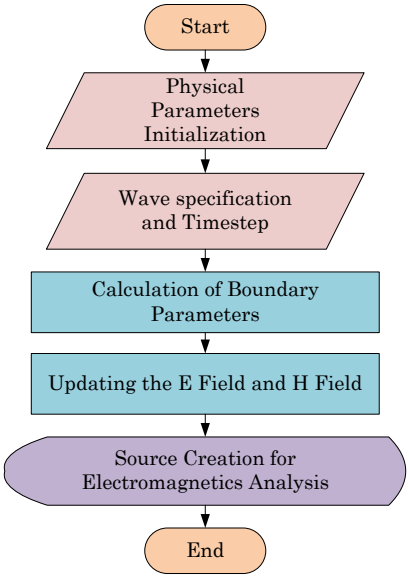


Fig. 4. Flowchart of Schrödinger Equation Solver

C. Flowchart of Finite Difference Time Domain Analysis

Fig. 5 demonstrates the Flowchart of Finite Difference Time Domain Analysis.

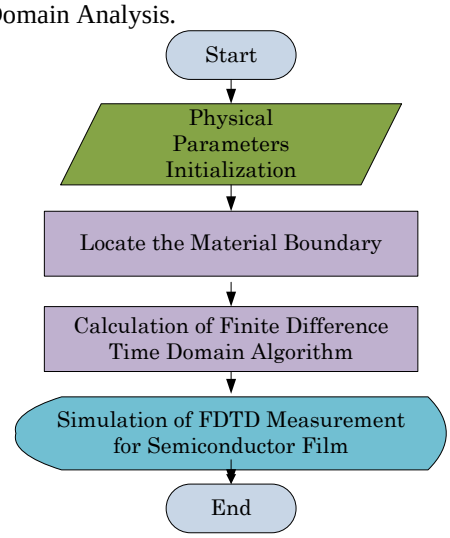


Fig. 5. Flowchart of Finite Difference Time Domain Analysis

D. *Implementation* (Electromagnetics Properties Analysis)

The implementation for the analysis of Electromagnetics properties of the proposed LED design is formulated based on the following governing equations.

1. Governing Equations

$$\nabla . D = \rho$$

$$\nabla . B = 0$$

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

$$\nabla \times H = J + \frac{\partial D}{\partial t}$$

Where:

D = Electric flux density (C/m^2)
B = Magnetic flux density (Wb/m^2)
E = Electric field intensity (V/m)
H = Magnetic field intensity (A/m)
J = Electric current density (A/m^2)
ρ = Electric charge density (C/m^3)

2. FDTD Algorithm

The modeling equations for defining the finite difference condition are revealed in this section. Initially, the finite difference equations for H_x, H_y, and H_z for magnetic field expressions are as follows.

$$\frac{E_z^{i,j+1,k}\Big|_t - E_z^{i,j,k}\Big|_t}{\Delta y} - \frac{E_y^{i,j,k+1}\Big|_t - E_y^{i,j,k}\Big|_t}{\Delta z} = -\frac{\mu_{xx}^{i,j,k}}{C_0}\frac{H_x^{i,j,k}\Big|_{t+\frac{\Delta t}{2}} - H_x^{i,j,k}\Big|_{t-\frac{\Delta t}{2}}}{\Delta t}$$

$$\frac{E_x^{i,j,k+1}\Big|_t - E_x^{i,j,k}\Big|_t}{\Delta z} - \frac{E_z^{i+1,j,k}\Big|_t - E_z^{i,j,k}\Big|_t}{\Delta x} = -\frac{\mu_{yy}^{i,j,k}}{C_0}\frac{H_y^{i,j,k}\Big|_{t+\frac{\Delta t}{2}} - H_y^{i,j,k}\Big|_{t-\frac{\Delta t}{2}}}{\Delta t}$$

$$\frac{E_y^{i+1,j,k}\Big|_t - E_y^{i,j,k}\Big|_t}{\Delta x} - \frac{E_x^{i,j+1,k}\Big|_t - E_x^{i,j,k}\Big|_t}{\Delta y} = -\frac{\mu_{zz}^{i,j,k}}{C_0}\frac{H_z^{i,j,k}\Big|_{t+\frac{\Delta t}{2}} - H_z^{i,j,k}\Big|_{t-\frac{\Delta t}{2}}}{\Delta t}$$

The additional help is to catch the electric field expressions founded on E_x, E_y, and E_z from Maxwell's Equations.

