Characteristic in Mg-doped p-type GaN changing activation temperature in N_2 gas ambient

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Abstract : Conventional furnace annealing (CFA) for activating Mg-doped p-type GaN films had been performed in pure N_2 ambient. All sample activated the same gas ambient. The annealing process change temperature : the first process is performed at 550 °C for 10 min. but, the first process is the same bulk. From second to five process increase activation temperature to change 50 °C and annealing time keeping for 10 min. It is found that the samples characteristic measure hall measurement. Similar results were also evidenced by photoluminescence (PL) measurement.

Key Words: Optoelectronic device; Mg-doped p-type GaN ; Conventional furnace annealing(CFA); Photoluminescence (PL); Hall measurement

1. Introduction

Gallium nitride (GaN)-based materials are very important for application in Blue LED(Lighting Emitting Diode) and ultraviolet optoelectonic devices due to direct and large band gap (3.4 eV). To these applications, the p-type GaN film is a critical concern to the success of GaN-based lighting emitting diodes[1,2] and laser diodes (LDs)[3]. Magnesium had been the common p-type dopant for GaN[4,5] growth using metalorganic chemical vapor deposition (MOCVD). However, it is well known that the as-grown Mg-doped GaN films exhibit high resistivity and do not have any p-type conduction [6-8].

To activate Mg-doped GaN, we are used the two method. The first method is conventional furnace annealing (CFA)[9]. The CFA due to a longer annealing time. Ths second method is rapid thermal annealing (RTA). The RTA has been used to activate dopants due to shorter annealing time than the CFA.

In this paper, samples to activate are used CFA method. The activation conditions are the same N_2 ambient[10] and different temperature. Four samples can be found the activation characteristic.

2. Experiments

The p-GaN films used in this study were grown by lowpressure MOCVD on c-plane sapphire substrate. A 300 Å thick AlN buffer(LT buffer) layer was grown at 600 °C, followed by a 3 ㎛ thick undoped highly insulating GaN layer grown at 1000 °C and 76 Torr. Finally, a 1.5 ㎛ thick Mg-doped GaN layer.

Samples were cut into 1 cm × 1 cm pieces and then loaded into CFA system with an ambient gas of pure N_2. The CFA annealing with an ambient N_2 is between 550℃ and 750℃ of different 50℃ degree temperature and for 10 min. After annealing, the GaN samples were cleaned by using aqua regia, followed by DI water. Samples to ensure activation was measured PL Intensity used the Accent RPM 2000. The ohmic contact was used Indium. Indium are annealed to 200℃ on hot plate. The EGK HEM2000 are used to measure the mobility and hall characteristics of our samples.

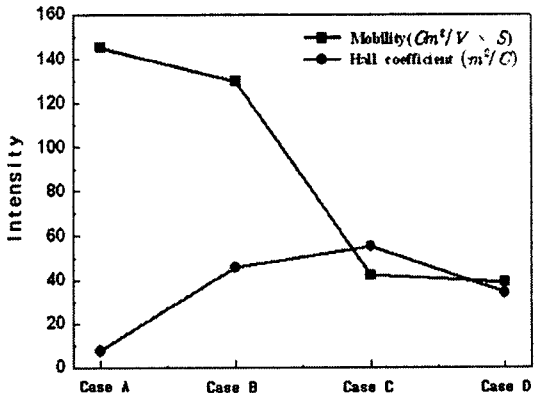

Fig. 1. Mobility and Hall characteristics of four samples

3. Results and discussion

The sample activated 550 °C temperature is the same bulk.

Table 1. Four sets of different temperature cases for activating Mg-doped p-type GaN films

	Case A	Case B	Case C	Case D
Temperature	600°C for 10 min	650°C for 10 min	700°C for 10 min	750°C for 10 min

The other samples express Table. 1. All case sample measure characteristic. Fig. 1. be shown attribute samples. Given the changes in temperature and checking mobility of samples and increasing temperature are reduced mobility. especially, Activation in 700 °C temperature is reduced than 650 °C temperature. Activation temperature over 700 °C are saturation. Activation increasing temperature be shown to be rising hall coefficient. 650 °C temperature especially are rising hall coefficient. also, Activation temperature over 700 °C are saturation.

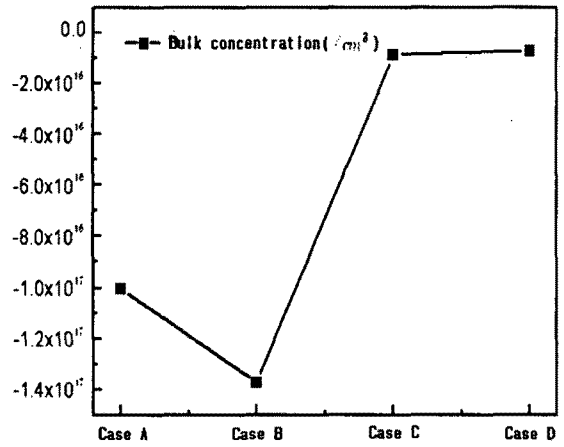

Fig. 2. Bulk concentration of four samples

Fig. 2. be shown bulk concentration of samples. Activation in 650°C temperature is low bulk concentration.

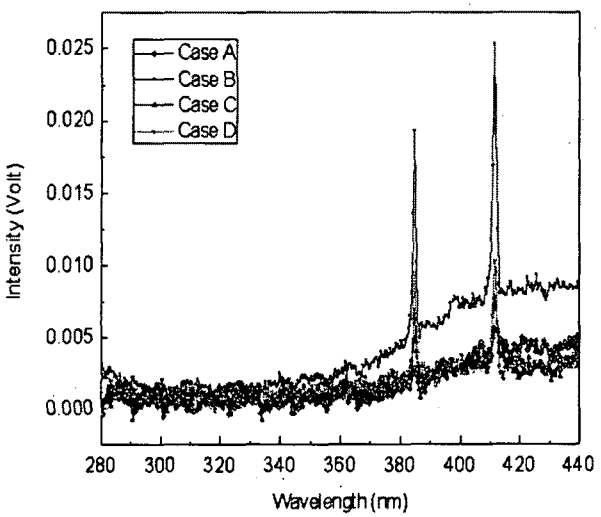

Fig. 1. PL spectrum for four samples

Therefore, The Photoluminescence (PL) of samples are attributed Fig. 3. Activation in 650°C temperature is the better than the other.

4. Conclusions

Changing activation temperature are affected mobility, hall, PL and so. Also, Mg-doped p-type GaN activation temperature is very important ohmic contact. As compared with the activation in different temperature, 650 °C activation exhibits better the other activation temperature. In addition, the PL measurements demonstrate the similar results. Thus, a lower bulk concentration can be achieved. The characteristic changing activation temperature is an explanation for our study.

Acknowledgement

The authors gratefully thank Professor C. J. Kim, University of Seoul. This work was supported by Korea Electronics Technology Institude.

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