Cathodoluminescence and 3D atom probe study of Mg implanted homoepitaxial GaN 物材機構<sup>1</sup>,富士電機<sup>2</sup>,筑波大<sup>3</sup><sup>0</sup>陳君<sup>1</sup>,衣瑋<sup>1</sup>,埋橋淳<sup>1</sup>,木村隆<sup>1</sup>,高島信也<sup>2</sup>,江戸雅晴<sup>2</sup>, 大久保忠勝<sup>1</sup>,関口隆史<sup>1,3</sup>

NIMS<sup>1</sup>, Fuji Electric<sup>2</sup>, Tsukuba Univ.<sup>3</sup>, <sup>o</sup>Jun Chen<sup>1</sup>, Wei Yi<sup>1</sup>, Jun Uzuhashi<sup>1</sup>, Takashi Kimura<sup>1</sup>, Shinya Takashima<sup>2</sup>, Masaharu Edo<sup>2</sup>, Tadakatsu Ohkubo<sup>1</sup>, Takashi Sekiguchi<sup>1, 3</sup>

Mg ion implanted homoepitaxial GaN has been investigated by secondary ion mass spectrometry (SIMS), 3D atom probe, and cathodoluminescence (CL) using angle cutting specimen as shown in Fig. 1. Mg ion implantation was performed to form 1E19 cm<sup>-3</sup> x500 nm BOX profile. The implanted wafer was annealed at 1300°C for 5 min with AlN protection layer, then AlN was chemically removed. CL can reveal the active Mg by donor-acceptor pair (DAP) emission. Figure 2 shows the DAP emission (3.28 eV) images of regions without or with high density of dislocations taken at 78 K. It is suggested that: (1) there exist high concentration of nonradiative defects in the implanted region; (2) enhanced DAP emissions are detected from threading dislocations from substrate to epilayer. The Mg implanted layer is not luminescent due to the formation of Mg clusters as confirmed by 3D atom probe observation. To achieve successful Mg doping by ion implantation, it is necessary to avoid the formation of dead region in implanted layer the diffusion of Mg along dislocations.

## Acknowledgement

This work was supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan through its "Program for research and development of next-generation semiconductor to realize energy-saving society".



(a) w/o dislocation
Surface
Mg implanted layer
Epilayer
Substrate
Substrate

Figure 1. Mg ion implanted GaN sample structure. CL observation with the e-beam scans across angle cutting plane. Schematic of Mg diffusion along dislocations.

Figure 2. Monochromatic CL images of Mg implanted homoepitaxial GaN taken at DAP emission. (a) Dislocation free region; (b) High dislocation density region.