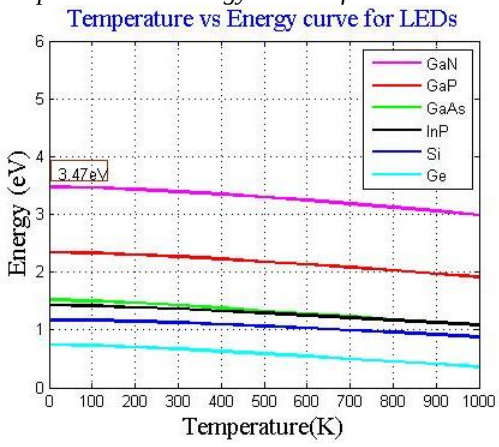
$$\frac{H_z^{i,j,k}\Big|_t - H_z^{i,j-1,k}\Big|_t}{\Delta y} - \frac{H_y^{i,j,k}\Big|_t - H_y^{i,j,k-1}\Big|_t}{\Delta z} = \frac{\varepsilon_{xx}^{i,j,k}}{C_0}\frac{E_x^{i,j,k}\Big|_{t+\Delta t} - E_x^{i,j,k}\Big|_t}{\Delta t}$$

$$\frac{H_x^{i,j,k}\Big|_t - H_x^{i,j,k-1}\Big|_t}{\Delta z} - \frac{H_z^{i,j,k}\Big|_t - H_z^{i-1,j,k}\Big|_t}{\Delta x} = \frac{\varepsilon_{yy}^{i,j,k}}{C_0}\frac{E_y^{i,j,k}\Big|_{t+\Delta t} - E_y^{i,j,k}\Big|_t}{\Delta t}$$

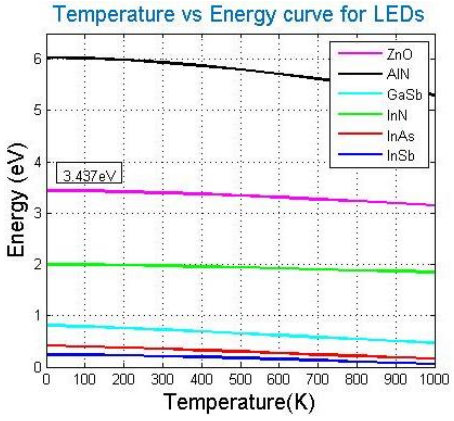
$$\frac{H_y^{i,j,k}\Big|_t - H_y^{i-1,j,k}\Big|_t}{\Delta x} - \frac{H_x^{i,j,k}\Big|_t - H_x^{i,j-1,k}\Big|_t}{\Delta y} = \frac{\varepsilon_{zz}^{i,j,k}}{C_0}\frac{E_z^{i,j,k}\Big|_{t+\Delta t} - E_z^{i,j,k}\Big|_t}{\Delta t}$$

IV. Results and Discussions

A. Temperature vs. Energy Curve of Materials



(a)



(b)

Fig. 6. Temperature Vs. Energy Curve of Materials for (a) GaN and (b) ZnO

B. Energy Difference Vs Carrier Concentrations

Energy Differences concerning carrier distributions for donor and acceptor concentration depend on each other. If the acceptor concentration is increased, the energy difference values will be decreased. If the donor concentration is increased, the energy difference values will increase.

