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Feasibility test of fast X-ray camera for high-speed phase-contrast X-ray imaging

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Introduction

Phase-contrast X-ray imaging, which uses phase-shifts caused by samples as image contrast, is a powerful method for biomedical imaging. Since the phase-shift cross-sections of light elements is about 1000 times larger than that of absorption cross-sections, phase-contrast X-ray imaging enables detailed observations of biological soft tissues without requiring any contrast agents. To date, the 3rd imaging system [1] fitted with a two-crystal X-ray interferometer was used successfully observe *in vivo* tumors implanted in nude mice[2] and drug effect on tumors [3].

To quantitatively analyze drug effects more accurately, measurement periods must be shortened to decrease X-ray irradiation, stress, and anesthesia. Therefore, we adopted a fast X-ray camera for our imaging system to speed up the observation period.

Fast X-ray camera and test results

The fast X-ray camera consists of a scintillator, a transferring optical fiber, and an interlined charge-coupled device (CCD) chip (Fig. 1). The incidence X-rays to the camera are converted to visible light by the scintillator (30-µm thick Gd2O2S) and transferred to the CCD chip by an optical fiber with a 1.38:1 taper ratio. The CCD chip has 4096×2650 pixels, which are 9-µm square. Therefore, the field of view of the camera is 50 mm. The maximum frame rate is 1.6 frames per second for the entire image.

Figure2 shows a phase map (a distribution of phase-shift caused by the sample) of 12-µm thick aluminum foil, which was obtained by the 3-step fringe scanning method. The exposure time was 0.5 s for one interference pattern, and the total measurement period was 3 s. The fluctuation of phase-shift (standard deviation) in the background area was 0.2 rad. This is an improvement over our previous camera [4], which required a measurement period of approximately 10 s to obtain this fluctuation.

In the future, after performing quantitative evaluations of density and spatial resolution using phantoms in two- and three-dimensional observations, we will perform *in vivo* observations, such as blood flows in the livers of living mice and tumors implanted in nude mice. Due to the fast X-ray camera, increased accuracy and higher time resolution are expected.

References

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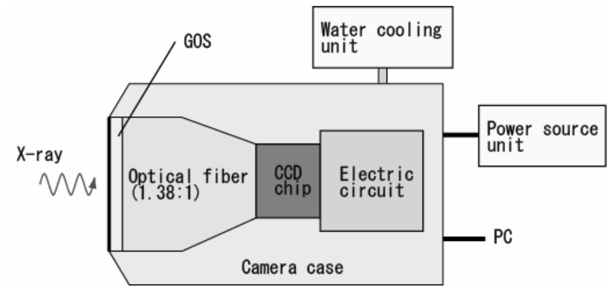

Fig. 1. Schematic view of the fast X-ray camera

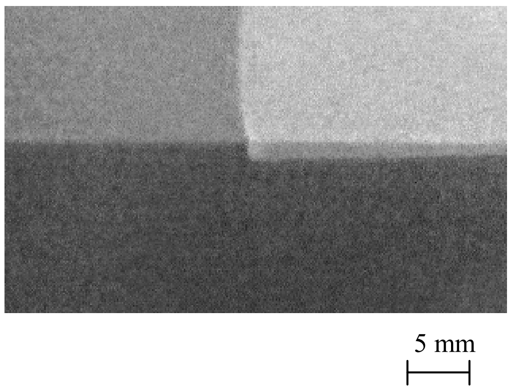

Fig. 2. A phase map of Al foil (12 µm) obtained 0.5-s exposure for one interference pattern.