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Phase-Contrast X-ray Imaging System Using a Two-Crystal X-ray Interferometer

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Introduction

Phase-contrast X-ray imaging with an X-ray interferometer enables the observations of the inner structures of biological samples without a contrast agent. However, the field of view is not sufficient for the observations of large samples. To generate a wide field of view, we have been studying a two-crystal X-ray interferometer[1]. A new imaging system with the interferometer having 30 mm × 30 mm field of view and its successful operation are reported.

Apparatus

In order to operate the two-crystal X-ray interferometer, the θ and ρ rotation tables (S2 and Tilt) should be controlled in nrad and μrad order respectively (Fig. 1). This specification was achieved with fine adjustment mechanisms using PZT. These tables were mounted on the S1 table, which was used to adjust the incident angle of X-rays to the X-ray interferometer.

The drift of the S2 table was suppressed by a feedback system, which controlled the voltage applied to the PZT so that the X-ray intensity of a small area of the interference pattern followed the target intensity.

Results

Figure 2 shows a 25 mm × 20 mm interference pattern obtained using 0.07-nm X-rays at BL-14C1. The visibility was 45 % at the best position. The observed fringes were caused by the lattice strains of the crystal blocks.

Figure 3 shows a phase-contrast tomogram of a piece of a rabbit liver with VX2 cancer. The diameter of the sample was about 10 mm. Cancerous lesion was differentiated from normal liver tissue appearing on the lower-right of the tomogram.

References

[1] A. Yoneyama et al., Rev. Sci. Instrum. 70, 4582 (1999).

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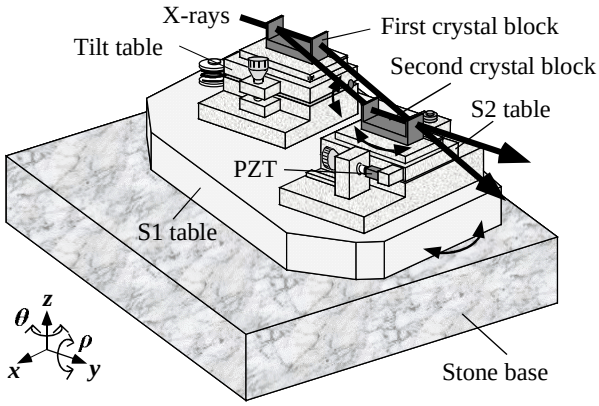

Fig.1 Phase-contrast X-ray imaging system

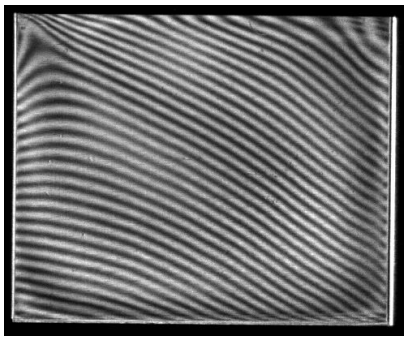

Fig.2 Interference pattern generated with the system. Field of view was 25 mm × 20 mm.

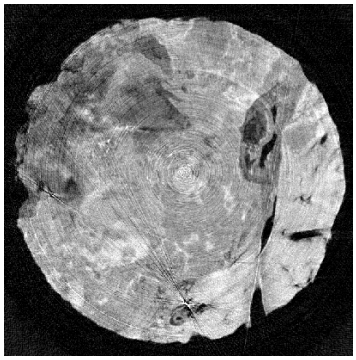

Fig.3 Phase-contrast tomogram obtained for a rabbit liver with VX2 cancer. Only bright lower-right is normal