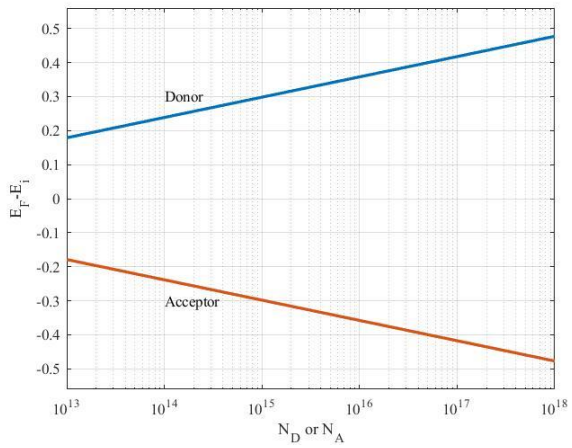


Fig. 7. Results for Energy Difference Vs Carrier Concentrations

In this research work, the MgZnO alloy is used instead of ZnO material for the n-type layer because the bandgap of MgZnO is larger than that of ZnO materials. Then, the band diagram of p-GaN/n-$Mg_{0.4}Zn_{0.6}O$ heterojunction LED is analyzed. The built-in voltage of this LED is 3.528 V for (x=0.4) and Vth is 3.38V. So, the recombination process can occur in this condition. When the Zero-Biased (Equilibrium) to the LEDs, Fig. 8 illustrates the Band Diagram Results for Equilibrium Condition.

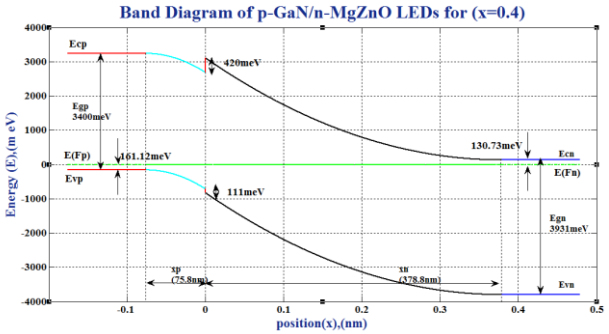


Fig. 8. Energy Band Diagram

Turn on voltage must be approximately 80% of the band gap.
V_{on} = 0.8×3.4=2.72V (GaN).
V_{on} = 0.8×3.931=3.145V(MgZnO)
Threshold voltage of p-GaN/n-MgZnO LED ≈ 3.38 V at 20 mA.

Fig. 9 illustrates the VI Characteristics of the proposed LED structure for a high-speed telecommunication system.

