COMPARISON ON CHARACTERISTICS OF INGAN-LEDS ON SAPPHIRE SUBSTRATES AND (-2 0 1) β-GA_2O_3 SUBSTRATE

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Abstract

To systemically compare the characteristics of a InGaN-LEDs on sapphire substrate and (-2 0 1) β-Ga_2O_3 substrate, which include electroluminescence spectrum, and Light-Current-Voltage (LIV) curves.

Introduction

β-Ga_2O_3, with large energy bandgap of 4.8eV-4.9eV is the stable under any temperature and conditions . Thanks to the growth method development, low-cost and large single crystal β-Ga_2O_3 wafer can be mass produced. A single crystal gallium oxide wafers become a potential candidate as a substrate for GaN-based devices owing to the lattice mismatch between β-Ga_2O_3 and GaN was found to be about 2.6-4.7%.

In this paper, we use commercially available 2-inch (-2 0 1) β-Ga_2O_3 wafer with intentional Sn doping and also commercial 2-inch sapphire, both been treated with acetone, methanol and isopropanol solvent clean. then fabricated the same LED structure . The characteristics of the two LEDs on a sapphire substrate and β-Ga_2O_3 substrate by measuring the photoluminescence spectrum, electroluminescence spectrum, and Light-Current-Voltage (LIV) curves were observation and analyzation.

Experiment

Step1.Wafer cleaning:

The procedure follows two steps, which one was organic solvent cleaning process. Next was acid cleaning process.

Step2.Deposited Nuclear layer:

The wafers have been put into the APMOCVD. During an epitaxial process, trimethylgallium (TMGa) and ammonia (NH3) were employed as the reactant source materials for Ga and N, respectively.With the temperature of wafer raised to the temperature of 500°C, a GaN buffer layer of 25nm-thick deposition on a sapphire substrate in a carrier gas of hydrogen. Since Ga_2O_3 wafer can be easily etched with hydrogen, the GaN nuclear layer growth on β-Ga_2O_3 substrate in a nitrogen ambient.

Step3.Deposited u-GaN and LED structure:

Deposited undoped GaN layer with 2μm-thick at 950°C (LT) and 2μm-thick undoped GaN layer at 1180°C (HT) on the GaN buffer layer .Final follow by fabricating a LED structure consisted of n-GaN, InGaN/GaN-MQW, p-GaN.

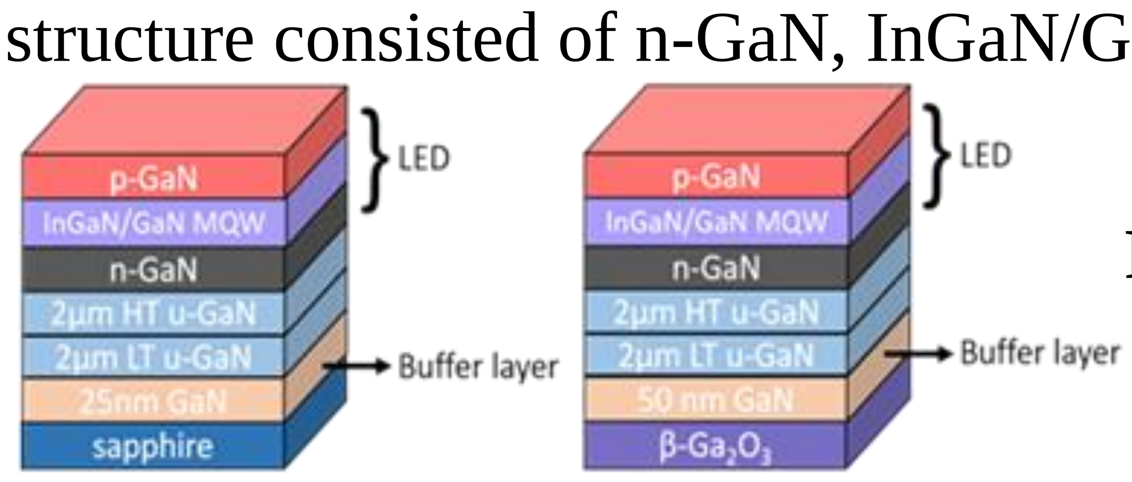

Fig.1 device structure

Reault and Discussion

Electroluminescence (EL) spectrum measurment:

At an injection current of 20mA, the peak wavelength of LEDs on sapphire substrate and β-Ga_2O_3 substrate also revealed 390nm and 385nm, individually.

