3

Step-free GaN Surfaces

Completely flat GaN surfaces formed by selective-area epitaxy

NTT

Motivation

The surfaces and interfaces of nitride semiconductor films are not smooth because of crystal defects, such as dislocations. Rough interfaces of heterostructures degrade the performance of nitride-based optical and electronic devices. The goal of this research is to obtain completely flat surfaces of GaN and apply them to novel nitride-based devices.

Originality

Epitaxial growth of a GaN film was performed selectively in an area with no screw-type dislocations using a GaN bulk substrate with low dislocation density. As a result, a step-free GaN surface with a 16 μm diameter was successfully formed. This is the first report of a step-free surface for nitride semiconductors.

Impact

Completely smooth heterostructures and quantum wells of nitride semiconductors can be fabricated without any fluctuation in thickness. As a result, the performances of subband devices will be substantially improved, and a novel full-color display will be achieved by integrating monochromatic LEDs. Our results will also contribute to basic research, such as clarification of the growth mechanisms of nitride semiconductor films.

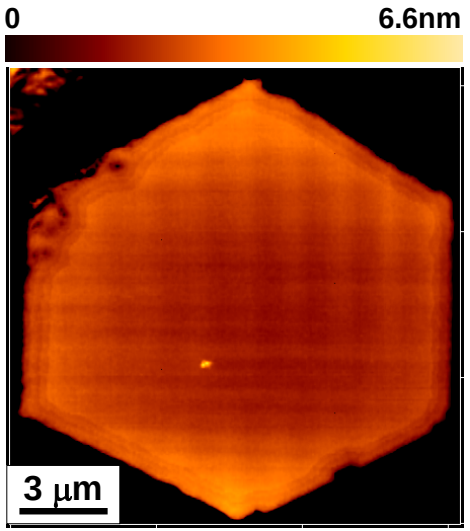

Fig. 1: Step-free GaN surface with 16 μm of diameter

A step-free GaN surface is formed within a hexagonal area with 16 μm of diameter (Fig. 1). A step-free surface is one that is absolutely smooth with no monolayer steps. We have successfully fabricated step-free surfaces of nitride semiconductors for the first time.

A step-free surface can be formed in a selective area with no screw-type dislocation which is a kind of crystal defect.

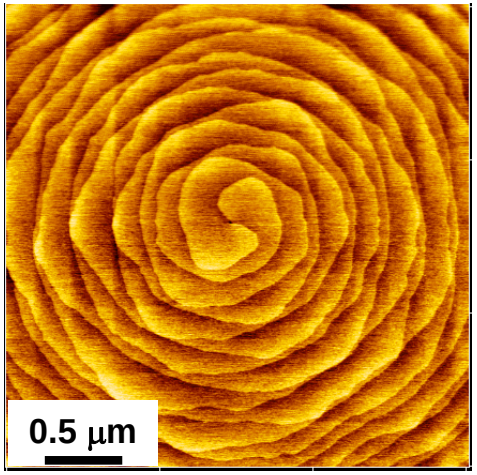

Fig. 2: Growth spiral observed in a selective area having a screw-type dislocation

A step-free GaN surface cannot be obtained in a selective area having any screw-type dislocation. A screw-type dislocation causes the spiral growth around itself (Fig. 2). The spirals of GaN are doubly folded.

One of the most important growth parameters, the degree of supersaturation, can be analyzed by the growth spirals. We are investigating the growth mechanisms of GaN in the step-free and spiral growth mode.

サイエンスプラザ 2009 ナノサイエンスが拓く量子の世界

NTT Basic Research Laboratories

Contact: Tetsuya Akasaka
akasaka@will.brl.ntt.co.jp