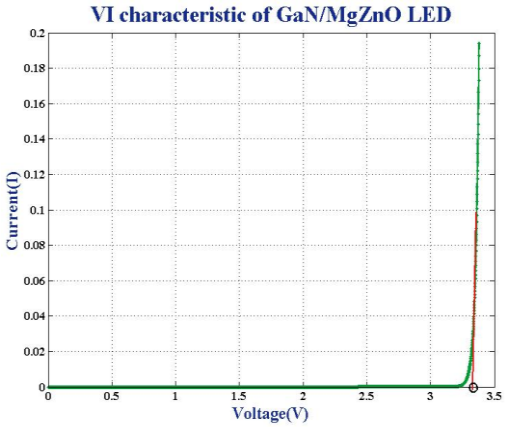


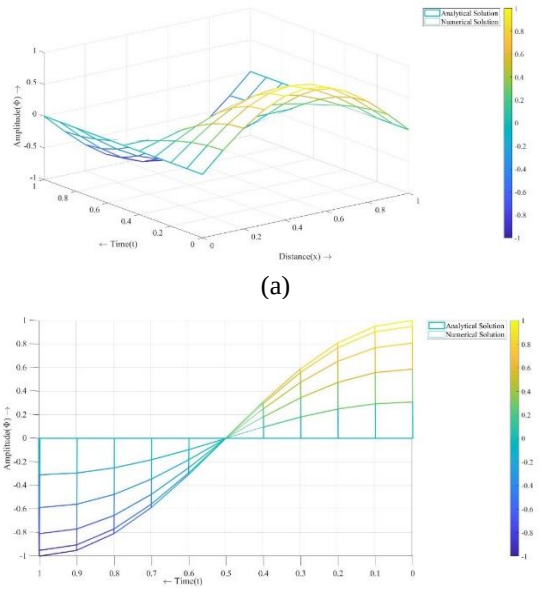
Fig. 9. VI Characteristics

The physical characteristics of the proposed LED structure depend on various parameters. Temperature concerning energy is one of the important physical characteristics of novel LED. Energy difference values depend on the carrier concentration for the numerical analysis. A band diagram is also important for designing the novel LED based on the real parameters. The important considerations of other physical characteristics will be analyzed in the future.

C. Electromagnetics Properties Analysis

1. Wave Equation Results from Maxwell's Equations

The Wave Equation Results from Maxwell's Equations are analyzed with analytical and numerical solutions. Fig. 10 (a) shows the Wave Equation Results from Maxwell's Equations (3D View). Fig. 10(b) mentions the Wave Equation Results from Maxwell's Equations (Front View).



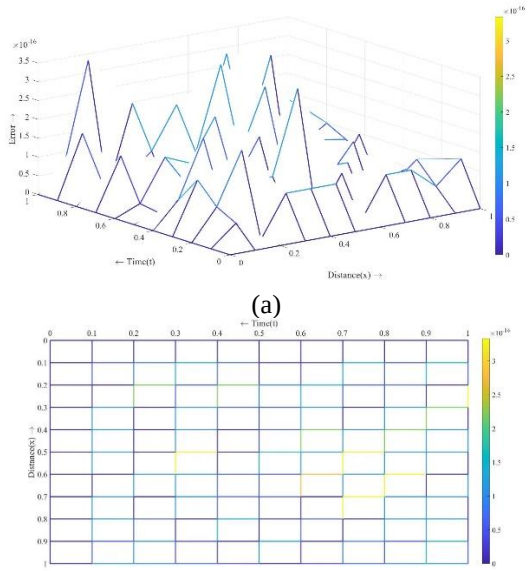
(a)

(b)

Fig. 10. Results for Wave Equation Results from Maxwell's Equations

2. Error Results Between Analytical and Numerical Solution for Wave Equation

Fig. 11 (a) shows the Error Results Between Analytical and Numerical Solutions for Wave Equation (3D View). Fig. 11 (b) demonstrates the Error Results Between Analytical and Numerical Solutions for Wave Equation (Front View).



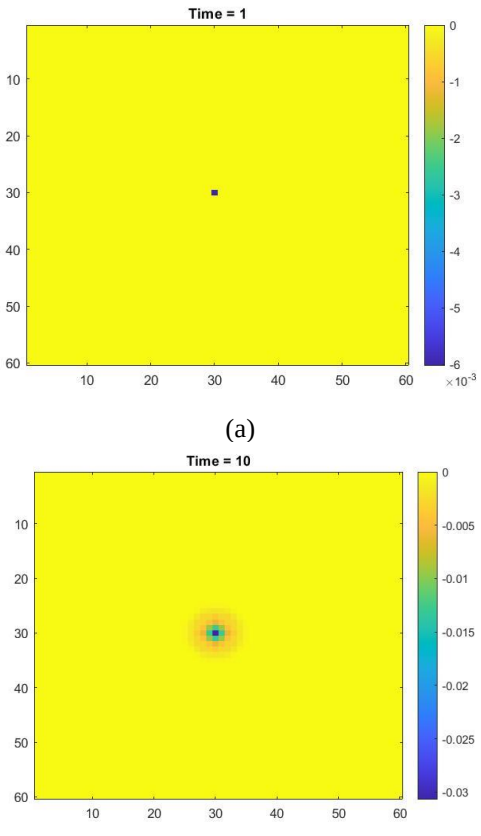
(a)

(b)

Fig. 11. Error Results Between Analytical and Numerical Solution for Wave Equation

3. Schrödinger Equation Solver for Time Step 1 and 10

The Schrödinger Equation Solver for Time Steps 1, 10, 100, and 1000 is developed for the implementation of Maxwell's Equations.

