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Reflection Double Slit for Multilayer Reflection Phase Measurements

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1 Introduction

Reflection phase control of multilayer mirrors is an issue to realize a diffraction-limited imaging in VUV microscopes of normal incidence reflection optics. A sub-nm figure error correction method was proposed, where removal of a bilayer from a multilayer surface causes no more than 6° reflection phase change at 97 eV [1]. We constructed a period-by-period ion milling system and milled 10 bilayers from a 40 period Mo/Si multilayer with the least damage of the multilayer [2]. For a experimental demonstration of the precise phase correction principle, we have developed a reflection double slit which enables interferometric measurements on multilayer reflection phase change by its surface milling.

2 Design

A reflection double slit is a kind of masked mirror. In this study, the mirror is a 40 period Mo/Si multilayer of 7.40 nm period thickness. The multilayer mirror is overcoated with a 1 μm thick photoresist with an aperture of a double slit pattern making a contact mask. The slit width and the slit separation are 30 μm and 80 μm, respectively. The center part of Fig. 1 shows a front view.

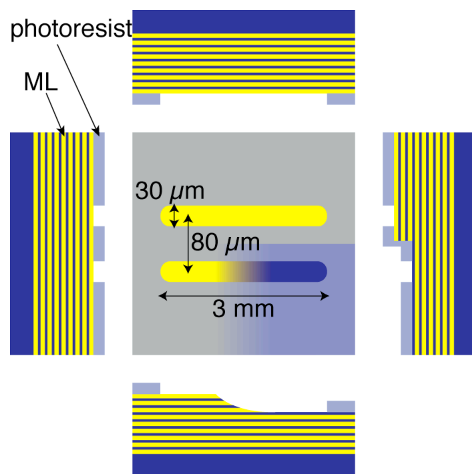

Fig. 1: Reflection double slit with a partially milled multilayer.

To measure the reflection phase change by multilayer surface milling, the multilayer is milled by 10 bilayers at right-bottom part (blue) in Fig. 1 before photoresist coating. Interference fringe formed by 40 bilayer areas is the origin of the phase change, and the surface milling effect will appear in fringe deformation due to interference of 30 and 40 bilayer areas. To avoid a possible fringe jump the milling boundary in a slit must have a gradation. Top, bottom, right and left parts of Fig. 1 shows cross sections of the masked multilayer.

3 Fabrication and Results

The three-dimensionally controlled ion milling system is described in our previous paper [3]. The boundary along the slit is sharp enough to fit between slits, and the boundary at the center of one slit has a 0.5 mm long gradation.

Reflectance contrast between the mirror and the mask makes the fringe visivility. We measured reflectances of 40 period Mo/Si multilayer and the photoresist at BL-12A. The angle of incidence was 5°. The results are shown in Fig. 2. The peak energy of the multilayer was 87 eV. The reflectance of photoresist was comfirmed to be lower by double digits. We expect that the photoresist will work as a good mask and the fringe observation using the reflection double slit will be successful.

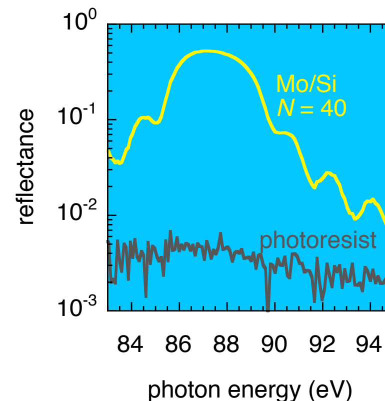

Fig. 2: Spectral reflectances of the Mo/Si multilayer and photoresist measured at BL-12A.

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References

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