Applied Science

15C/2010G070

Observation of two-dimensional distribution of lattice strain and undulation of SiGe-on-insulator wafers by synchrotron x-ray topography

Takayoshi SHIMURA*[1], Tomoyuki INOUE[1], Daisuke SHIMOKAWA[1], Takuya MATSUMIYA[1], Takuji HOSOI[1], Heiji WATANABE[1], Atsushi OGURA[2], and Masataka UMENO[3]
[1] Graduate School of Engineering, Osaka University, 2-1 Yamadaoka, Suit, Osaka 565-0871, Japan
[2] School of Science and Technology, Meiji University, 1-1-1 Higashimita, Kawasaki 214-8571, Japan
[3] Dept. of Management Info. Sci., Fukui Univ. of Tech., 3-6-1 Gakuen, Fukui 910-8585, Japan

Fabrication methods for the SiGe-on-insulator (SGOI) structure are being intensively investigated, since such a structure will enable high-speed metal-oxide-semiconductor field-effect transistors (MOSFETs) with channel materials of strained Si, SiGe, and strained Ge [1]. SGOI structures are currently fabricated mainly by two methods, layer transfer [2] and Ge condensation [3,4]. In the layer transfer method, hydrogen implantation is employed in order to separate a thin SiGe layer from graded SiGe substrates. In the Ge condensation method, a SiGe layer with a low Ge concentration grown on a silicon-on-insulator (SOI) substrate is thermally oxidized, where Ge atoms in the SiGe layer are ejected from the oxide interface resulting in a SiGe layer with a high Ge concentration. However, these methods require complex processing and do not always produce high-quality fully relaxed SiGe layers [5].

Synchrotron radiation (SR) x-ray topography is an effective technique for characterizing imperfections in crystalline thin films, yielding a two-dimensional distribution of atomic-level structural information [5]. It represents valuable information for achieving an accurate understanding of the crystalline quality of wafers and for improving wafer fabrication techniques. In this study we demonstrate observations of two-dimensional distributions of lattice strain and undulation of SiGe-on-insulator wafers by synchrotron x-ray topography.

Fig. 1 shows a series of x-ray topographs of a layer transferred SGOI wafer obtained by changing the incident angle and they show clear crosshatch pattern. Fig. 2 shows the distributions of peak position, FWHM, and integrated intensity derived from the rocking curve at each pixel of CCD detector. Some of them are no longer crosshatch, but line patters. This is because the crosshatch pattern is mainly due to the lattice undulation. Fig. 3 (a) and (b) show the distributions of lattice undulation and lattice strain, respectively, which were estimated by comparing the distributions of peak position obtained using x-ray topographs of 113 and -1-13 reflections. The fluctuation of strain was estimated to be less than 0.02%.

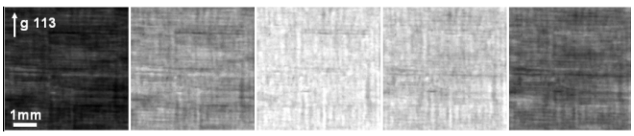

Fig 1. X-ray topographs obtained by changing the incident angle

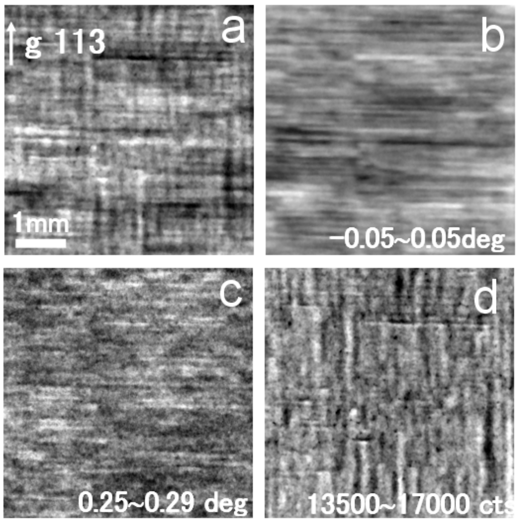

Fig 2. (a) shows x-ray topograph. (b)~(c) show the distributions of peak position, FWHM, and integrated intensity of rocking curve at each pixel of CCD detector, respectively.

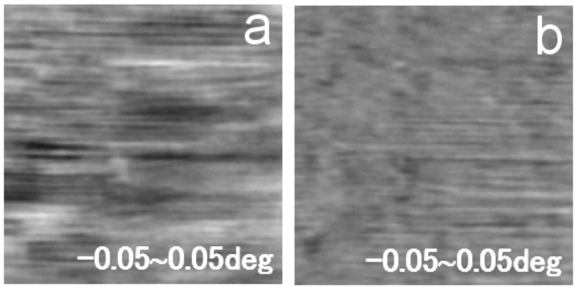

Fig. 3 (a) and (b) show the distributions of lattice undulation and strain, respectively.

[1] M. L. Lee *et al.*, J. Appl. Phys. 97, 011101 (2005).
[2] L. J. Huang *et al.*, Appl. Phys. Lett. 78, 1267 (2001).
[3] T. Tezuka *et al.*, Jpn. J. Appl. Phys. 40, 2866 (2001).
[4] S. Nakaharai *et al.*, Appl. Phys. Lett. 83, 3516 (2003).
[5] T. Shimura et al., J Mater. Sci.: Mater. Electron. 19, S189 (2008).

*shimura@mls.eng.osaka-u.ac.jp