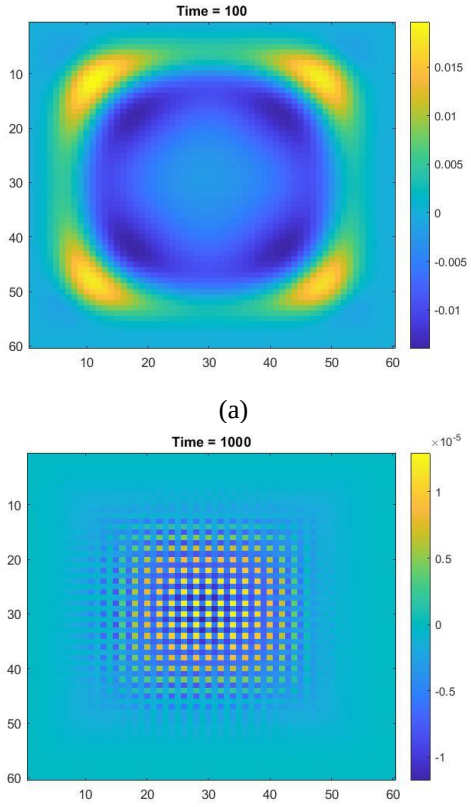


(a)

(b)

Fig. 12. Schrödinger Equation Solver for Time Step 1 and 10

4. Schrödinger Equation Solver for Time Step 100 and 1000



(a)

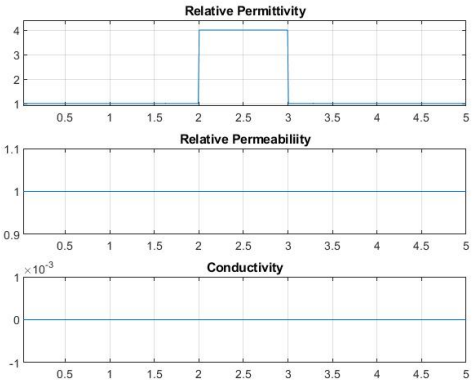
(b)

Fig. 13. Schrödinger Equation Solver for Time Step 100 and 1000

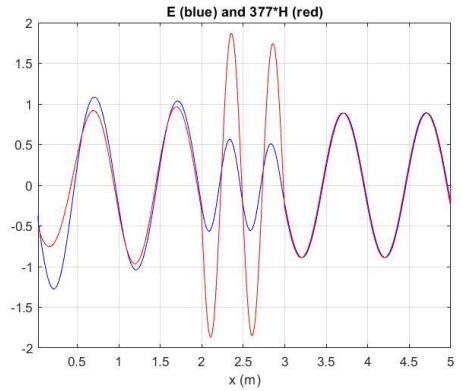
The Schrödinger Equation Solver for Time Steps 1, 10, 100, and 1000 is developed for the implementation of Maxwell's Equations. Fig. 12 (a) shows the FDTD Simulation Results for Time Step=1. Fig. 12 (b) illustrates the FDTD Simulation Results for Time Step=10 Schrödinger Equation Solver for Time Step 100 and 1000. Fig. 13 (a) demonstrates the FDTD Simulation Results for Time Step=100. Fig. 13 (b) points out the FDTD Simulation Results for Time Step=1000.

5. Finite Difference Time Domain Analysis for Source in Photonic Measurement

The Finite Difference Time Domain Analysis for Source in Photonic Measurement is also focused on considering the specific region in semiconductor materials.



