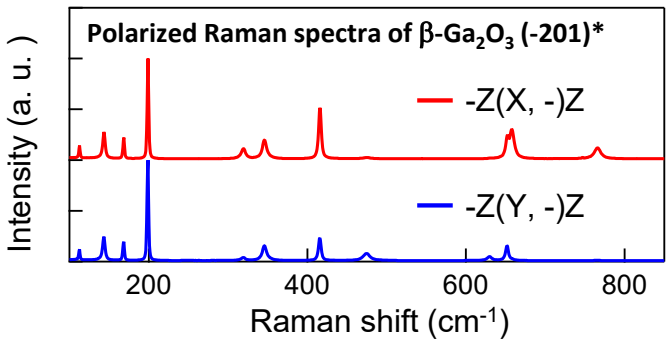
Mechanical Damage Analysis of Gallium Oxide by Raman Spectroscopy

Gallium oxide is expected to be used for next-generation power devices and mechanical damages are caused during the device fabrication such as a dicing process and a surface smoothing process. These damages can be evaluated quantitatively using Raman spectroscopy.

Raman spectra of Gallium oxide

*X and Y axes are parallel to [102] and [0-10] directions, respectively, and Z axis is normal to (-201) plane.



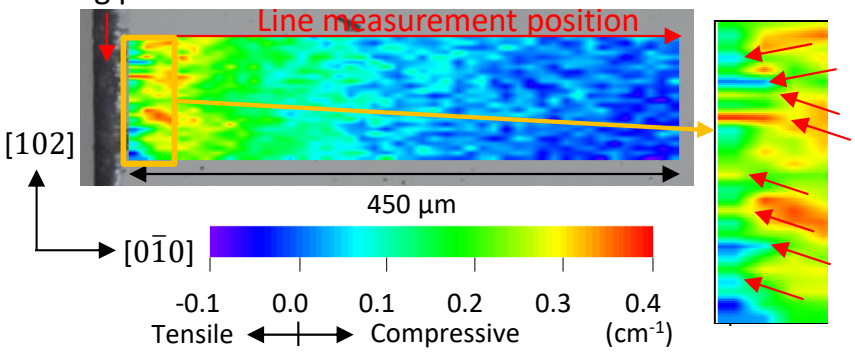
- Stress can be evaluated from the peak frequency shift of Raman line using Raman spectroscopy.
- Because observable Raman lines change in accordance with measurement conditions due to crystal anisotropy of β-Ga_2O_3, understanding of Raman scattering is important for the measurements.
- A peak frequency shift caused by stress changes depending on a Raman line.

➡ In Toray Research Center, Raman line which is sensitive to stress can be chosen based on the basic experiments.

Evaluation of dicing damage

β-Ga_2O_3 (-201) wafer was cut parallel to [102] direction by a blade dicing and stress was evaluated.

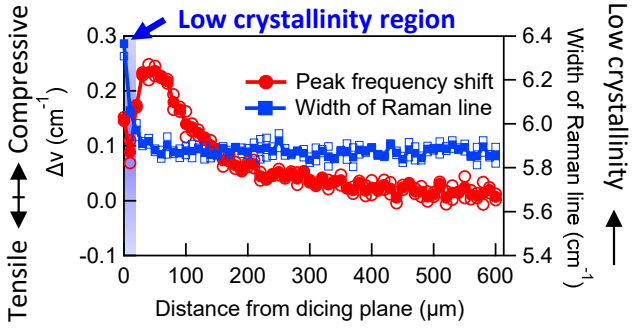
Dicing position



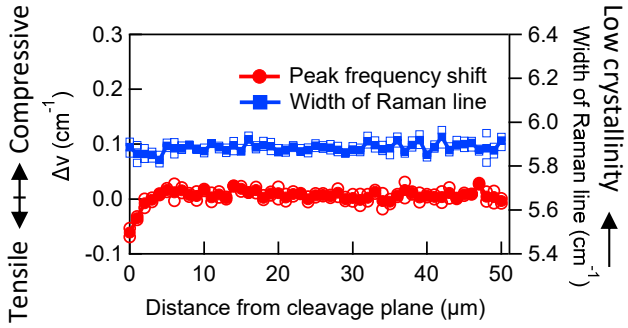
Many striated stress pattern were observed near the dicing position. β-Ga_2O_3 wafer can be cleaved in the [0$\bar{1}$0] direction, while it cannot be cleaved in another directions. When it was cut along the [102] direction by the blade dicing, **the inside defects were generated along the [0$\bar{1}$0] direction, which was easy to be cleaved, and the non-uniform stress distribution was caused from them.**

Stress distribution in the vicinity of the dicing plane

Near the dicing plane



Near the cleavage plane



◆ The stress near the cleavage plane was lower than measurement limit, whereas **the compressive stress near the dicing plane was remained at a distance of 400 μm from the dicing plane**.

◆ There was **the low crystallinity region, which is 20 μm from the dicing plane,** judging from the Raman line width.

➡The dicing damage in Ga_2O_3 was far-reaching more than expected **because of the dicing in the direction which cannot be cleaved.**

Stress and crystallinity evaluation using Raman spectroscopy is effective in gallium oxide, and this technique is useful for optimization of the fabrication process and local stress analysis.

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