Significant enhancement of emission intensity from Eu ions embedded in a GaN micorcavity

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Realization of red GaN-based light-emitting diodes (LEDs) enables the fabrication of a nitride-based monolithic optical device which is composed of red, green, and blue LEDs for full color LED display. We have obtained red emission from GaN-based LEDs using Eu-doped GaN (GaN:Eu) as an active layer [1]. However, the light output is not sufficient for practical use yet. One of the limitting factor of the light output is low transition probability of Eu ion and light extraction efficiency. In this contribution, we investigated modulated Eu emission propeties of the GaN:Eu by the microcavity .

The sample structures are shown in the inset of Fig.1. The microcavity was consisted of the 42 pairs of $Al_{0.18}In_{0.82}N$/GaN distributed Bragg reflector (DBR) and the 10pairs of ZrO_2/SiO_2. The spectra from the sample with microcavity are markedly different each other, depending on an emission angle θ defined with respect to the surface as shown in Fig.1. The peak intensity is enhanced by 12.9 times, compared to the without the microcavity sample at θ = 0°. As for the PL intensity dependence on θ, PL intensity of the sample with microcavity decreased drastically compared to the sample without microcavity. Time-resolved PL (TR-PL) profiles were measured in the samples with and without the microcavity. The decay curves were analyzed by a stretched exponential fitting. Decay time constants of the samples with and without the microcavity were 168 and 205 μs, respectively. PL lifetime of the sample with the microcavity was 1.2 times larger than that without the microcavity. Therefore, we can predict the light extraction efficiency was improved by 10.8 times because PL intensity enhanced by the improvement of light extraction efficiency and transition probability.

Reference : [1] A. Nishikawa, *et al*., Appl. Phys. Exp. **2**, 071004 (2009).

微小共振器を用いて発光特性を変調することで、光として取り出せなかった発光を効率的に取り出すことが可能となる。また、光る過程の高効率化も可能であるため高輝度発光デバイスを作製するのに有効な手法である。

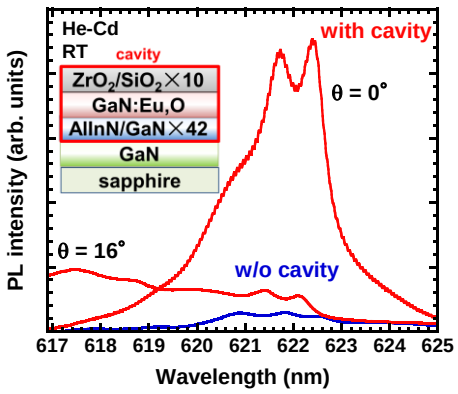

Figure 1 PL spectra of the samples. The insets is the schematic drawing of the sample structure.

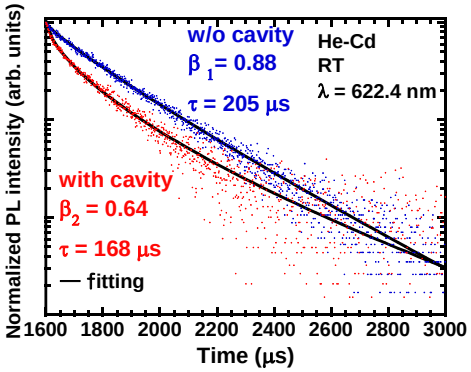

Figure 2 TR-PL signals of the samples.