(a)



(b)

Fig. 14. Finite Difference Time Domain Analysis for Source in Photonic Measurement

D. Laser Processing Analysis

The optical properties analyses and results could be observed based on the laser technology and FDTD algorithm approaches.

1. Response Function (dB) concerning Frequency (GHz) according to Laser Power

The gain compression parameter ϵ has a small value and the term ϵS is small compared with the one even at very high optical power. The effect of this term on DC properties is small and can be neglected.

However, it significantly affects the dynamics of a semiconductor-metal structure. Fig. 15 shows the response function (dB) concerning Frequency (GHz) according to laser power.

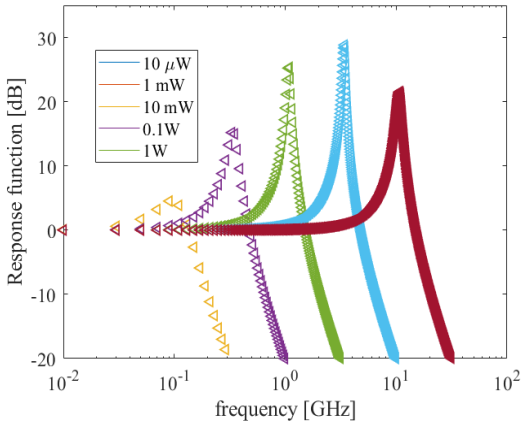


Fig. 15. Response Function (dB) concerning Frequency (GHz) according to Laser Power

2. Response Function (dB) concerning Frequency (GHz) according to Dielectric Function

The plot of response r(ω) is shown in Figure for three values of ϵ. The effect of gain compression parameter ϵ is visible.

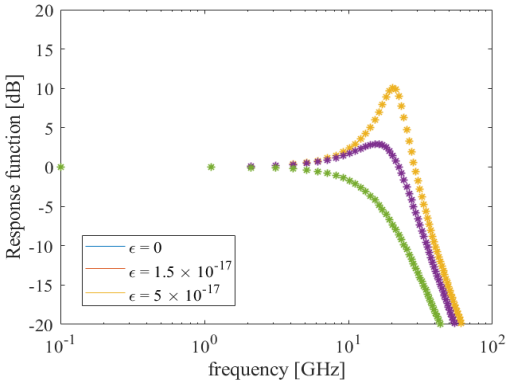


Fig. 16. Response Function (dB) concerning Frequency (GHz) according to Dielectric Function

3. Carrier Density and Photon Density concerning Time (ns)

Numerical solutions of large-signal rate equations after applying rectangular current pulse at t = 0. Normalized values of electron density N(t) and photon density S(t) are shown in Fig. 17. One can observe that when the spontaneous emission term in the rate equation for photons is neglected, photon density tends to zero (steady-state value) as t → ∞, the result which is also evident from the steady-state analysis.

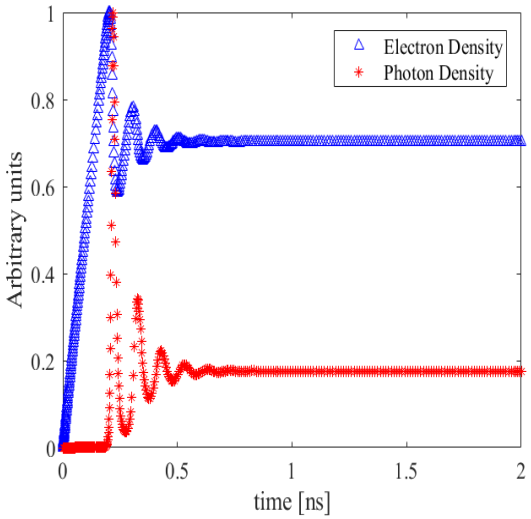


Fig. 17. Carrier Density and Photon Density concerning Time (ns)

4. FDTD Calculation for quantum mechanics analysis (30 Degrees)

The FDTD consideration on metal-semiconductor structure with P- and S- polarization based on difference inclination angles of optical sources such as 30 degrees, 45 degrees, and 55 degrees are analyzed.

