X-ray diffraction topography of polished silicon surfaces under total reflection conditions

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Introduction

The progressing ULSI technology demands more and more severe quality of the surface of the silicon wafers. In order to characterize the near-surface imperfection supposed to be induced by mechano-chemical polishing, the grazing incidence diffraction topography has been proposed[1), which takes advantage of the wavelength tunability of synchrotron radiation.

We verified and developed this technique using the extremely bright undulator radiation of BL24XU (Hyogo Beamline) in SPring-8, and applied it to silicon wafers prepared under several conditions of mechano-chemical polishing.

Experimental and Results

Silicon wafers (CZ, (100), p-type 10Ωcm) prepared by stock removal polishing and by final polishing were chosen for the samples. We set up the experimental arrangement for the grazing incidence diffraction topography on BL24XU. The energy of the monochrome beam was selected to be near 9.67 keV by double-crystal monochromator, so as to satisfy a Bragg condition of a (444) asymmetric reflection at grazing incidence on (100) surfaces and to be around the first order peak of the undulator spectrum of BL24XU. Then the brilliant undulator radiation of BL24XU enabled the surface-sensitive topography under total reflection conditions, in which the angle of the incidence θ_0 is smaller than the critical angle θ_c (0.185 degrees in this case), with synchronized traversing of the specimen and the film. The penetration depth of x-ray under these conditions are less than 10 nm.

In the topographs of the specimen prepared by the stock removal polishing, taken under the conditions of $\theta_0<\theta_c$, the irregular contrasts were clearly observed (fig.1), which attributed to the near-surface lattice distortion induced by mechano-chemical polishing. It shows this technique is quite powerful to characterize the near-surface quality of the silicon wafers.

Reference

1)T.Kitano, T.Ishikawa, J.Matsui, K.Akimoto, J.Mizuki, and Y.Kawase: Jpn. J. Appl. Phys. 26(1987)L108

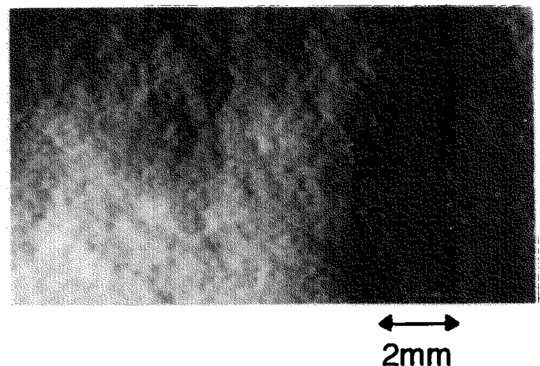

Fig.1 A x-ray topograph of a silicon wafer prepared by stock removal polishing obtained under total reflection condition ($\theta_0=0.5\theta_c$, the penetration depth is about 5 nm).

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