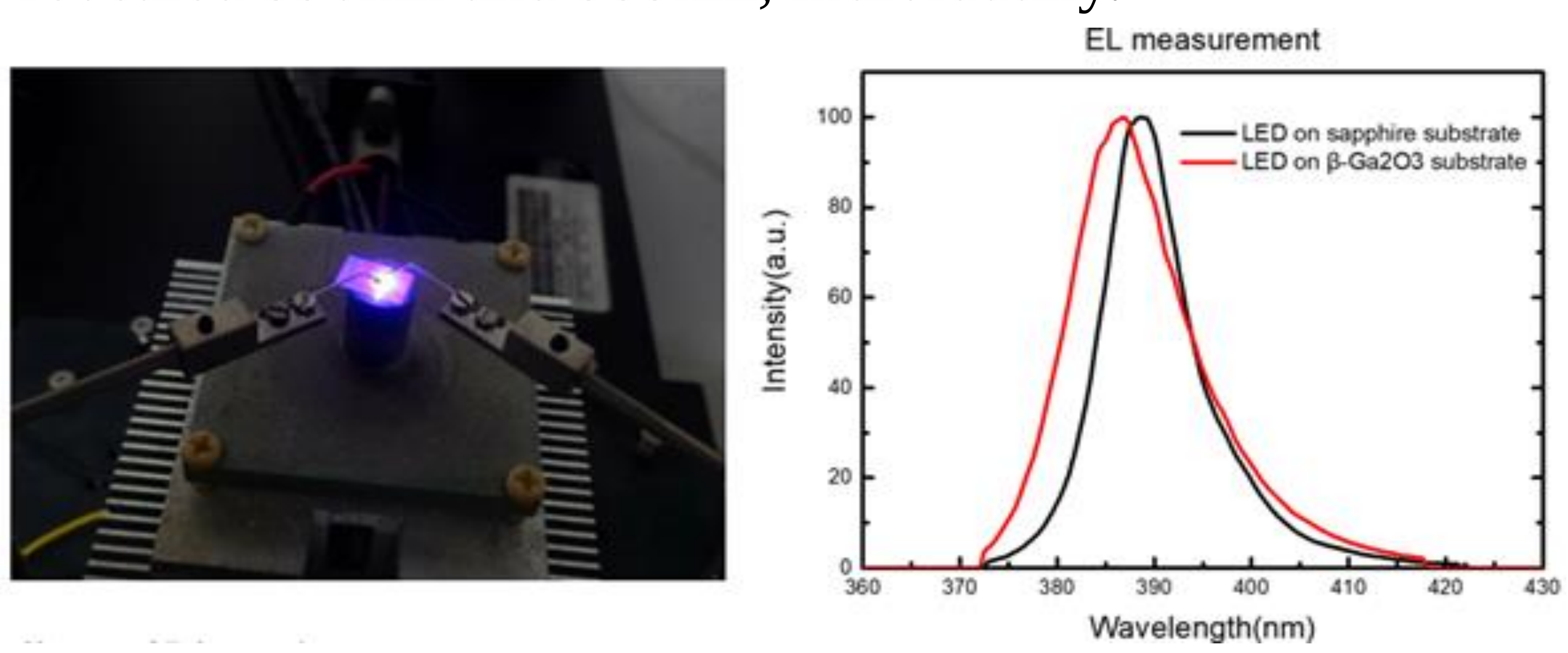

Fig.2 EL spectrum of LEDs on sapphire substrate and β-Ga_2O_3 substrate

LIV curve:

Turn on voltage of both samples was about 3V. With the injection current achieving 50mA, forward voltages were 6.8V and 4V for LED on sapphire substrate and β-Ga_2O_3 substrate, respectively. Competitive output power between the two samples.