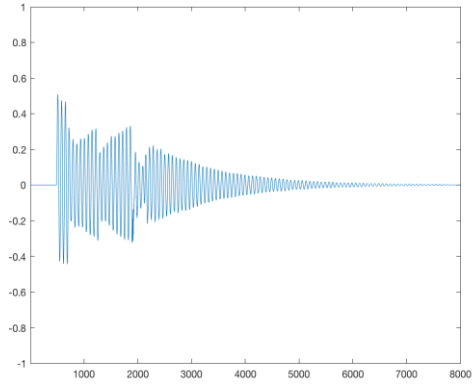
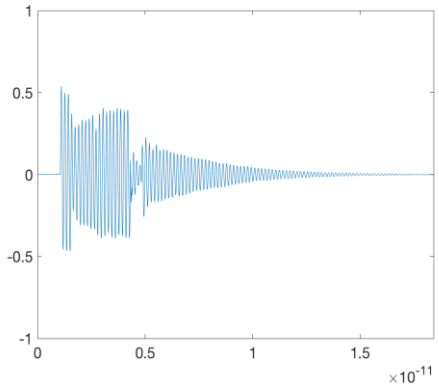


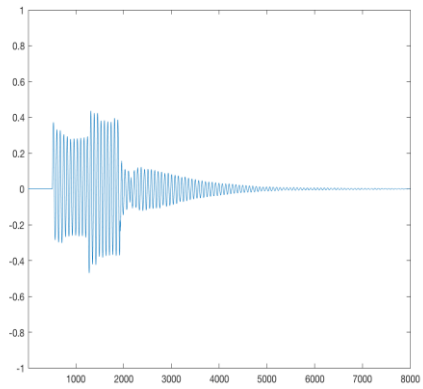
Fig. 18. FDTD Calculation for quantum mechanics analysis (30 Degrees)

5. FDTD Calculation for quantum mechanics analysis (45 Degrees) and (55 Degrees)

The FDTD analysis on the metal-semiconductor structure is a challenging issue for designing the hybrid photodiode design. The incident angles of 30 degrees, 45 degrees, and 55 degrees are not important to consider the electromagnetic properties but the observation of optical power for specific material could be observed. The finite difference method is one of the solutions to solve the quantum mechanics analysis for high-performance devices. The combination of such material systems should be promising for the future generation of III-V-based optoelectronic devices for High-Speed Applications because of the unique long-wavelength capability.



(a)



(b)

Fig. 19. FDTD Calculation for quantum mechanics analysis (45 Degrees) and (55 Degrees)

V. Conclusion

The LED design for Optical Transmission in 5G Telecommunication will be developed. The device modeling of LEDs would be performed by using the physics of LEDs. The physical parameters for the theoretical analysis of LEDs could be utilized and specific device structures would be formulated. To use the MgZnO instead of the ZnO for n-type, the color range could be varied from blue to ultra-violet emission in $Mg_xZn_{1-x}O$. With **n-MgZnO**, it is more closely to the **ultra-violet range**. Based on this work, the p-GaN/n-MgZnO heterojunction LED could be utilized to make the **UV LED**. Electromagnetics Properties analysis could be supported to analyze the optical properties consideration. The optical properties analysis could be extended to measure the photonic characteristics. The source for measurement could be checked for holographic imaging with a developed LED design. According to this simulation results, the optical source for the interface region of metal and semiconductor structure confirmed the quantum mechanics analysis for carrier lifetime. The second portion is considered based on the FDTD method. The inclination angles of 30, 45, and 55 degrees are considered in this study. This emission is allowed by forming electric dipoles based on the boundary condition or interface polarization charges at pairs of metal-semiconductor interfaces that face each other.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author Contributions

This study mainly focuses on the Analysis of the Physics of Novel Light Emitting Diode for Holographic Imaging. The theoretical analyses on mathematical modeling for Novel LED design are vital role in enhancing the high-performance telecommunication system with holographic imaging. This work could be provided to find the solution for research problems in advanced semiconductor device modeling under photonic technology in reality.

