

Cathodoluminescence and Atom Probe Study of Mg Diffusion and Activation along Threading Dislocations in Mg Implanted Homoepitaxial GaN

NIMS¹, Fuji Electric², JFCC³ °Wei Yi¹, Ashutosh Kumar¹, Jun Uzuhashi¹, Jun Chen¹, Takashi Kimura¹, Ryo Tanaka², Shinya Takashima², Masaharu Edo², Yongzhao Yao³, Yukari Ishikawa³, Tadakatsu Ohkubo¹, Takashi Sekiguchi¹, and Kazuhiro Hono¹

E-mail: YI.Wei@nims.go.jp

To realize precise p-type doping in vertical devices, Mg ion implantation is an important technique. At present, dislocations still remain in GaN substrate and epitaxial growth, the effect of dislocations on Mg diffusion and activation should also be explored. Recently, we have proposed a high spatially resolved cathodoluminescence (CL) imaging on the slanted cross-section of Mg implanted GaN epilayer, and Mg pipe diffusion through threading dislocations (TDs) have been found [1]. It is noted that some TDs exhibit enhanced Mg-related donor-acceptor pair (DAP) while the others not. In this work, we have carried out a comprehensive study on the interaction between TDs and Mg in Mg-imp homoepitaxial GaN layer. It includes optical characterization by CL focusing on the distribution of activated Mg, structural analysis of dislocation character based on etch pit and transmission electron microscope (TEM), and atomic distribution of Mg at different dislocations by atom probe tomography.

Active-Mg related donor-acceptor pair (DAP) emission from certain TDs are identified by CL image (Fig. 1a). The character of TDs has been clarified based on etch pits (Fig. 1c). The edge type TDs tend to have strong DAP emission than the background, while other TDs are non-radiative. Atom probe study suggests that there exists great difference in Mg concentration and incorporation state between the TDs with different optical properties.

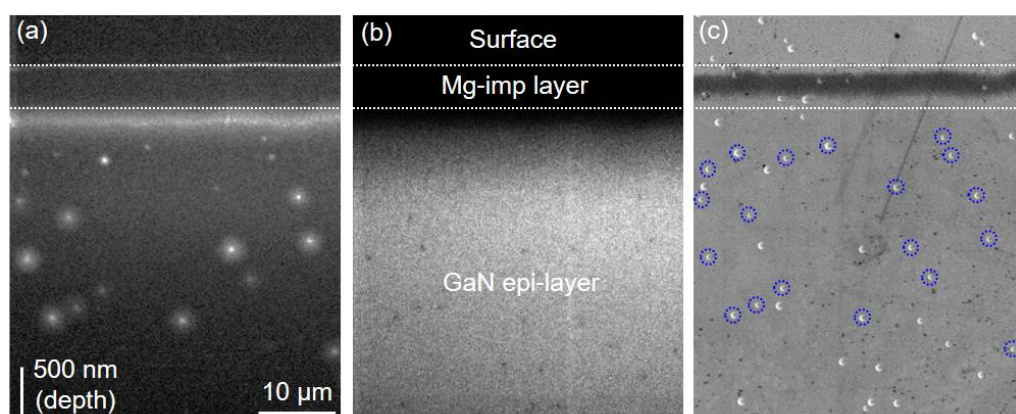


Fig. 1 Monochromatic CL images of Mg implanted GaN epilayer taken at (a) DAP emission of 3.28 eV and (b) NBE emission of 3.47 eV. (c) SE image of etch-pits at corresponding region.

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[1] J. Chen, W. Yi, T. Kimura, S. Takashima, M. Edo, and T. Sekiguchi, Appl. Phys. Express 12, 051010 (2019).