Application Note B-XRD2001

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B-XRD2001 - Evaluation of crystal quality (tilt and twist widths) of Group-III nitride film by the rocking curve method

Introduction

In recent years, group-III nitride materials, especially GaN, have been attracting attention, and the development of light-emitting devices (ultraviolet to blue) and power devices has been underway. The properties of these devices are related to the crystal quality of the grown films. One technique for evaluating crystal quality is the X-ray rocking curve method. In this example, we evaluated the tilt width (tilt distribution of the crystallographic axis in the growth direction) and twist width (in-plane rotation distribution of the crystallographic axis parallel to the sample surface) of a GaN film grown on a sapphire substrate using the rocking curve method.

Measurements and results

A GaN thin film (film thickness 2 μm) was grown on a c-plane sapphire substrate. The tilt and twist widths of GaN were evaluated using the rocking curve of the GaN 0002 reflection (ω scan) and the GaN 1010 reflection (φ scan), respectively. The following figures show the geometry (Figures 1 and 3) and observed rocking curve profiles (Figures 2 and 4) for each measurement.

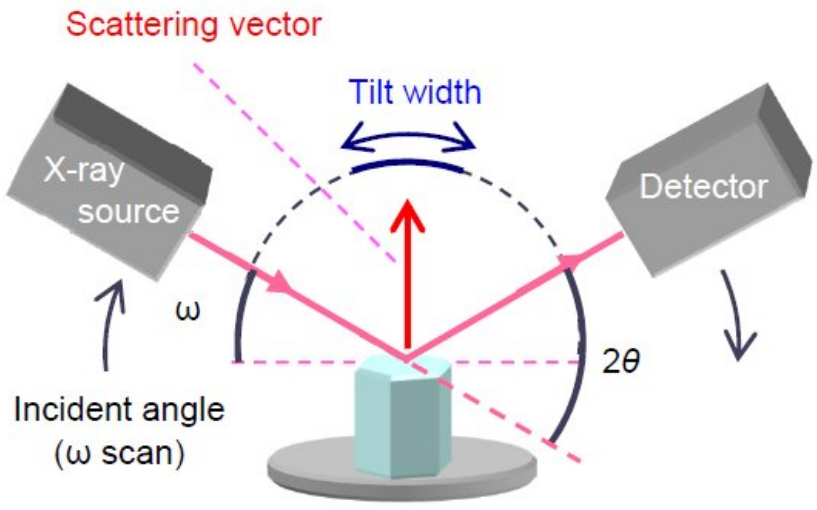

Figure 1: Measurement geometry of the tilt distribution

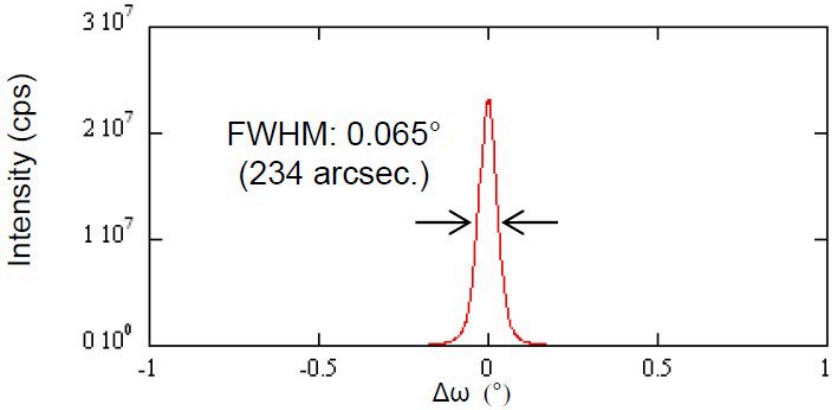

Figure 2: GaN 0002 reflection rocking curve

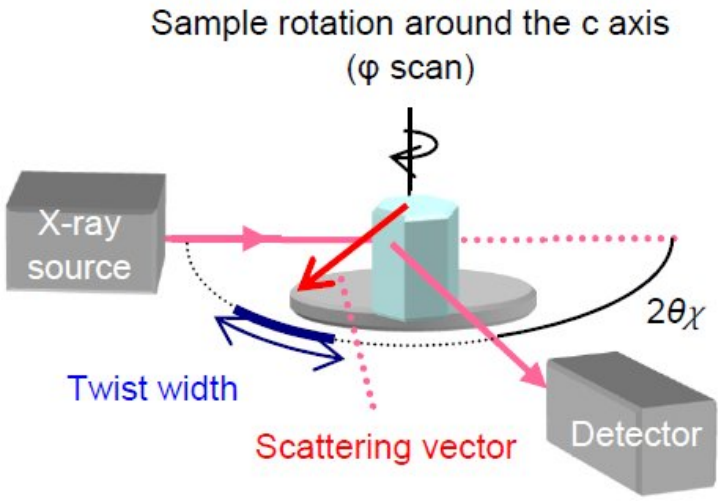

Figure 3: Measurement geometry of the twist distribution

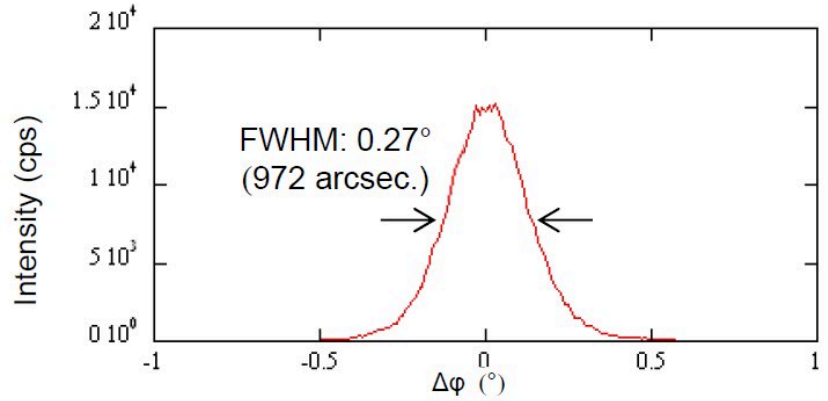

Figure 4: GaN 1010 reflection rocking curve

From the FWHM of the rocking curves, the tilt and twist widths of the GaN layer were estimated to be 0.065° (234 arcsec.) and 0.27° (972 arcsec.), respectively. These measurements were performed using a theta-theta goniometer with an in-plane arm. This goniometer allows both the tilt and twist width measurements to be performed with the sample placed

horizontally, making the measurement easy with no risk of the sample falling.

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