SiC 上 GaN 成長における TMAl 先行供給により形成した Al 層の解析

Analysis on Al layer formed by TMAl preflow for growth of GaN on SiC

東大院工 ○朱 逸夫，王 建威，百瀬 健，霜垣 幸浩，出浦 桃子

Univ. of Tokyo, ○Yifu Zhu, Jianwei Wang, Takeshi Momose, Yukihiro Shimogaki, and Momoko Deura

E-mail: shu@dpe.mm.t.u-tokyo.ac.jp

Introduction We have proposed a 3C-SiC thin film formed using Si surface carbonization as a buffer layer for heteroepitaxy of III-nitrides on Si substrates[1]. We succeeded to grow a continuous, flat, and single-oriented GaN layer on the SiC/Si substrate by metalorganic vapor phase epitaxy (MOVPE) with a trimethylaluminum (TMAl) preflow [2]. Here, the TMAl preflow was performed for improvement of GaN wettability on the SiC surface [3]. However, an AlN peak appeared in the X-ray diffraction (XRD) measurement after the GaN growth though no Group-V gas was supplied during the TMAl preflow. In this work, therefore, we analyzed the compositional depth profile of the Al layer deposited by the TMAl preflow.

Experimental setup 4H-SiC(0001)just substrate was pretreated just before the introduction into the MOVPE reactor. TMAl was supplied at 1100 °C and 200 mbar with the H_2 carrier gas and cooled down just after stopping the TMAl supply. No N_2 or NH_3 were supplied during the whole process. Surface morphology of the Al layer was characterized by atomic force microscope (AFM). Depth profile was measured by X-ray photoelectron spectroscope (XPS) with Ar etching to analyse the compositional change in the deposition direction. The sample surface was exposed to the air for a few minutes before the XPS measurement.

Results and discussion Figure 1 shows the AFM image of the Al layer on the SiC substrate with the TMAl partial pressure of 4.4×10^{-3} mbar and the preflow time of 60 s, which is estimated to be approximately 10 nm AlN calculated by reflectance data. As-supplied SiC substrate was extremely flat with the average roughness (Ra) of 0.03 nm. However, the surface became rough with the Ra of 2-3 nm and grains with the size of ~50 nm were formed after the TMAl preflow. Figure 2 shows the change in the XPS Al2p and N1s peaks and the N/Al compositional ratio with the etching time for the Al layer. The etching time is expected to be 0.6 nm/min. Data for shorter etching time may be affected by charging up of the sample. Nitrogen was detected through the Al layer even though no N-contained gas was supplied. The Al2p peak after 30-min-etching appears near the Al-N bonding position. The N/Al ratio increases with the etching time, which indicates that the number of incorporated N atoms in the Al layer became smaller as the TMAl preflow time proceeds. Therefore, the Al layer was nitrided during the TMAl preflow process by the N atoms desorbed from the inner wall of the reactor and/or remaining in the gas supply tubes and the amount of N atoms decreases with the preflow time.

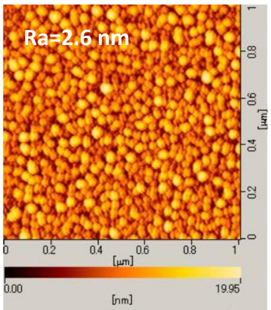

Fig. 1. 1×1 μm^2 AFM image of the Al layer on the SiC substrate.

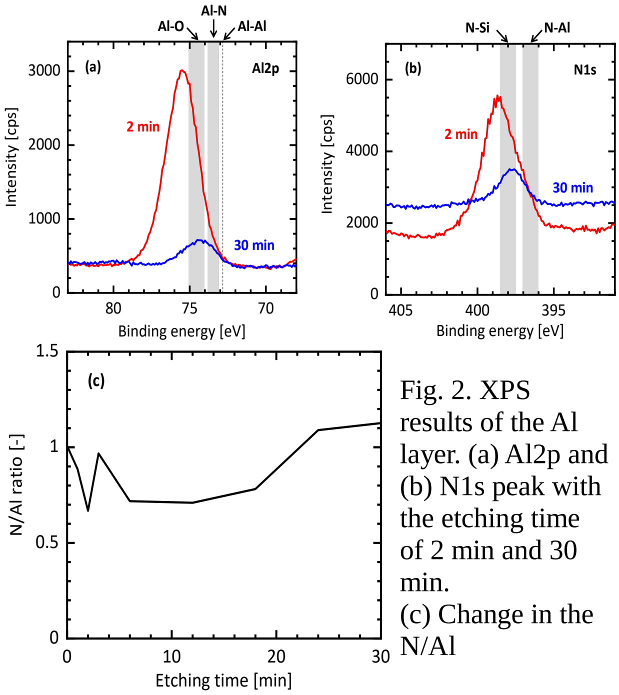

Fig. 2. XPS results of the Al layer. (a) Al2p and (b) N1s peak with the etching time of 2 min and 30 min.
(c) Change in the N/Al

Acknowledgments This study was supported by JSPS KAKENHI Grant Number JP19H04534, Shiseido Female Researcher Science Grant, and the Murata Science Foundation.

[1] M. Deura and H. Fukuyama, J. Cryst. Growth **434** (2016) 77.
[2] Y. Zhu, M. Deura *et al.*, JSAP 66th spring meeting, 10a-W541-5 & 6 (2019).
[3] Z. Sun *et al.*, Jpn. J. Appl. Phys. **55** (2016) 05FB06.