Synchrotron section topography study of silicon-on-insulator structures with cavities

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The sample studied is a silicon-on-insulator test structure especially made for an investigation of strain fields created by oxide at the oxide - silicon single crystal interfaces. In the wafer investigated there are rectangular and round cavities etched in the oxidized silicon substrate. The silicon oxide layer has a thickness of 1 µm. The cavities have a maximum width of 800 µm. After the wafer having been etched in the way described another silicon wafer is bonded to it. The bonded wafer is subsequently thinned to a thickness of 19.9 µm. Synchrotron x-ray topographs were made at the HASYLAB-DESY F1 topography station in the transmission geometry on high-resolution VRP-M films from Slavic with sample-to-film distances of 60 mm. The test structures of the sample were on the film side. The wafer was tilted 16 degrees about the horizontal [110]-axis in order to record the small-index 220, 400 and 111 reflections. The x-ray topographs were magnified with an optical microscope equipped with a digital camera.

Figure 1. 220 transmission topograph of a silicon-on-insulator sample with cavities.

Figure 1 shows a 220 large-area transmission topograph of the silicon-on-insulator sample. The rows of square and round cavities are the prominent features of the diffraction image. These images are interpreted as a result of strain produced by the oxide at the square and round cavity edges. The contrast follows the diffraction vector.
The other images observed in the topograph are the numerous small spots seen all over the topograph except for the cavities. Their contrast is evidently a result of the silicon oxide layer.

Figure 2 a, b and c show three transmission section topographs made with a narrow ribbon-like beam limited to the width of 15 µm in the vertical direction. This x-ray beam hits the sample at the area where there are the two round cavities. The narrow black line is the kinematical diffraction image of the topmost thinned silicon wafer bent at the two round cavities. The dynamical diffraction image of the substrate shows the oxide-induced defects, the strained edges of the cavities and a few distorted interference fringes.

![Figure 2: a) 220, b) 111 and c) 400 transmission section topograph of a silicon-on-insulator sample with cavities.](image)

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