GaN-Based Electroluminescence Device with AC Operation Using GaN Powder

Tohru HONDA, Kyousuke MAKI, and Hideo KAWANISHI
Department of Electronic Engineering, Kohgakuin University
2665-1 Nakano-machi, Hachiohji, Tokyo 192-0015, Japan
E-mail: ct11761@ns.kogakuin.ac.jp (T. Honda)

1. Introduction

The inorganic electroluminescence devices (ELDs) are surface emitting sources and those have been actively investigated towards application to the full-color flat-panel display. The greatest obstacle for practical use is a blue-emitting device. Recently GaN-based light emitting diodes (LEDs) and laser diodes (LDs) operating in blue spectral region were reported [1] and those have been commercialized. Those successes in the current injected light emitting devices suggest that GaN will be a good EL phosphor. However, the epitaxial growth of GaN using metalorganic vapor phase epitaxy (MOVPE) or molecular beam epitaxy (MBE) requires a high reacting temperature, which prevents the fabrication of ELDs with low cost and large area. One of the best solutions for the processes with low temperature is that the reaction of GaN and the stacking of its layer are performed separately.

In this study, electroluminescence devices using GaN powder as an emission layer were fabricated and the possibility of GaN-based ELDs was discussed. Thus a GaN powder was used for the light emission layers.

2. Experiment

The purity of the GaN powder was 99.9%, which was fabricated using a nitridation technique of gallium metal. The main impurity in the GaN powder was silicon. The typical structure of GaN-based ELDs is shown in Fig. 1. We specially mentioned the uniformity of the emission layer, which decided the lifetime of the ELDs. The GaN layer was fabricated as follows; first, GaN powder was dispersed in a methanol under the ultrasonic wave. Next, GaN was deposited by dipping the glass substrate with an electrode and a dielectric layer in the solution. In this study, Cr was used as a bottom electrode, which was not transmitted to keep its conductivity. The typical thicknesses of the GaN emission layer, a topside dielectric layer and a bottom side dielectric layer were 2 μm, 0.2 μm and 0.4 μm,

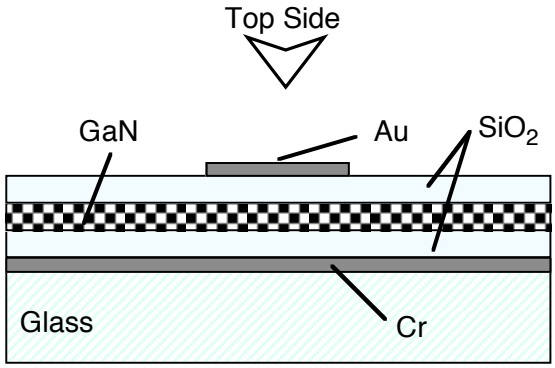

Fig. 1 Structure of GaN-based ELD.

respectively. The maximum temperature of the stacking process was under 300°C, which was very low compared with the process using the epitaxial growth.

3. Results and Discussion

Electroluminescence (EL) spectra were shown in Fig. 2. The EL spectra were observed under the AC operation of 80 V_{max}. The blue-white emission was observed from the GaN-based ELDs. The inset in Fig.2 is the emission pattern observed at the topside. The emission spectra were similar to the cathode luminescence (CL) spectra of a GaN powder. Those results indicate that the EL spectra originate from the GaN powder.

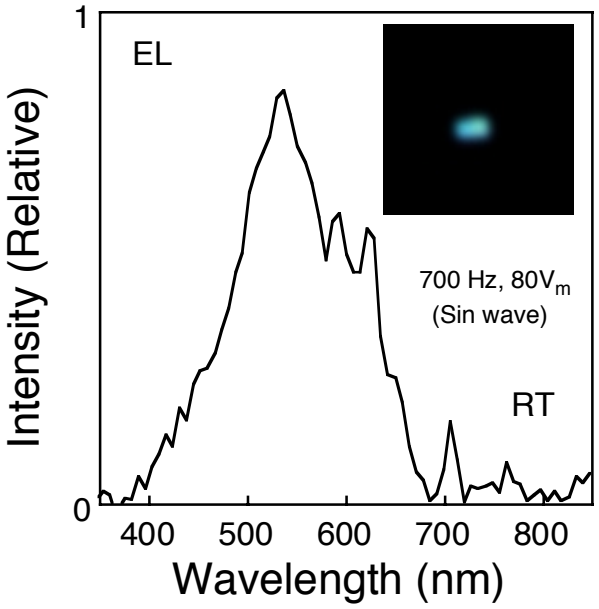

Fig. 2 EL spectra at room temperature.

The similarity between the EL spectra and the CL spectra indicates that the carrier in the GaN emission layer was excited by the alternating electric field and recombined. Although the center wavelength of the emission light located at blue green spectral region, the spectra included the near-band-edge emission. The emission from the GaN-based ELDs indicates that GaN will be one of the good phosphors for blue light emitters. Because the CL spectra correlated with the EL spectra, the improvement of the quality in optical properties of the GaN powder leads to blue ELDs with a high intensity.

[1] S. Nakamura and G. Fasol, “The Blue Laser Diode” (Springer, Berlin, 1997) Chap. 1.