

High efficiency blazed multilayer gratings for EUV and soft x-rays

Dmitriy L. Voronov,^a Rossana Cambie,^a Minseung Ahn,^b Erik H. Anderson,^a Chih-Hao Chang,^b
Eric M. Gullikson,^a Ralf K. Heilmann,^b Farhad Salmassi,^a Mark L. Schattenburg,^b
Valeriy V. Yashchuk,^a Tony Warwick,^a Leonid. I. Goray,^c Sunling S. Yang,^a
and Howard A. Padmore^a

^aLawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720

^bSpace Nanotechnology Laboratory, Massachusetts Institute of Technology, 70 Vassar St., Cambridge, MA02139

^cInternational Intellectual Group, Inc., P.O. Box 131611, Staten Island, New York 10313

e-mail: dlvoronov@lbl.gov

High dispersive and high-efficiency diffraction gratings are required for high-resolution soft x-ray spectroscopy and EUV astrophysics. Here we report a development of a diffraction grating fabrication process which provides both high effective groove density and high diffraction efficiency. First, saw-tooth silicon gratings with the period of 200 nm were fabricated by anisotropic etching of silicon wafers patterned by scanning beam interference lithography. The optimized KOH etch process provides almost perfect triangular profile of grating grooves with 6-degree tilted blazed facets, very short anti-blazed facets, and very low roughness of facet surface (Fig. 1). Second, a Mo/Si multilayer was deposited on the gratings by dc-magnetron sputtering. The d-spacing of the multilayer was optimized to provide blazed condition for the 3rd diffraction order of the gratings. Diffraction efficiency of the blazed 3rd order at the wavelength of 13.6 nm and the angle of incidence of 11° was measured to be 37.6% for the multilayer consisting of 30 bilayers (Fig. 2). Grating efficiency simulations performed with commercial codes are consistent with experimental results. The contributions of different grating imperfections to efficiency losses for EUV and soft x-ray spectral range are discussed. This work was supported by the US Department of Energy under contract number DE-AC02-05CH11231.

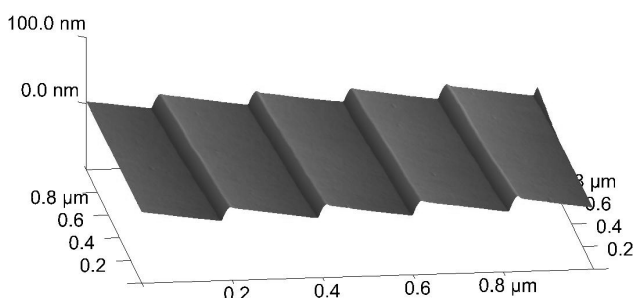


Fig. 1. An AFM image of a 200nm-period blazed grating fabricated with KOH etching of silicon single crystals.

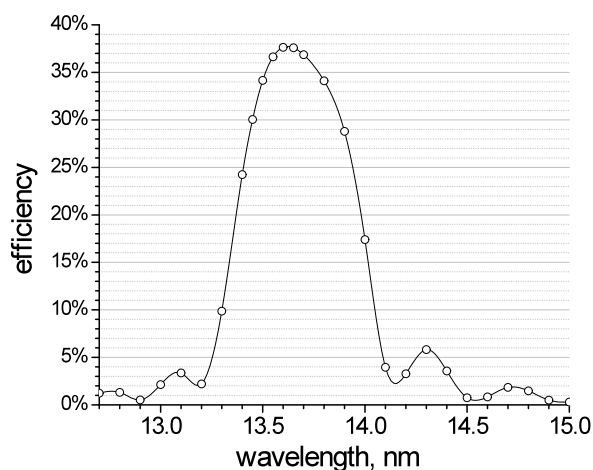


Fig. 2. Efficiency of the 3rd diffraction order of the blazed grating coated with the Mo/Si multilayer versus the wavelength.