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Fluorescent X-Ray Computed Tomography Using Pinhole Effect

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We propose a fluorescent x-ray computed tomography using volumetric beam and pinhole collimator to obtain 3-dimensional image effectively, aimed at providing molecular imaging with quantifiable measures and sub-millimeter spatial resolution. In this study, we demonstrate the feasibility of this concept by imaging physical phantoms. A preliminary imaging system using monochromatic synchrotron x- rays was constructed at the AR-NE7A bending-magnet beamline (6.5 GeV) at KEK, Japan.

1 Introduction

So far, we have developed two types of FXCT with sub-millimeter resolution: one based on pencil-beam geometry, and the other on sheet-beam geometry. The former acquires a set of projections by translational and rotational scans using pencil-beam geometry [1]. Unfortunately, it takes an enormous amount of acquisition time to acquire a 3-dimensional tomographic image as the pencil beam method sequentially collects data. In order to overcome this difficulty, a parallel data acquisition scheme has been proposed using an incident-sheet beam using a linear detectors array [2]. We demonstrated the efficacy using a preliminary simulated system. However, although the system requires a linear array of energy-resolving detectors with fine pixel size, such detector arrays have progressively been technically refined; unfortunately the spatial resolution has not yet reached sub-millimeter dimensions. In this research, we propose a 3-dimensional FXCT imaging method using a pinhole methodology which utilizes an x-ray CCD (charge coupled device) camera with no energy resolution.

2 Experiment

Figure 1 shows a schematic diagram of the proposed imaging geometry. An incident monochromatic volumetric beam, with photon fluxes parallel to one another are linearly polarized within a horizontal plane, impinging and covering the object. Imaging agents, such as iodine, are thus excited and isotropically emit x-ray fluorescent photons on de-excitation. A thin W plate with a pinhole is placed between the object and the CCD camera, such that the plate surface and the detective surface are parallel to the beam propagation. Only fluorescent photons passing through the pinhole are detected by the CCD, as discussed below. The projection acquisition is repeated while rotating the object over 180 degrees.

3 Result

We imaged a hand-made physical phantom to evaluate the vertical spatial resolution. The phantom was an acrylic screw with a 200-to-300-μm-thick Polyester thread wound along the groove after it was first dipped in iodine solution and then dried out (Fig. 2 (a)). Figure 2 (b) shows the 3-D FXCT image. The 200-to-300-μm thick thread was satisfactorily delineated.

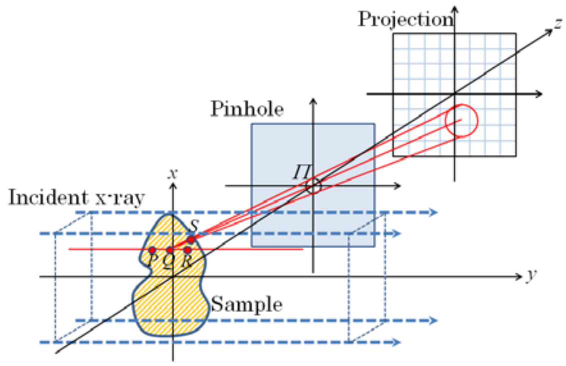
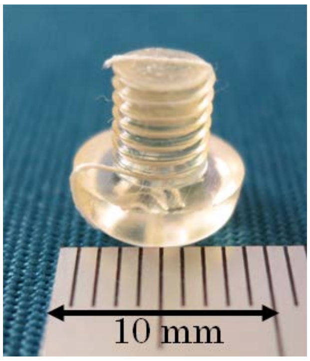
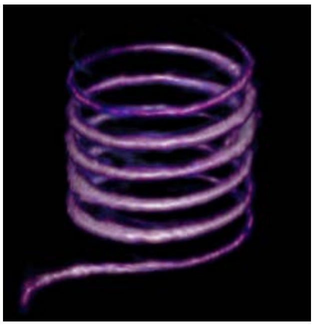


Fig. 1 Schematic diagram of the proposed imaging geometry.





(a) (b)

Fig. 2 (a) a picture of the phantom, (b) 3-D FXCT image.

References

[1] T. Yuasa *et al.*, *IEEE trans Nul. Sci.* **44**, 54 (1997).
[2] Q. Huo *et al.*, *Opt. Lett.* **33**, 2494 (2008).