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Relationship between optical and structural characteristics of GaAsN/GaAs grown on GaAs by RF-MBE

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ABSTRACT

GaAsN has large bandgap bowing characteristics^[1], where the bandgap energy (E_g) of GaAsN decreases with the nitrogen composition in a low nitride composition range. Therefore, GaAsN is expected as a low E_g material in a GaAs system. However, it is difficult to grow a high-quality GaAsN, so it is necessary to clarify the influence of defects in GaAsN. The main defect is the edge dislocation generated by the lattice relaxation. However, there might be other defects that may influence optical characteristics. Hence, in this study, we have closely evaluated the relationship between the optical and the structural characteristics of GaAsN using Photoluminescence (PL) and X-ray Reciprocal Space Mapping (XRSM).

All structures were grown on semi-insulating (001) GaAs substrates by RF-MBE at 580 °C. Two kinds of structures were grown while changing the nitrogen composition of GaAsN. A GaAsN/GaAs superlattice (SL) structure is named “Structure 1”, while a bulk GaAsN is named “Structure 2”. These structures are shown in Fig. 1.

In Structure 1, the PL intensities of GaAsN/GaAs SLs with the average nitrogen composition $[\bar{N}]$ above 1 % are weaker than those of GaAsN/GaAs SLs with $[\bar{N}]$ below 1 %. It is ascribed to the defects generated in GaAsN/GaAs SLs with $[\bar{N}]$ above 1 %. The XRSM measurements show that all of Structure 1 were fully strained on the GaAs substrate, so the weak PL intensities of GaAsN/GaAs SLs with $[\bar{N}]$ above 1 % are not ascribed to the lattice relaxation.

In Structure 2, when the ion density of N_2 plasma is high, the PL spectra of GaAsN was not observed. In contrast, when the ion density is decreased, the PL spectra were observed. Therefore, it was found that the ion damage degrades the optical characteristics of GaAsN, even though GaAsN was strained in the XRSM measurements.

Keywords: GaAsN, RF-MBE, defect, Photoluminescence, X-ray Reciprocal Space Mapping

REFERENCES

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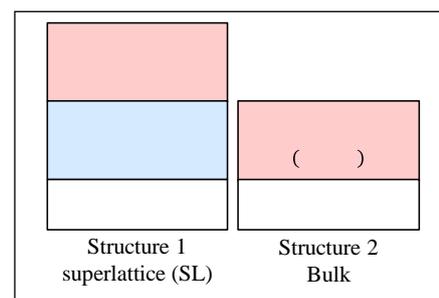


Fig. 1. Structures