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Development of SOI pixel detector for X-ray imaging

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1 Introduction

The SOIPIX group is developing monolithic pixel sensors using Silicon-On-Insulator (SOI) technology. The development project has started as an important subject in KEK Development and Technology Project (KEK-DTP). We have started a feasibility study of the SOI sensors for X-ray imaging. The sensors were evaluated with monochromatic X-rays at KEK-PF beamlines, PF BL-14A, BL-14B and BL-14C1, and KEK-PF-AR beamline, NE-5A. This document describes a part of the experimental results.

2 Experiment

The experiment was done in PF BL-14B in FY2016. The summary is shown in Table 1. In BL-14B, a large-area and uniform beams are available and so it was used for tests of the phase- and absorption-contrast imaging and X-ray CT.

Table 1: Experiment summary

Beamline	Beam time [year/month]	Beam Energy [keV]	Subjects
14B	2016/6	34.5	Imaging

3 SOI Pixel Sensors

SOI pixel sensors were developed in multi-project wafer (MPW) runs in every year. Various LSI designs were gathered in a common process mask. Therefore, various SOI image sensors have been used in several beam times since 2009 [1-4]. Integration-type pixel sensors, INTPIX4-8, were developed using several wafers. We demonstrated X-ray phase-contrast and absorption imaging and CT in BL14B. In this period, a vacuum chamber was installed for SOI sensors to be cooled. Fig. 1 is a picture of the experimental setup for Diffraction Enhanced Imaging (DEI). X-ray beam energy was set to 34.5 keV. In the beamtime, the storage ring was operated under storage mode and therefore the beam intensity was gradually dropped. So any CT experiment was not done. The INTPIX4 with N-type Float Zone (FZ-n) wafer was used. The SOI sensor was cooled by a Pertier module down to about 0 degree. Several samples, IC chips, nylon mesh, SD adapter and so on, were used to demonstrate X-ray imaging. We obtained clear X-ray images of an IC chip at a full depletion condition, as shown in Fig.2. The images were obtained in net irradiation time of 8 sec (50 msec/frame x 160 frames) .

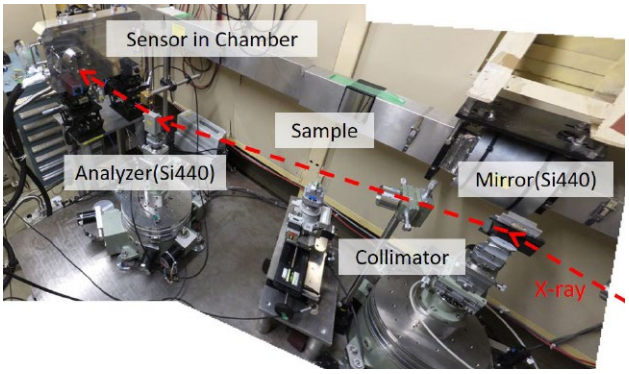

Fig.1 Experimental setup at PF beamline 14B

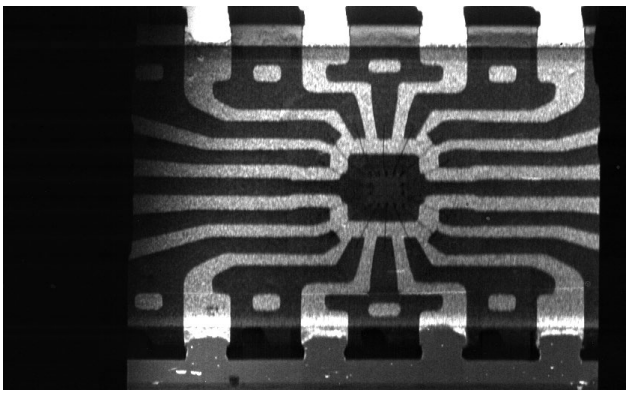

Fig. 2 An X-ray image of an IC chip.

4 Future plan

In FY2017, we will continue the SOI studies. The DAQ for integration-type pixel sensors will be updated and applied for imaging experiments with monochromatic X-ray. The SOI detector system with a vacuum chamber for cooling will be tested again.

References

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