Funding

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REFERENCES

[1] Choi, S., Lee, H., Ghaffari, R., Hyeon, T., & Kim, D. H. (2016). Recent advances in flexible and stretchable bio-electronic devices integrated with nanomaterials. *Advanced materials*, *28*(22), 4203-4218.

[2] Kim, R. H., Kim, D. H., Xiao, J., Kim, B. H., Park, S. I., Panilaitis, B., ... & Rogers, J. A. (2010). Waterproof AlInGaP optoelectronics on stretchable substrates with applications in biomedicine and robotics. *Nature materials*, *9*(11), 929-937.

[3] Park, S. I., Xiong, Y., Kim, R. H., Elvikis, P., Meitl, M., Kim, D. H., ... & Rogers, J. A. (2009). Printed assemblies of inorganic light-emitting diodes for deformable and semitransparent displays. *science*, *325*(5943), 977-981.

[4] Han, T. H., Lee, Y., Choi, M. R., Woo, S. H., Bae, S. H., Hong, B. H., ... & Lee, T. W. (2012). Extremely efficient flexible organic light-emitting diodes with modified graphene anode. *Nature Photonics*, *6*(2), 105-110.

[5] Liang, J., Li, L., Niu, X., Yu, Z., & Pei, Q. (2013). Elastomeric polymer light-emitting devices and displays. *Nature Photonics*, *7*(10), 817-824.

[6] Yang, J., Choi, M. K., Kim, D. H., & Hyeon, T. (2016). Designed assembly and integration of colloidal nanocrystals for device applications. *Advanced materials*, *28*(6), 1176-1207.

[7] Dai, X., Deng, Y., Peng, X., & Jin, Y. (2017). Quantum-dot light-emitting diodes for large-area displays: towards the dawn of commercialization. *Advanced materials*, *29*(14), 1607022.

[8] Pimputkar, S., Speck, J. S., DenBaars, S. P., & Nakamura, S. (2009). Prospects for LED lighting. *Nature photonics*, *3*(4), 180-182.

[9] Tun, H. M. (2021). Radio network planning and optimization for 5G telecommunication system based on physical constraints. *Journal of Computer Science Research*, *3*(1), 1-15. https://doi.org/10.30564/jcsr.v3i1.2701

[10] Win, P. S., Swe, H. M. T., & Tun, H. M. (2021). Computerized FDTD Method for Longitudinal Optical Phonon Energy on Semiconductor Hybrid Structure for High Power Devices Fabrication. *Journal of Computer Science Research*, *3*(2), 39-51. https://doi.org/10.30564/jcsr.v3i2.3139

[11] Tun, H. M., & Nwe, M. S. (2022, February). Fabrication of High Performance High Electron Mobility Transistor Design Based on III-V Compound Semiconductor. In *Proceedings of the 11th International Conference on Robotics, Vision, Signal Processing and Power Applications: Enhancing Research and Innovation through the Fourth Industrial Revolution* (pp. 376-381). Singapore: Springer Singapore. https://doi.org/10.1007/978-981-16-8129-5_59

[12] Amar, A., Radi, B., & El Hami, A. (2021). Reliability based design optimization applied to the high electron mobility transistor (HEMT). *Microelectronics Reliability*, *124*, 114299.

[13] Tun, H. M., Than, T., Than, M. M., Tun, K. S., Naing, Z. M., Latt, M. M., & Moe, W. K. (2018). Analysis on Research and Education for Electromagnetic-Applied Subjects with Finite Difference Time Domain Theory. *American Journal of Electromagnetics and Applications*, *6*(1), 6-16. https://doi.org/10.11648/j.ajea.20180601.12



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