

STEM Moiré Observation of the Compositionally Step-Graded SiGe Thin Film and its Image Analysis

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In the field of semiconductor devices, it is very important to study lattice strains or lattice - space distributions because they strongly affect electric properties. Recently, a very unique method to analyze lattice strains using STEM moiré has been proposed by other researchers [1-7]. In this technique, the moiré between the crystal lattices and the STEM scanning lines is utilized to show lattice-spacing distribution. Our group also reported our experimental results about STEM moiré observation of Ge/Si (100) [8]. The main advantages of this method are as follows: (1) It is possible to collect the information from relatively wide areas in comparison with high-resolution images. (2) High-end-model STEM is not required.

Now we have been applying this new technique to our other specimens such as SiGe/Si (110) hetero-structures. In this study, we applied this new method to the compositionally step-graded SiGe thin film which is grown onto Si (110) substrate by MBE. Specifically, we focused on the lattice - space changing of the compositionally step graded SiGe layers. The specimens were fabricated by focused ion beam (FIB) for TEM and STEM observations. 200 kV type FE-TEM, FEI's Tecnai Osiris which does not have Cs correctors nor monochromater, was utilized to take ordinary STEM images and the STEM moiré. Figure 1 is a STEM moiré taken from the step-graded SiGe region of the Si/step-graded SiGe/Si (110). Image analysis software "sMoiré" produced by HREM Research Inc. is utilized to calculate the lattice spacing from the STEM moiré. The results show the potential of this technique in distinguishing slight differences of the lattice spacing between the SiGe layers.

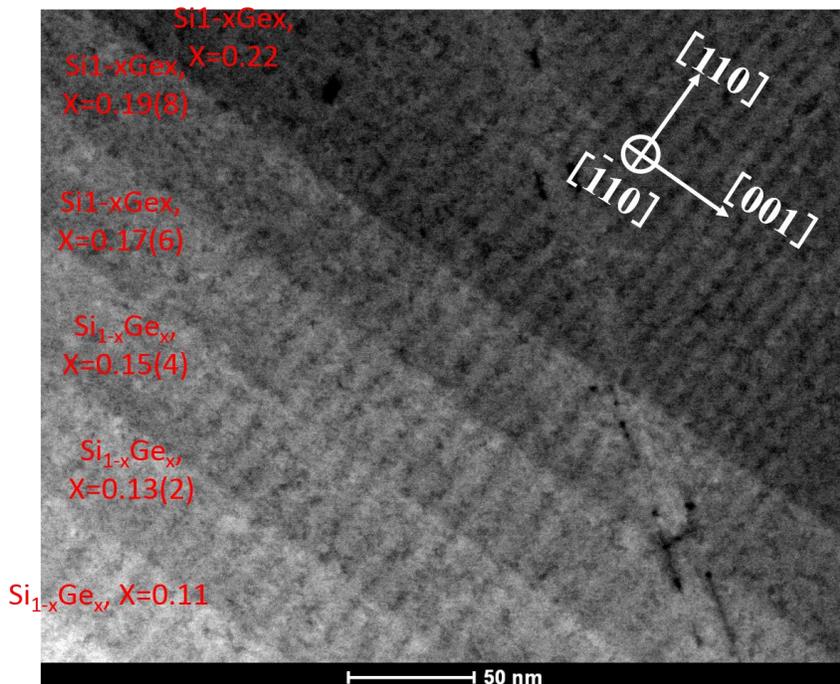


Figure 1. A typical STEM moiré taken from the compositionally step-graded SiGe thin film.

References:

- [1] Y. Kondo and N. Endo, Kenbikyo Vol.49 No. 3, 226 (2014), in Japanese
- [2] Kim, S., et al., Applied Physics Letters, Vol. 102, 161604 (2013)
- [3] Kim, S., et al., Applied Physics Letters, Vol. 103, 033523 (2013)
- [4] Kim, S., et al., ECS Solid State Letters, Vol. 3, Q1-Q3 (2014)
- [5] Kim, S., et al., Journal of Applied Physics, Vol. 114, 053518 (2014)
- [6] Kim, S., et al., AIP ADVANCES Vol. 3, 092110 (2013)
- [7] A. Ishizuka, et al., Microscopy, Vol. 66, 217 (2017)
- [8] J. Yamanaka, et al., Journal of Materials Science and Chemical Engineering, Vol. 5, 102 (2017)