Instrumentation and Technique

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Preliminary tests of a fast CCD camera for quick XRF imaging experiments

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Introduction

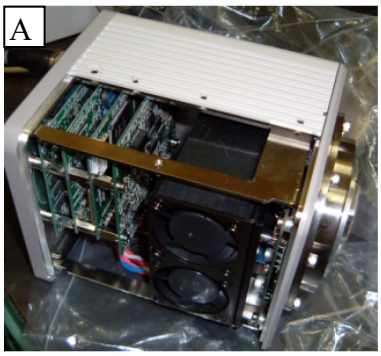
A non-scanning X-ray fluorescence (XRF) microscope is a new procedure for chemical composition imaging [1]. Its recent successful combination with substantially higher photon flux [2] has enhanced its performance, and now it is even possible to reduce the exposure time to 0.03~0.1 sec for typical samples. When considering practical movie applications, however, there is another limitation, i.e., the speed of the CCD detector. We report the preliminary tests of a new fast camera system, Hamamatsu C8880S.

Instrumentation

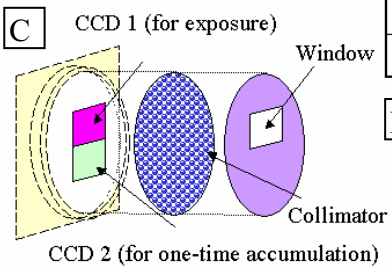
As summarized in Fig.1, a new CCD chip, TC281 (Texas Instruments) has been employed. It has 1000 × 2000 pixels so that one half can be used as a one-time storage area to which the data are transferred from the other half, the exposure area. It is possible to repeat the exposure at a speed of 30 frames/sec. In the previous study, we used a Hamamatsu C4880 system with a TC215 chip. It was necessary to close the shutter when reading CCD pixels, and also the data transfer was slow. The present system is very fast. One can note several advancements in the detector technologies. The power source for Peltier cooling is prepared as an independent box, but all other functions are stored inside the camera – there are 5 boards as shown in Fig.1A. There is no need for a so-called controller any more. In addition, no water is required for cooling the Peltier device.

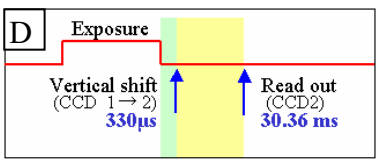
Results

A preliminary XRF image for a typical patterned sample is shown in Fig 1E. The quality of the image is quite comparable with our previous data collected by the conventional slow camera system. It has been found that optimizing the internal shape of the window plate and the collimator is very important, because the circuit for reading out the CCD data is extremely sensitive and easily degrades the image data, especially when a higher amplification gain is chosen. Further commissioning is under way. The authors wish to thank Mr. E. Toda of Hamamatsu for his useful discussions and technical cooperation on the present research.



B	TC215	TC281
Pixels	1000×1018	1000×1000×2
Size of pixel	12×12 μm²	8×8 μm²
Effective area	12×12 mm²	8×8 mm²
Peltier cooling	–30°C water cooling	–30°C air cooling
A/D conv.	10 bit/ 14 bit	12 bit
Controller	Outside	Stored
Shutter	Required	Not required
Trans. rate	0.25/ 4 fr/sec	30 fr/sec





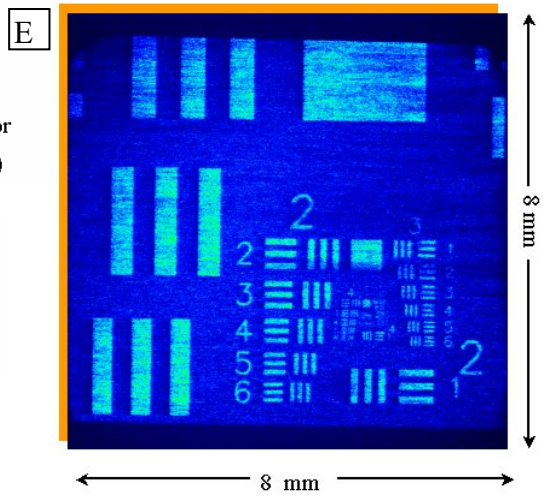


Figure 1
Summary of a new fast X-ray CCD camera, Hamamatsu C8880S.
(A) Internal structure of the camera. (B) Comparison with conventional CCD used in the previous study. (C) Role of 2 CCDs. (D) Timing chart for reading and transferring images. Transfer time from CCD1 to CCD2 is only 330 μsec, while readout takes ca. 30 msec. (E) Typical XRF image for Cr patterns on glass substrate. Viewing area 8×8mm². Exposure time 1 sec. Incident energy 10 keV.

References

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[2] K.Sakurai, M.Mizusawa and A.Iida, Photon Factory Activity Report 2001 #19, 222 (2002).
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