Atomic Structures and Chemical States of Active and Inactive Dopant Sites in GaN

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論 文 名　：Atomic Structures and Chemical States of Active and Inactive Dopant Sites in GaN

（GaN 中ドーパントの活性サイト・不活性サイトの原子構造及び化学状態）

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論　文　内　容　の　要　旨

Gallium nitride (GaN) has great potential for application in power devices due to its superior properties, such as a wide band gap, and high breakdown field, etc. For N-type GaN, Si is usually used so as to form the sallow donor states in the bandgap of GaN. In the case of P-type GaN, Mg is widely used to obtain shallow acceptor levels in the bandgap. However, the carrier concentration is much lower than the number of dopants. According to previous studies, the carrier concentration is one order of magnitude less than the dopant concentration. In spite of many studies on dopants in GaN, there are few methods directly to investigate chemical states and atomic structures of dopants in GaN. Therefore, elucidating the chemical states and atomic structures of dopants in GaN is indispensable for improving the doping efficiency and preparing GaN-based devices with high performance.

In the doctor study, I aim to clarify the chemical states and atomic structures of active and inactive dopant sites of dopants in GaN using Auger electron spectroscopy (AES), photoelectron spectroscopy (PES), and X-ray absorption near-edge structures and photoelectron holography (PEH). The present results are useful for the improvements of the doping efficiency and the preparation of GaN with high performance.

The doctoral thesis consists of five chapters and is structured as follows.

Chapter 1 introduces the general background, the introduction of GaN, the preparation method of GaN, and the preparation method of N and P-type GaN. Chapter 1 also includes issues that should be solved and the purpose of this doctoral thesis.

Chapter 2 presents the sample preparation methods and experimental procedures used in the present thesis. The principle of the characterization methods (PES, AES, XANES, PEH, etc) used in the present thesis is also explained.

Chapter 3 describes the results on the use of chemical state-discriminated PEH to clarify the local atomic structures of active and inactive dopant states for Mg dopants in Mg-doped GaN.

Chapter 4 presents the clarification of the atomic structures and chemical states of active and inactive dopant sites in Si dopant in Si-doped GaN using XANES and the XANES simulations.

Chapter 5 describes the conclusions and the outlook of the thesis. The conclusions subchapter summarizes the most important results.

Supplementary information is included in which the performance of the institutes and the beamlines of Aichi synchrotron radiation and SPring-8 are described.