# Study of sublattice inversion in GaAs/Ge/GaAs(001) crystal by X-ray diffraction

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Some compound semiconductors such as GaAs are of great interest for the fabrication of new nonlinear optical devices because of their remarkably large optical nonlinearity. To exploit the optical nonlinearity of compound semiconductors, which are optically isotropic, the quasi phase matching method by sublattice inversion is very effective.

We have investigated prototype nonlinear optical devices of GaAs/Ge/GaAs(001) using synchrotron radiatin [1]. In this research for the verification of the sublattice inversion, we investigated two samples: a 500Å-thick-GaAs epilayer on a Ge intermediate layer (Sample A) and a 5μ-thick GaAs epilayer on a Ge intermediate layer (Sample B) [2].

The measurements were performed at BL-14B in the arrangement of the quasi-parallel setting; X-rays of wavelength 1Å reflected by a Ge(333) were incident on the sample.

First we measured the intensity distribution of crystal truncation rod (CTR) scattering around the (004) Bragg point of Sample A. As shown in Fig.1, intensity oscillation of the CTR scattering was observed. The period of the oscillation indicates that the thickness of the epilayer is almost equal to the designed value of 500Å.

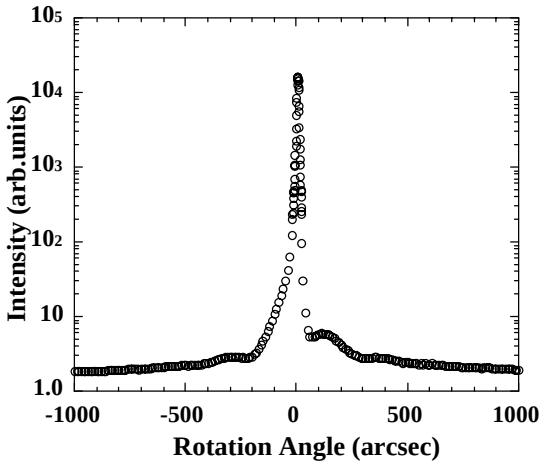


Fig. 1. CTR scattering around the (004) Bragg point.

We then performed X-ray standing wave (XSW) measurement using the -1-15 reflection of Sample B. Fluorescence X-rays of both Ga and As were measured. The measured and calculated intensities of the fluorescence X-rays are shown in Fig.2. The solid lines, which agree with the experiment, are calculated based on the model in which the sublattice inversion takes place. The curves for the sublattice-inversion-free model are drawn in dashed lines for comparison. This result clearly shows the sublattice inversion of the epilayer on the sample, i.e. the epilayer is rotated 90 degrees with respect to the substrate crystal.

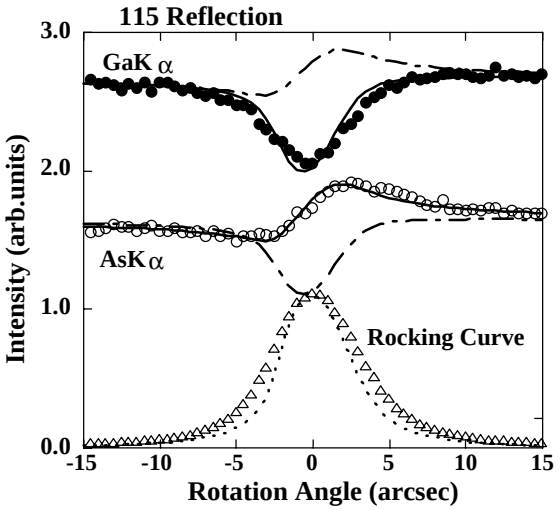


Fig. 2. The result of the XSW of the -1-15 reflection.

To summarize, we investigated the structure of GaAs/Ge/GaAs(001) systems by X-ray diffraction. From the CTR measurement, the good quality of the epilayer was verified and from the XSW measurement, sublattice inversion was confirmed

## References

[1] S. Kusano et al., PF Activity Report. #17, 143 (1999)
[2] S. Nakatani et al., Appl. Surf. Sci. 159-160, 256 (2000).

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