Development of focusing optical system for 6 nm X-ray

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The development of novel technologies for lithography, spectroscopy and microscopy is currently being envisaged by various researchers. These schemes require highly efficient focusing X-ray optics and narrow bandwidth, high brightness soft X-ray source. We have constructed a micro-XPS system with line-focused laser plasma X-ray source and have demonstrated its performance of X-ray photo electron microscope using 13 nm X-ray[1]. It is desirable to introduce shorter wavelength X-ray source for own system to extend its applicability. In this system, it is necessary an efficient focusing optics for short wavelength X-ray.

The schematic of the experimental setup is shown in Fig.1. A Nd:YAG laser system operates with a repetition rate of up to 10 Hz and a maximum energy of 3 J. The X-ray source consists of segmented lens system, tape target and debris shield. Emitted X-rays go through a 0.1 micron thickness Al film and a pinhole (100 micron diameter), and impinge into the focusing X-ray optics system. An elliptic mirror coated with Au layer was set on the beamline at a distance of about 1m from the pinhole. The size of the microbeam was measured using the knife-edge method. The knife edge was set on a micro-motor stage. X-rays after the knife-edge were detected by a microchannel plate (MCP) with phosphor screen. The visible image on the screen was recorded by a CCD camera.

We measured the variation of the microbeam size with respect to the position of pinhole vertical and along the optical axis and the distance of the knife from the mirror exit. Comparisons between experimental results and calculations were made, and it was found a good agreement. The minimum spot size measured in this experiment was less than 5 micron.

On the other hand, we are constructing a focusing optics by using Schwarzschild mirror for 6 nm X-ray.

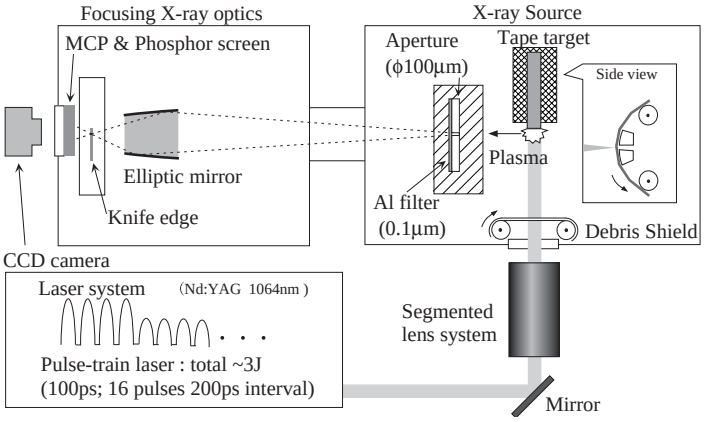

Figure 1. Schematic layout of the focusing X-ray optics using a laboratory-sized laser-plasma source.

[1]Y. Nishimura, Z. Takahashi, A. Sakata, H. Azuma, N. Yamaguchi and T. Hara, Rev. Laser Engineer. 32 (2004) 799.