

X-ray Microscope with a Gas-puff Plasma X-ray Source and Grazing Incidence Mirrors

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We have developed a laboratory-size X-ray microscope that consists of a gas puff plasma Z-pinch X-ray source, Wolter-type1 mirrors, and a back-illuminated CCD camera.

To realize a compact and high resolution X-ray microscope, we designed an optical system that includes a condenser and an objective mirrors. We also fabricated special 100x and 300x objective mirrors whose sample-to-objective distances are 20 and 15 mm, respectively. Resultantly, the overall length of the optical system is less than 6 m. Moreover, ray-tracing simulations showed that the magnification was variable by changing the sample-to-objective and objective-to-detector distances. For example, in the case of the 100x objective, the magnification factor is varied over a range between 60 and 300. Thus, we can obtain both coarse and detail images at suitable magnifications without exchanging objectives.

Figure1 shows a schematic of the X-ray microscope. In Fig.1, the gas-puff plasma X-ray source equips capacitor banks that store 1.2kJ at charged voltage of 30kV. The X-ray wavelength is determined with a combination of the working gas (Ne, Ar, N₂) and filter (Ti, Al, C) materials.

Imaging tests were carried out using the 300x mirror. We confirmed that zones of about 300 nm width were clearly resolved from the image of a zone plate at wavelength of 2.9 nm (strongest radiation line from N₂ plasma). Figure2 shows the image of a glomerulus of a rat, which was embedded in epoxy resin and sliced at 200 nm thickness. It was stained with uranyl acetate and lead citrate. Several images were put together to obtain a large field of view. Each image was taken with a single pulse X-ray source of the wavelength ranging mainly from 10 nm to 20 nm using Ne plasma and a 100nm-thick C filter. Tissues, podocytes, mesangial cells, etc., are clearly observed in the image.

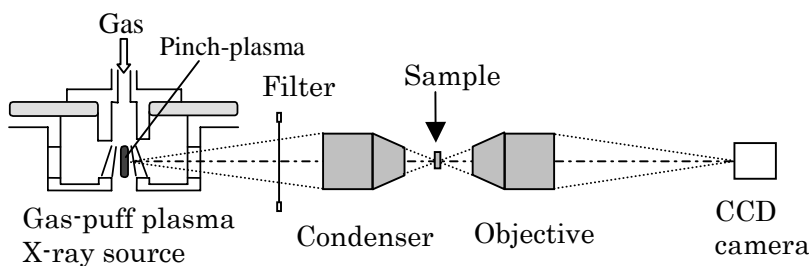


Fig.1. Schematic of the X-ray microscope system

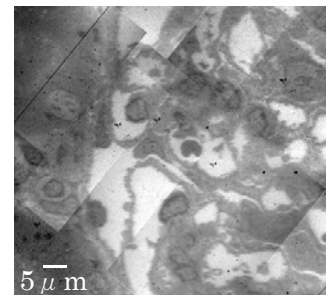


Fig.2. X-ray image of a glomerulus of a rat
Sample: Dr.Y.Muranaka and Dr.I.Ohta
(Hamamatsu University School of Medical)