Effect of Growth Parameter on InGaN/GaN MQW Structures Grown with Laminar-Three Flow Multi Wafer AP-MOVPE

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We have investigated a growth condition of (In)GaN epitaxial layers on sapphire using an atmospheric pressure horizontal MOVPE (SR-6000) with a 6" diameter wafer platen. Low material consumption efficiency due to a serve vapor reaction and narrow process margin under atmospheric pressure, are expected for large scale MOVPE system. To overcome these problems, a laminar-three flow reactor was employed. Most of growth parameters for (Al)GaN are linearly scaled as that for smaller laminar-three flow reactor [1]. However, earlier experimental reports suggest that the most of optical characteristic of InGaN-based LEDs relate to a phase separation [2, 3]. Tachibana reported the existence of a self-formed dot-like structure in the InGaN/GaN system [4]. The formation process of InGaN dot-like structure may be different as reactor scale becomes enlarged, since more complicated surface process would be involved in In segregation and its structure.

Thus far, to quantify the influence of large-scale reactor, the optical characteristic of InGaN/GaN MQWs was compared with those grown using a small reactor. All layers were evaluated using room temperature photoluminescence (PL) and high-resolution X-ray diffraction (XRD) measurements. Indium concentration between 7% and 15% were used in quantum wells of approximately 3 nm, when investigating the effects of growth rate, growth temperature, and barrier thickness. PL peak wavelengths were tuned from 410 nm to 480 nm by growth temperature between 700℃ and 760℃. Besides this, decreasing the growth rate was found to have beneficial effects on the MQW integrated intensity, which increased by several ten times. Figure 1 shows a barrier thickness dependence of integrated PL intensity of MQWs (open circle) and LEDs (closed circle). The intensity of MQWs was increased by several ten times when the barrier thickness was increased up to 45 nm, while the intensity of LEDs saturated for the thickness of 45 nm. These results indicate that degradation mechanism at p-GaN growth temperature for LEDs is thought to be changed with barrier thickness of over 25 nm. Figure 2 shows XRD (002) rocking curve of $In_{0.1}Ga_{0.9}N$/GaN=(3 nm/30 nm) 5QW structures. The experimental data (thick solid line) have been collected with just a slit and not an analyzer crystal. Higher order satellite peaks are observed and it indicates that the films have sufficient uniformity. The experimental results are good agreement with the simulation results (thin solid line).

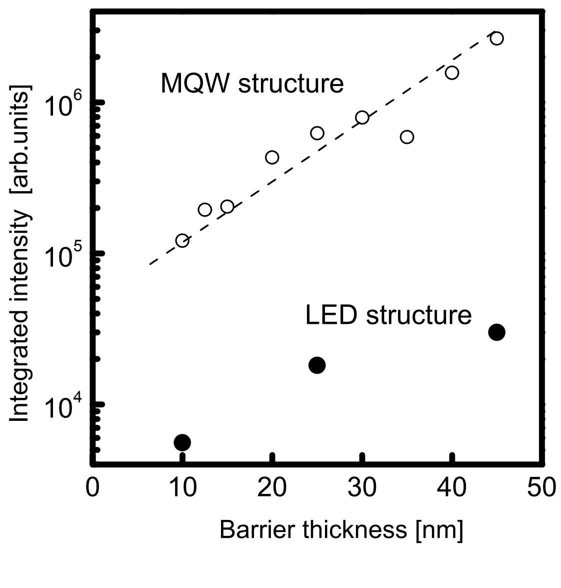

Fig.1 Barrier thickness dependence of integrated PL intensity for both MQW and LED structure.

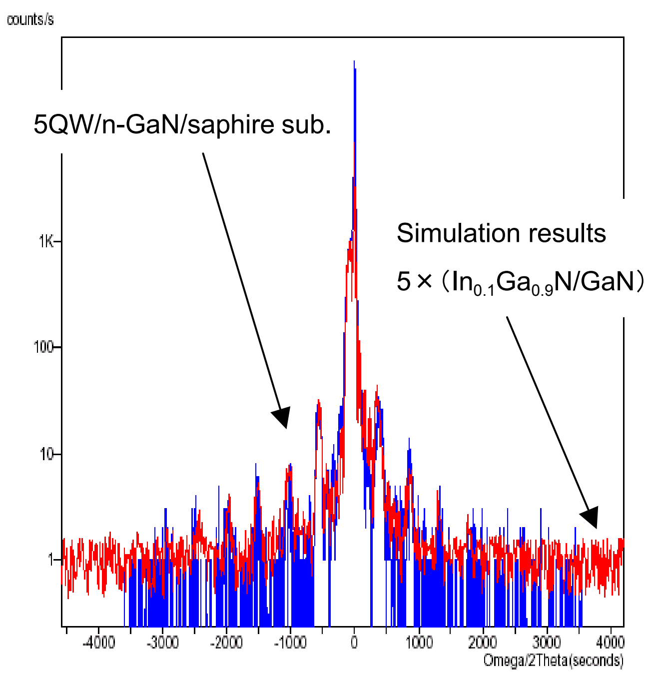

Fig.2 XRD (002) rocking curves of InGaN/GaN MQWs.

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