17A, 17C/2002Y003

X-ray CTR Scattering on Ultrathin SiO_2 / Si Interface

Shuuichi DOI*, Naoki AWAJI and Kenji NOMURA
Fujitsu Laboratories LTD., 10-1 Morinosato-wakamiya, Atsugi 243-0197, Japan

Introduction

As a result of increasing demand for scaling down the CMOS transistors, the thickness of SiO_2-based gate dielectric films approaches atomic dimension. In developing advanced CMOS transistors with ulrathin gate dielectric films, precise control of the structure at SiO_2/Si interface is important issues because the interface region dominates the electric properties of gate dielectric film. To fabricate the CMOS transistors with high performance and high reliability, it is required to investigate the SiO_2/Si interface at atomic level.

X-ray Crystal Truncation Rod (CTR) scattering is one of the powerful techniques which enable us to characterize such thin films and buried interfaces. By analyzing the distribution of the intensity along CTR, we can obtain the interface structure at atomic scale. In this study, we performed X-ray CTR scattering measurements to characterize the SiO_2/Si interface structure.

Experimental and Results

The CTR measurements were carried out by using the HUBER six-circle diffractometer at the BL-17A. The x-ray wave length was chosen to be 0.116nm. A Si (111) analyzer crystal was used to obtain high angular resolution. The rocking curve of the CTR was collected by the ω scan. After subtracting the background scattering from each rocking curve, the integrated intensity was obtained.

Figure 1 shows the measured intensity of the (11L) CTR from a sample of 1.0nm thick SiO_2 on Si (001) substrate. The vertical position of Si atoms at the interface strongly influence on the asymmetry of this peak profile. We applied the model with the structural parameter of the vertical displacement Δ of the topmost Si atoms at the interface. Applying the least squares procedures, we determined Δ for the Si atoms which showed the clear dependence for the samples with different fabrication condition.

In summary, we evaluated the atomic displacement at ultrathin SiO_2/Si interface by using x-ray CTR scattering which provides a useful tool for the development of advanced MOS devices.

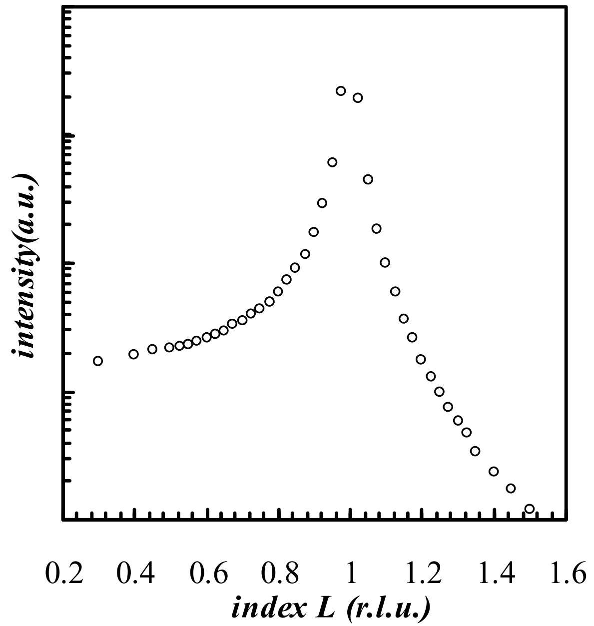

Figure 1. The measured intensity distribution of the (11L) CTR from the 1.0nm thick SiO_2 / Si (001) sample.

* doi.shuuichi@jp.fujitsu.com