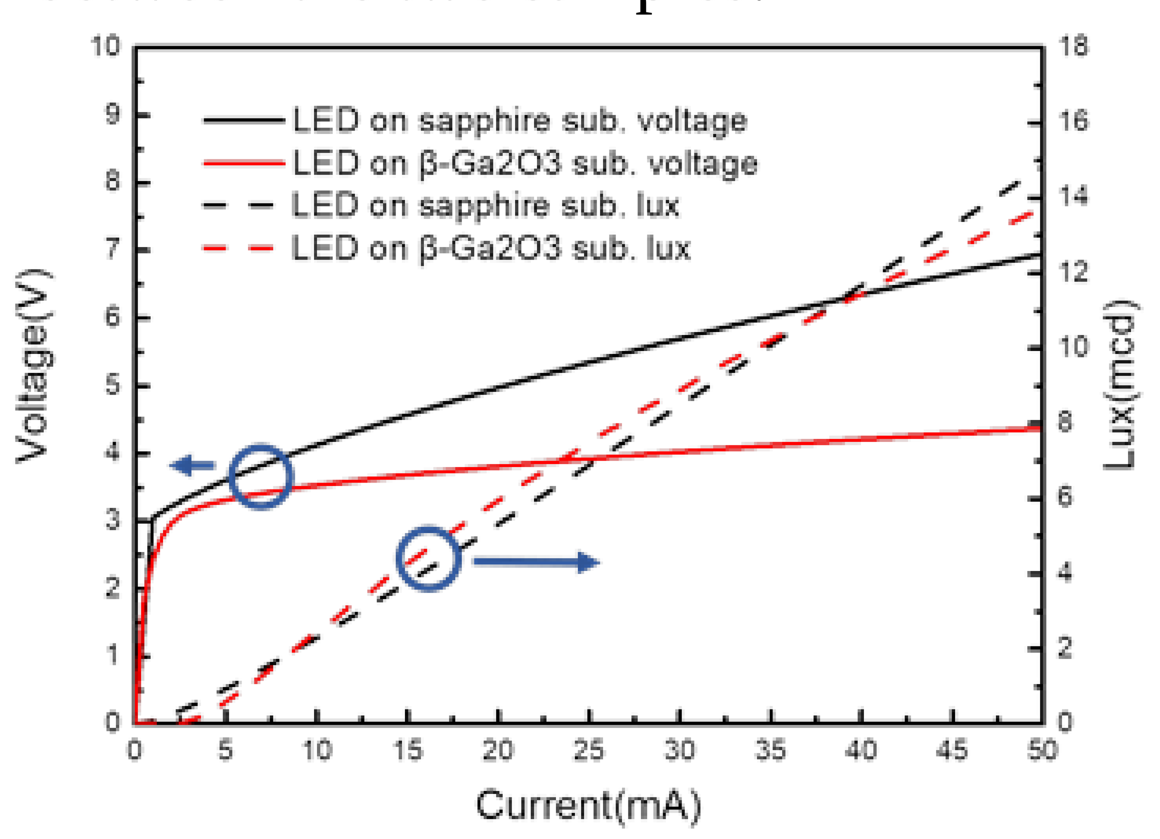

Fig.3 L-I-V curve of the two LEDs the black line is LED on sapphire substrate and the red line is one on β-Ga_2O_3 substrate. The solid line and dash line represent forward voltage and output intensity, respectively.

Conclusion

- The results revealed the characteristics of LED deposited on the β-Ga_2O_3 substrates were competitive.
- The β-Ga_2O_3 is not only for optical devices but also for high power devices.
- In the future, the studies of β-Ga_2O_3 definitely play an important role.