Growth of GaInN/GaInN MQWs on nanocolumns with thick GaInN buffer layer using RF-MBE

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GaInN, a nitride semiconductor, can emit light in the full visible light range by controlling the In composition. However, at high In compositions, luminescence efficiency decreases due to the increased lattice strain at GaInN/GaN film heterojunction. In contrast, nitride semiconductor nanocolumns possess the effects of threading dislocation filtering [1], strain relaxation [2], and increased critical film thickness [3], which can contribute to the improvement of GaInN luminescence efficiency in red region.

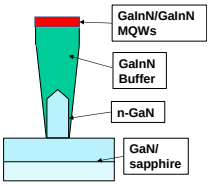

Fig.1 Structural diagram of GaInN nanocolumn.

In this study, thick GaInN nanocolumns were grown on underlying GaN nanocolumns by RF-MBE; the thick GaInN was utilized as a buffer layer to grow GaInN/GaInN MQWs on that, which contribute to the decreased lattice strain at the MQW heteroboundary. In the growth first, we prepared 200 nm-height n-GaN nanocolumn arrays arranged in triangle lattice with the lattice constant (period; *L*) of 100~600 nm. Subsequently, thick GaInN buffer layers of 500 nm thickness were grown under a constant nitrogen supply of 2.0 sccm, investigated systematically changing the RF input power and heater temperature in the ranges of 250-450 W and 865-910°C, respectively. On the GaInN buffer layer prepared by the optimized growth condition, five pairs of GaInN/GaInN MQWs were grown at the nitrogen flow rate of 2.0 sccm, RF input power of 350 W, and heater temperature of 865°C, as schematically shown in Fig.1.Figure 2 shows the bird's-eye SEM images of GaInN buffer nanocolumns with *L*= 200 nm grown at RF input powers of 450 and 350 W, respectively. The acute column tops were prepared at 450 W, while flat c-plane column tops were observed at 350 W. The PL intensity of the GaInN/GaInN MQWs with *L*= 200 nm was maximized by optimizing the heater temperature to be 910°C using the c-plane nanocolumn tops. Figure 3 shows a PL spectrum of the sample prepared under the optimized condition; a high red emission peak was observed at 603 nm.

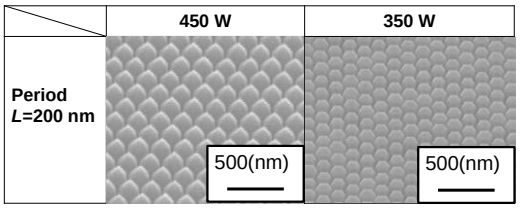

Fig.2 Bird's-eye view SEM images of nanocolumns after growing the GaInN buffer laver.

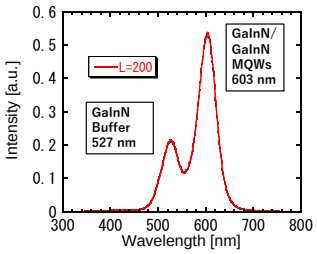

Fig.3 PL spectra of GaInN nanocolumn with L=200nm.

References

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