High throughput EUV Microscope TXM^3 for single shot imaging

T. Ejima, H. Murata, Y. Nakamura, M. Toyoda, T. Harada, M. Furudate, A. Arai, E. Sasaki, S. Yanagida, T. Tsuru, T. Hatano, M. Yanagihara, and M. Yamamoto

IMRAM, Tohoku University, 2-1-1, Katahira, Aoba-ku, Sendai, JAPAN

ejima@tagen.tohoku.ac.jp

A Transmission-type X-ray Multilayer Mirror Microscope (TXM^3) for laboratory use has been developed using two pairs of normal-incidence reflection optics, one for illumination and the other for imaging, both coated with high throughput period-graded multilayers at a wavelength of 13.5 nm. The microscope is composed of the illumination-, sample- and detection- sections. In the illumination section, a point source of laser plasma, generated by a YAG laser (Spectra-Physics LAB-170) focused on a Sn evaporated glass rod is fed by a pair of illumination mirrors to the sample point at a NA of 0.24. A debris stopper was designed and mounted to stop all Sn particles flying at any speeds below 40m/sec. In the sample section, a sample is inserted by a three-axes goniometer of a side-entry type for easy operation. Between the sample and the illumination optics, a Zr membrane is installed to cut off visible light. In the detection section, a Schwarzschild objective (SO) of a 50X installation [1] was newly developed. The magnified image at 1m apart from the sample point is detected by a back illuminated CCD with 1024×1024 pixels, each of a 13×13 μm^2 area (Hamamatsu, C4742-98-24KAGD). For alignment of the SO and the sample position, a visible observation system was developed. All elements except for vacuum pumps are placed on a 1.8×1.5m^2 optical table of –30dB vibration isolation at 10Hz - 20Hz.

The Mo/Si multilayers for specific high-throughput imaging were prepared on super-polished mirror substrates by our ion-beam sputtering system, presented in an accompanying paper [2]. By the reflection band-pass matching among 4 mirrors, a total throughput of 0.1 was achieved. The wave-front error of the SO installed in a special housing with flexural hinges was 8 nm in RMS as measured by a Zygo interferometer. After alignments, the EUV image of a Cu#1500 mesh with Zr membrane roles was taken under EUV exposure by one laser shot of ≈10 nsec as shown in Fig. 1. The EUV intensity distribution is shown by a color scale conversion of the A/D converter output from the CCD. The spatial resolution estimated from the edge response was 440 nm in 20-80% band width. White regions in the figure give clear evidence that the EUV intensity of a single shot was above the saturation of the CCD camera.

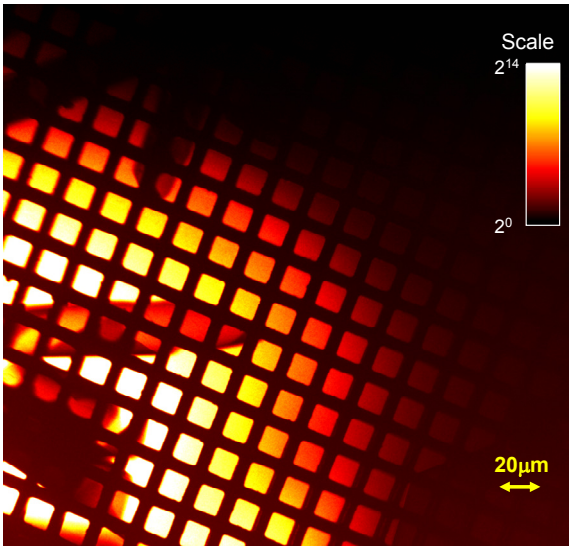

Figure 1: Single shot EUV image of Cu#1500 mesh with Zr membrane roles.

[1] M. Toyoda, et al., Jpn. J. Appl. Phys., **39** (2000) 1926.

[2] T. Harada, T. Hatano, M. Yamamoto, "High Confidence Mo/Si Multilayer Deposition for the Transmission X-Ray Multilayer Mirror Microscope TXM³", **5.5**, 6/Feb/08 in this conference.