

Plasma-Induced Damage of GaN by Chlorine-containing Plasma

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1. Introduction

Gallium nitride is a well-known semiconductor that has a wide bandgap and realize the emission of high energy photons. The material now tries to be applied to the high power devices, such as power inverters etc. With the use of our current technology, many elements will be fabricated even on a GaN substrate like a conventional silicon substrate. Plasma is definitely utilized for the fabrication, but the use of plasma could induce undesirable changes on the elements on the substrate. We have so far monitored GaN films during and after the plasma exposure. In particular, our in-situ monitoring was made with the photoluminescence (PL) that is emitted from a GaN film by means of excitation with external illumination.[1] In this presentation, we will present the following research, especially with the use of chlorine containing plasma.

2. Preliminary Experimental Result

Fig. 1 shows one of preliminary results in order to understand the mechanism of damage creation on the GaN that is exposed in processing plasma. The figure shows the normalized intensity of near-band edge (NBE), which was integrated from 350 to 380 nm in order to observe the change of PL property by plasmas. Here, the figure shows the PL evolution 1) without plasma, 2) with argon plasma, and 3) with argon-chlorine (2:1) plasma. The total pressure was 2.3 Pa in this experiment.

As can be seen in the figure, the NBE value decreased as temperature increased. This is a typical phenomenon that can be observed with GaN films. Furthermore, the NBE value shows a different trend for the argon plasma. This result indicates that the argon plasma changed the tendency. However, we did not observe the same trend for the chlorine-containing plasma. Note that argon plasma gives physical effect to GaN, while chlorine-containing plasma gives both physical and chemical effect. This might be strange by considering that the species from chlorine etch the surface. However, we conclude that a fresh layer likely kept showing up during the plasma exposure according to our investigation of plasma emission.

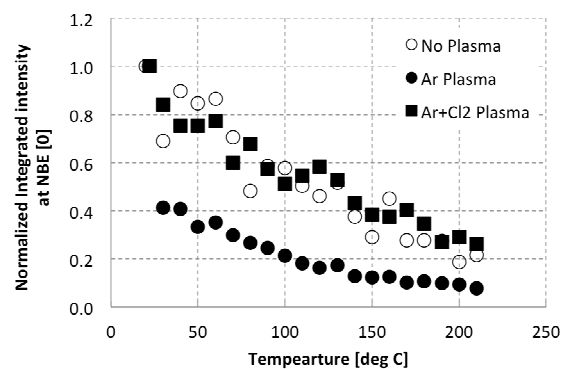


Fig. 1 Evolution of NBE emission as a function of the GaN surface temperature.

References

- [1] M. Chen, K. Nakamura, Y. Nakano, S. Yu, and H. Sugai: Appl. Phys. Lett. 101 (2012) 071105.