Development of an ion milling system by a wide-area ion beam for accurate phase correction of EUV multilayer mirrors

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Multilayer mirrors are successfully utilized for various normal incidence imaging optics in the extreme ultraviolet (EUV) wavelength region. For the diffraction limited imaging required by a multilayer mirror optics, figure errors should be reduced within a sub-nm level. These figure errors are extremely difficult to correct with the current polishing technology. Therefore we have proposed the phase correction method with accuracy of 0.1 nm by period-by-period milling of the multilayer mirror to overcome the difficulty [1].

For the accurate reflection phase error compensation, we have developed a milling system with an ECR ion gun enabling effective, gentle and even milling of EUV multilayer imaging mirrors. An Ar ion beam of a large 150 mm diameter accelerated at a low 500 V to avoid the surface roughness is irradiated through a template selecting areas for milling. The template has several apertures corresponding to the position of figure errors mapped by our EUV interferometer [2]. A multilayer mirror up to 100 mm in diameter, together with the template, is mounted on a rotating holder facing to the ion beam. A constant milling rate over a mirror rotated at 200 rpm was successfully realized by a mask-plate designed for uniform radial distribution of ion dose within the exposure time. Measurement systems of emission and/or reflection VIS spectrum, integral light intensity and yield current are equipped to distinguish milling materials during ion beam irradiation. The milling rate was found to be 2 min/period by milling Mo/Si multilayer with uniform ion beam.

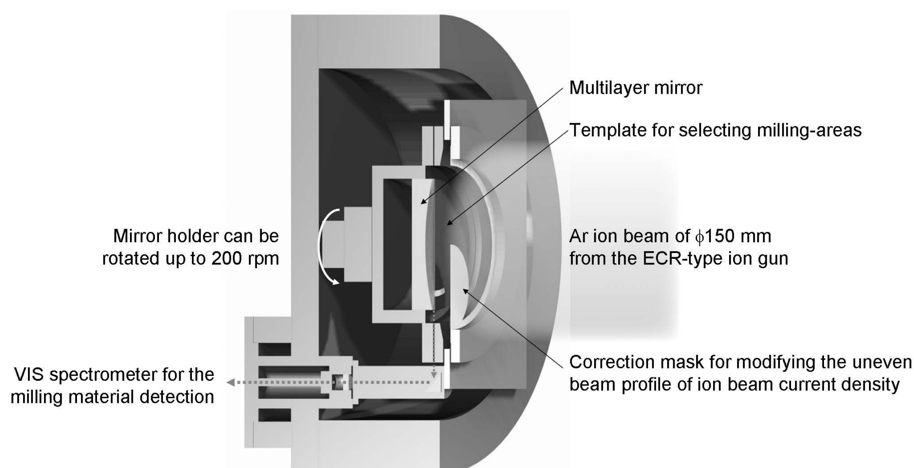

Fig. 1 Schematic drawing of a milling process chamber

[1] M. Yamamoto, Nucl. Instrum. Methods A **467-468** (2001) 1282

[2] M. Yamamoto, T. Hatano and M. Furudate, Opt. Precis. Eng. **9** (2001) 405