Advances in blue and white Light Emitting Diode using AlInGaN mesa structure and Display Module

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Abstract : The main goal of this work is advances in 1.0mm × 0.5mm light emitting diode using AlInGaN cell structure and display module. In the first place, we proposed 200μm × 200μm cell structure using AlInGaN. Secondly, we describe new type 1.0mm × 0.5mm blue and white LED fabrication procedure and results of an examination include mobile application.

Key Words : AlInGaN, 1005size Chip LED, Display module

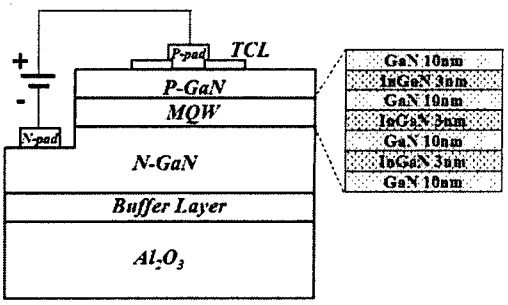
1. INTRODUCTION

In this article, we describe the smaller size light emitting diode (LED). The LED is a basic element for many electronic devices and industrial applications such as liquid crystal display (LCD) TV's, mobile applications and light source of illumination devices [1]. Especially, the overall performances of mobile applications are highly dependent on the LED design. Many researchers have studied to fabricate the smaller LED, reason that it has a simple structure and thereby can provide useful device for human life. Nowadays, most of personal mobile phones use the LED for LCD display backlight unit and numeric key lighting. The most widely used LED in such applications is a 1.6mm×0.8mm(1608size) LED[2].

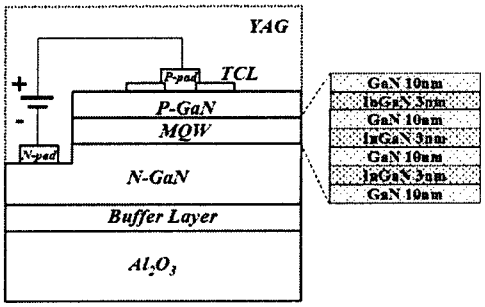
It reason that we attempted to develop a new light emitting diode with smaller size 1.0mm×0.5mm(1005size), for display applications, which is the smallest size among commercially available LEDs. To implement the 1005size LED we fabricated the 200μm×200μm AlInGaN cell structure and proposed a packaging procedure for it. Futhermore, we designed new control integrated circuits (IC) with MAXIM Dallas for mobile handset application.

2. EXPERIMENT

A new type *1.0mm×0.5mm* size LED packaged technology is vast significant for dice cell structure stability and fabricated procedure in this work. Therefore, we will describe of developed new type *1.0mm×0.5mm* size LED and its using displayed mobile application method. Fig.1(a) shows we proposed 200μm × 200μm AlInGaN MESA structure of blue LED used *AlInGaN*. Fig.1 (b) is 200μm × 200μm AlInGaN MESA structure of white LED used *AlInGaN*. This bare dies are quite small size structure. Moreover, we applied a top surface emitter method for *AlInGaN* bare dies.



(a) 200μm×200μm AlInGaN MESA structure of blue LED



(b) 200μm×200μm AlInGaN MESA structure of white LED

Fig. 1. AlInGaN MESA structure of blue and white LED

The 200μm × 200μm mesa dies are composed of Al_2O_3 substrate, buffer layer, N-GaN layer, Multi-Quantum Well layer and P-GaN layer. N-GaN is grown above the buffer layer on Al_2O_3 substrate. N-pad, negative bias, locates in N-GaN layer. On the other hand dies are composed of P-pad, positive bias, locates in above P-GaN TCL layer. MQW layer is placed in between N-GaN layer and P-GaN layer. As shown in Fig.2, the cathode and anode are formed of a Gu material, It shown wire bonding process complete to silver filled and die attached process. We found a defect

of inrushing solder cream into 200 μm × 200 μm dies at our first try. The reason was unconsidered surface mount condition and the amount of solder cream. Thus, we concentrated on those conditions. We tried several times of pilot samples and finally the problem was fixed by design-change of electrode pad.

