Transmission-Diffraction and Total-Reflection X-ray Topography of Large-Diameter Silicon Wafers

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We have investigated crystal perfection and strain distribution in 300-mm diameter CZ-Si wafer using large-area X-ray diffraction topography in the Laue geometry which gave asymmetric reflections of horizontally wide (~300-mm) X-rays being incident at a skew angle. In addition, total-reflection X-ray topography was obtained for observing surface morphology.

The samples for the diffraction topography were B-doped (resistivity: 15 Ω-cm), 300-mm diameter, (100) CZ-Si wafers whose front and back surfaces were polished. Some of them were annealed at 780°C for 3 h and at 1000°C for 16 h in dry O2.

After the sample wafer was supported with two plastic bars, placed parallel to each other, on a plastic sample slider, step-scanned X-ray topographs were taken at a step-interval of 3 arcsec with the asymmetric 117 reflection of 49.8 keV X-rays being incident at a glancing angle of 2.9° in the Laue geometry.

We found a similar zebra-pattern in both the as-received wafer and the annealed wafer. This result means that both the wafers had the same strain distribution or the wafer-setting method strongly affected the formation of zebra-patterns. Further experiments are required in order to clarify this result.

Total-reflection X-ray topography is designated here as a new imaging technique to visualize surface morphology by mapping the variations in intensity of the X-ray totally-reflected from various positions on the surface of a wafer.

The test sample was a 200-mm, (100) CZ-Si wafer whose front and back surfaces were polished. The whole surface of the sample was irradiated with the 22.72 keV X-ray beam, and it caused total-reflection.

The image of the totally-reflected beam was recorded, together with a part of the direct X-ray beam, on an X-ray film or an imaging plate placed at 10.18-m position from the sample. Fine surface structure images are observed in Fig. 1, and these images seem to be correlated with the pattern obtained by optical interferometry.

Total-reflection X-ray topography may be a useful tool to evaluate 'nano-topography'.

Fig. 1. Total-reflection topograph showing fine surface structure images.

Development of a System for Early Detection of Breast Cancer Using "Owl"

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We have been developing an x-ray dark-field imaging system "Owl" [1,2] with a large view area for early detection of breast cancer.

The SR beam was expanded by an asymmetric Si 311 monochromator to obtain a 80 mm x 80 mm area at 35 keV. We employed a Si 311 Laue-case analyzer to obtain dark-field images. We tried to take dark-field image of a real breast cancer specimen, but the large size Laue-case analyzer did not work well probably because of distortion of the crystal.

The Figure shows a dark-field image of breast cancer taken by this distorted analyzer, where some internal structure is visible although a particular cancer part is not clearly visible.

Reference

Figure: Tentative x-ray dark-field image of a real breast cancer specimen. The circular size is 30 mm².