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# B-XRD2034 - Twist width evaluation of Group III-V nitride films by rocking curve measurement

## Introduction

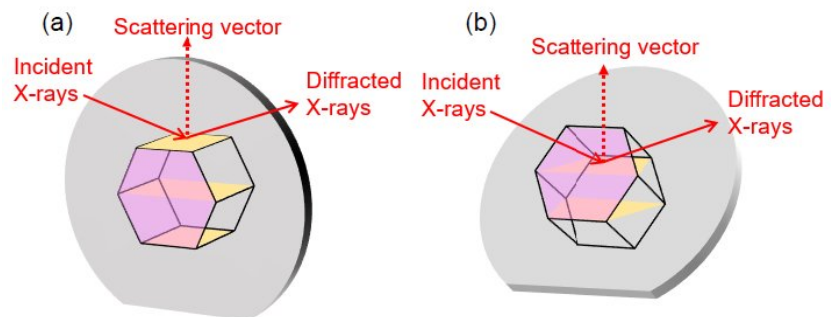
Deep ultraviolet LEDs are preferable for wide use as an alternative to mercury lamps since they are ultraviolet sources with low environmental impact. In recent years, their sterilization function has been especially attracting great attention, and practical application of this function is expected soon. In order to increase light emission efficiency and carrier lifetime, the quality of the AlN layer, which is the base for the active layer, must be improved. In this measurement example, an appropriate evaluation method was examined for the crystal orientation distribution (twist width) in the in-plane direction, which is used as an indicator of the threading edge dislocation density of the AlN layer.

## Measurement and analysis

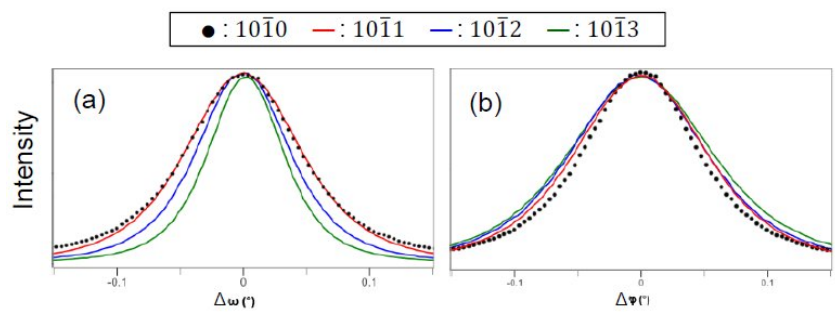
A c-plane AlN film on a c-plane sapphire substrate was used for this measurement. The twist width of the AlN is directly determined from the  $\omega$  scan rocking curve peak width of AlN m-plane diffraction, such as 1010, with pseudo in-plane geometry. However, the X-ray incidence efficiency for the sample is low in this method, which negatively affects the efficiency of the evaluation of thin-film samples with small thickness. For this reason, a reflection oblique to the surface, 101 $l$ , is used for evaluation (Figure 1).

Figure 2 shows the rocking curve profiles for AlN 101 $l$  reflections ( $l = 0$  to 3). Figure 3 shows the rocking curve width (FWHM) of reflections 101 $l$  ( $l = 0$  to 5), 112 $l$  ( $l = 2, 4$ ), and 0002, and the relationship with the angle between each lattice plane and the sample surface. For reflections 1011 (approx. 62°) and 1122 (approx. 58°) with large angles between the lattice plane and sample surface, peak widths equivalent to the twist width determined from the 1010 reflection were observed in both  $\omega$  and  $\varphi$  scans. On the other hand, for reflections 1012 to 1015, and 1124 with small angles between the lattice plane and the sample surface,  $\omega$  scans tend to have a smaller peak width, and  $\varphi$  scans tend to have a larger peak width.

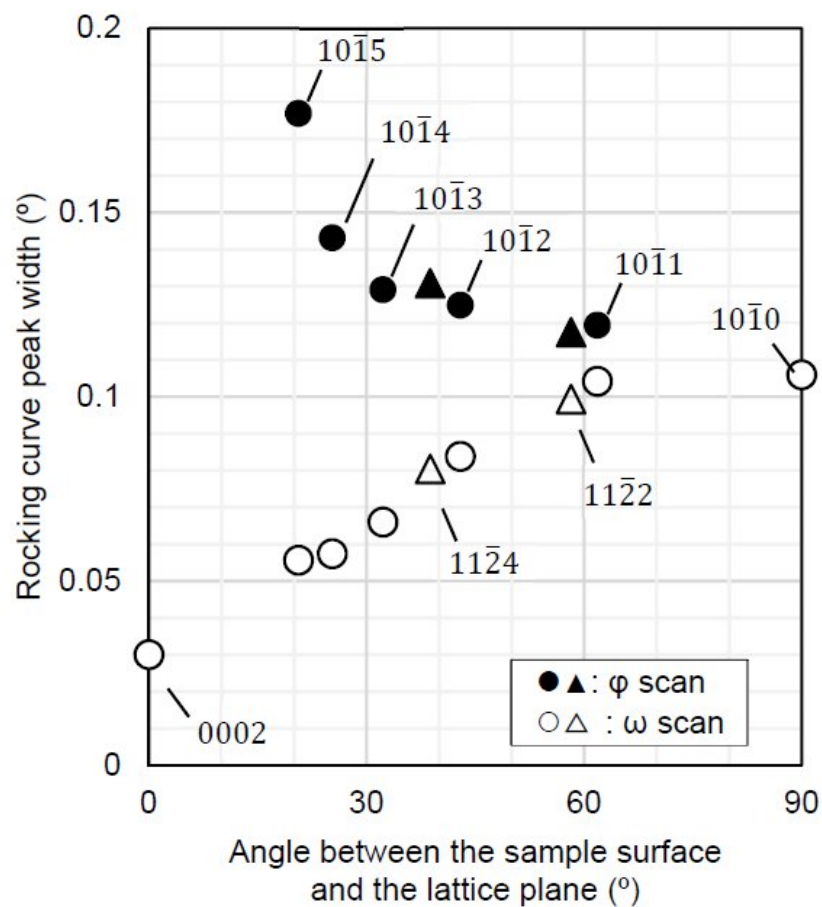
As we can conclude from the above, the twist width of the AlN film can be evaluated from the rocking curve of reflections like 1011 and 1122 with a large angle between the lattice plane and the sample surface. When using other reflections for evaluation, the difference with the true twist width must be considered.



**Figure 1:** Evaluation of the twist width of AlN using a rocking curve (a) Pseudo in-plane geometry measurement of reflection 1010 (b) Symmetrical geometry measurement of reflection 101 $l$



**Figure 2:** Rocking curve of AlN 101 $l$  ( $l = 0$  to 3) (a)  $\omega$  scan (b)  $\phi$  scan



**Figure 3:** The rocking curve width (FWHM) and the angle between each lattice plane and the sample surface of AlN reflections  $101l$  ( $l = 0$  to  $5$ ,  $\bullet$  in the figure),  $112l$  ( $l = 2, 4$ ,  $\triangle$ ), and  $0002$  ( $\circ$ )

Samples provided by: Dr. Kentaro Nagamatsu, Tokushima University

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