Investigation of Lightly Mg-Ion-Implanted GaN Using MOS Structure

Hokkaido Univ.[1] ◦Masamichi Akazawa[1], Kei Uetake[1], and Ryo Kamoshida[1]

E-mail: akazawa@rciqe.hokudai.ac.jp

Mg-ion implantation is a promising technique for selectively forming a p-type region in GaN, which is useful for the mass production of high-power devices. However, the technology is not yet fully established completely. The annealing temperature required for acceptor activation is high (> 1200°C), whereas the obtained activation ratio is frequently low. There is thus room for reappraisal of the annealing method. To address this issue, one should investigate the effect of annealing from a low temperature to a high temperature. In addition, to investigate the deep levels generated by implantation, one should start from a low dosage. We here present the results of a study on the effect of low-temperature annealing on lightly Mg-ion-implanted GaN.

In this work, Au/Ni/Al_2O_3/GaN metal-oxide-semiconductor (MOS) diodes on GaN free-standing substrates were used to investigate the electrical properties of Mg-ion-implanted GaN because they enable the investigation in the near-surface region. The measured capacitance–voltage (C–V) characteristics for a MOS diode with as-implanted GaN exhibited anomalous behavior as shown in **Fig. 1**. MOS diodes fabricated on GaN annealed at several temperatures (400–800°C) after implantation showed improved C–V characteristics (an example is shown in **Fig. 2**) as the annealing temperature increased. The observed C–V characteristics were reproduced on a computer by performing a simulation [1] considering bulk deep levels. We found that acceptor-like deep levels on the conduction-band side of the band gap are responsible for these characteristics. Thus, low-temperature annealing affects the deep levels in GaN generated by Mg-ion implantation.

This research was supported by the Ministry of Education, Culture, Sports, Science and Technology, Japan, through its “Program for research and development of next-generation semiconductor to realize an energy-saving society.” The authors appreciate Dr. T. Narita, Toyota Central Research Center, for providing the GaN epitaxial wafers.

[1] K. Nishiguchi et al., Jpn. J. Appl. Phys. **56**, 101001 (2017).

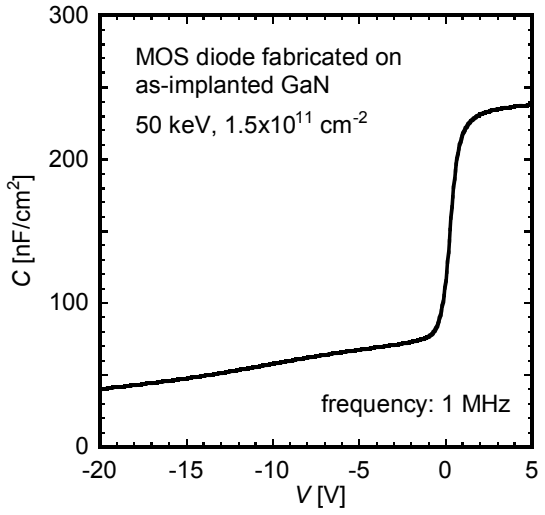

Fig. 1 C–V curve measured for the MOS diode fabricated on as-implanted GaN.

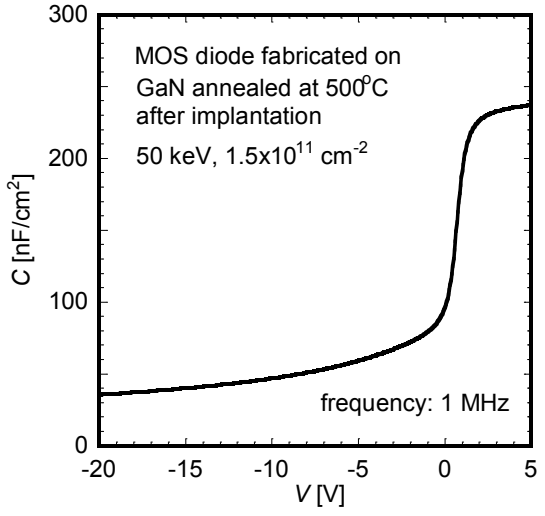

Fig. 2 C–V curve measured for the MOS diode fabricated on GaN annealed at 500°C after Mg-ion implantation.