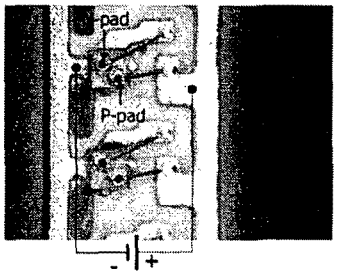


Fig. 2. Bare LED image of 1.0 mm × 0.5 mm size blue - color LED array including 200μm×200μm dies

Table.1 shows the material description of each inner layer about we proposed new type 1.0mm×0.5mm size blue-color LED. In this 1.0 mm × 0.5 mm chip type LED technology can be easily apply for growth the1.0 mm × 0.5 mm white color-LED. Reason why, it can be used not only the same die but also the same fabrication process. For instance, 1.6 mm × 0.8 mm white LEDs popularized adding YAG materials in mold section on blue dies [3]. However, nobody tried to 1.0mm×0.5mm chip type white color like as in this work. Therefore, It is a significant aspect.

Table1. Material description of each Inner layer section; 1.0mm×0.5mm blue LED.

Section	*Raw Materials*
Substrate	*PCB*
Electrode Pad	*Gu/Ni/Au/Sn*
Electrode Pattern	*Gu/Ni/Au/*
Silver filled	*Ag/Solidify solvent*
Dice	*AlInGaN*
Wire	*Pure Gold*
Molding	*Epoxy8523*

3. RESULTS

An experiment was performed to verify the feasibility of the proposed method. We proposed electrical forward voltage of 1.0mm × 0.5mm blue color-LED is 2.7V at forward current 2mA. The operating voltage range is 2.5V to 3.0V at 2mA. The color Bin range is minimum 18mcd to 28mcd at 2mA. Fig. 3 shows a uniform emission image of 1.0mm × 0.5mm size packaged LED, it operated at 2.7V. characteristic of relative intensity versus wavelength. We proposed LED wavelength result display of between *420nm* and *500nm*. Futhermore, x-axis chromaticity coordinates marked 0.28, y-axis chromaticity coordinates marked 0.26 at 2mA Bin range.

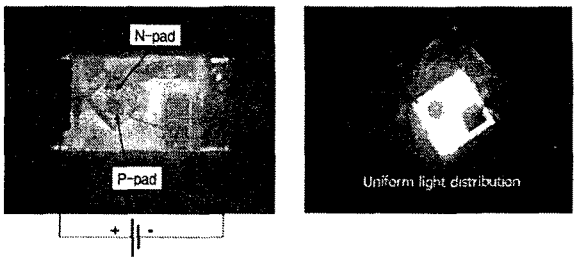


Fig. 3. Proposed blue LED polarities;1.0 mm × 0.5 mm (a) and Emission image (b).

4. CONCLUSION

Fig.4 shows the realized text display image at mobile application it used we proposed 1.0mm×0.5mm size chip type blue LED. We suggested 1.0mm×0.5mm LED display module showed a good performance in a dark environment and night. It has advantage of long visibility range. Moreover, it can be possible real-time displaying at incoming call, scrolling music title and alarm function. As a result, we thought our suggested and developed 1.0mm×0.5mm chip type blue LED is successful task. At the same time we expect the 1.0 mm × 0.5 mm chip type blue LED will apply industrial goods and personal mobile applications.

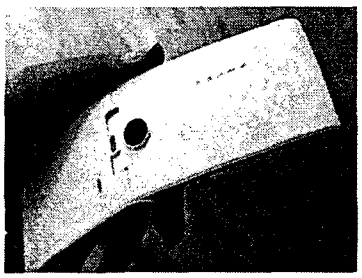


Fig. 4. Scrolling Incoming call text image applied personal mobile handset.

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