Surface Planarization Effect on {20$\bar{2}$1} GaN Crystal Growth Applying Flux-Film-Coated Technique in Na-flux Method

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A semi-polar {20$\bar{2}$1} plane GaN is expected to improve luminous efficiency in light-emitting devices as it is less affected by piezoelectric polarization than the conventionally used c-plane GaN. However, lack of high-quality {20$\bar{2}$1} plane GaN substrate prevent realization of such GaN devices. We grew {20$\bar{2}$1} plane GaN by Na-flux method to produce high-quality substrate. A surface of the grown crystal is composed of several planes such as {10$\bar{1}$1} and {10$\bar{1}$0} planes. The amount of oxygen impurities differs depending on the crystal plane. As a results, the lattice constants were not uniform in a crystal composed of several planes [1]. Recently, we found that by adding Li to the flux, a {20$\bar{2}$1} plane became stable and the crystal became flattened [2]. However, Li was incorporated into the crystal as an impurity. In this study, we investigated the possibility of planarization of {20$\bar{2}$1} plane GaN crystals grown with Li-free system by applying Flux-Film-Coated (FFC) technique [3], in which, lateral growth is promoted and {10-11} planes disappear, resulting in a formation of uniform c plane.

A {20$\bar{2}$1} plane GaN template (GaN/Sapphire) was used as a seed crystal. Ga, Na and additive carbon (0.5 mol%) were placed in a crucible and sealed in a stainless-steel vessel. First, the growth was performed for 6 hours under a nitrogen atmosphere at a temperature of 870°C and a pressure of 3.0 MPa, and then FFC process was performed for 20 hours for planarization. Next, FFC process was performed for 195 hours for thickening and planarization. The obtained GaN crystals were evaluated using coherence scanning interferometry to measure root-mean-square surface roughness (Sq) values.

The relationship between the thickness and Sq value of crystals grown by the Na-flux method in the {20$\bar{2}$1} plane is shown in Fig 1. In the Li-free system, the Sq value tends to increase as crystal thickness increases. Whereas in the Li-added system, the Sq value is kept low regardless of the thickness. The obtained crystal applying the FFC technique in Li-free system, the thickness of the crystal was 0.7 mm, and the surface flatness was comparable to that with Li-added system. The surface uniformly composed with {20$\bar{2}$1} plane may indicate the evenly distributed amount of oxygen impurities and thus, the lattice constants are expected to be uniform.

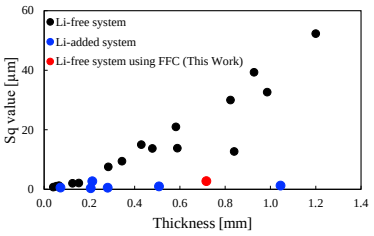

Figure 1. The relationship between the thickness and Sq value of crystals grown by the Na-flux method in the (20-21) plane.

References

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