Study of a-Si/1ML-Ge/Si(001) interface structure by X-ray standing wave

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Introduction

Very fine structures at the hetero-interface have been realized by the recent development of molecular beam epitaxy (MBE). Exact characterizations for those structures are necessary to fabricate new devices using them. X-rays are useful for the characterization because they can investigate buried interfaces without destroying the structures. Especially, X-ray standing wave (XSW) is a unique method for its fine spatial resolution since it makes use of the interference fringes of x-rays as a scale. We examined the interface structure of an a-Si/Ge/Si(001) crystal by XSW. Besides the view point of fundamental science, this system is interesting from the viewpoint of application; the SiGe-based hetero-structures have a possibility for novel devices like ultra fast LSI and optoelectronic devices.

Experimental

Our sample was prepared by the MBE deposition of 1ML of Ge on the Si(001) substrate followed by the MBE deposition of 1ML of Si and the subsequent deposition of an a-Si cap layer of 50 Å to stabilize the Ge-interface structure.

The experiment was performed using synchrotron radiation from a vertical wiggler of BL-14B. X-rays of wavelength 1 Å were selected by a double-crystal monochromator. The X-rays were reflected by a Si(111) fore crystal and incident on the sample. The skew 111 reflection of the Si(001) substrate was used so that the (+,-) parallel setting was completed.

The intensity curve of the X-rays reflected from the sample (rocking curve) and the yield curve of fluorescent X-rays of GeKα were measured around the 111 Bragg point in the skew arrangement.

Results and discussion

The result of the measurement is shown in Fig.1. The profile of the measured rocking curve is slightly different from calculation at both tails. This means that the strain in the substrate is not negligible. The fluorescence yield curve, which indicates the interaction between the XSW field and Ge atoms, shows that the most of Ge atoms stay 0.7 Å below the ideal Si site. This result is different from other reports[1,2] probably because of the effect of the strain.

In the last machine time of this project, we performed the same measurement under the stress free condition. The result of data analysis will be reported elsewhere[3].

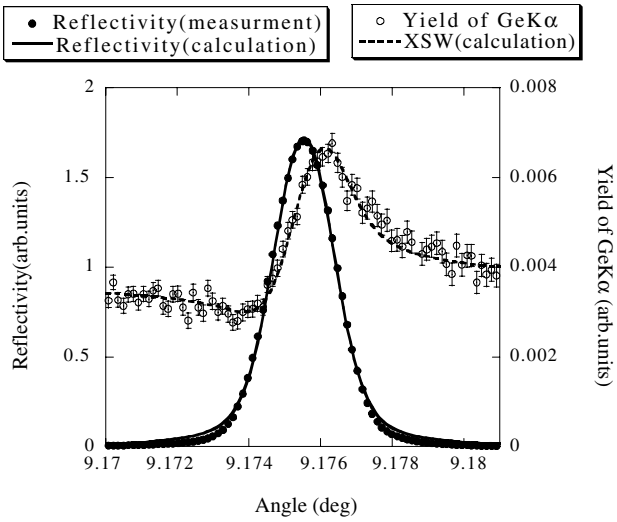

Fig.1. Rocking curve of the 111 reflection and yield of GeKα fluorescence.

References

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