Efficiency and polarization performance of a multilayer-coated laminar grating in the 6.5–6.9-nm wavelength region

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Introduction

A multilayer coating has high polarizance on the basis of the Brewster reflection. A multilayer-coated grating works as a polarizing dispersive element around an incidence angle of 45° in the soft x-ray region, which enables us to construct a polarizing spectrometer for soft x-rays with a few optical elements. The polarizing spectrometer is applicable to the studies on polarized soft x-ray emission. This work was motivated by polarization of the B 1*s* emission from layer-structured B compounds such as h-BN [1], TiB_2, MgB_2, *etc.*

Experimental

A 1-m, 2400-grooves/mm concave grating was employed as the substrate grating. The grating is a laminar type with a groove depth of 7.4 (±2.5) nm. It causes cancellation at 45° for the zero-order light of 7.0 nm, very close to the B 1*s* emission, 184 eV. The multilayer coating consisted of 50 layer pairs with Mo layers of 1.15 nm thick and B_4C layers of 3.57 nm thick. It was deposited using a magnetron sputter system under an Ar pressure of 2.0 mTorr. The efficiency and polarizance of the grating were evaluated using the reflectometer [2] at the beamline BL-12A. The energy width was 2.2 eV at 200 eV. The degree of linear polarization was once confirmed to be higher than 99% at 400 eV [3].

Results

Figure 1 shows the grating efficiency measured at 45.35° grazing angle of incidence for *s*-polarized radiation of photon energies from 180 eV to 188 eV. The peaks from the –3 grating order through to the +3 grating order are presented. The +1 and –1 order peaks are dominant, and the zero order peak is very small as expected from the grating profile. In Fig. 2 are plotted the grating efficiency in the +1, 0, and -1 grating orders as a function of incident photon energy at 45.35°. Concerning the +1 order, the highest efficiency (3.1%) occurred at 184 eV. The highest efficiency (3.4%) was obtained at 188 eV in the –1 order within the studied region. In Fig. 2 is also shown with the solid stars a spectral reflectance at 45.35° measured for the multilayer coating deposited on a Si wafer. It should be noticed that the FWHM of the diffraction band of the +1 order and that of the reflection band of the multilayer coating agrees to each other. On the other hand, the highest efficiency in the +1 order at 184 eV for *p*-polarized radiation was 0.017%. Using the result for *s*-polarized radiation we obtain a polarizance of the grating to be 98.9% in the +1 order on the assumption that the incident radiation was completely linearly polarized.

These results meet our desire in the study of the polarized B 1*s* emission from the above borides.

References

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[2] S. Mitani *et al.*, Rev. Sci. Instrum. **60**, 2216 (1989).
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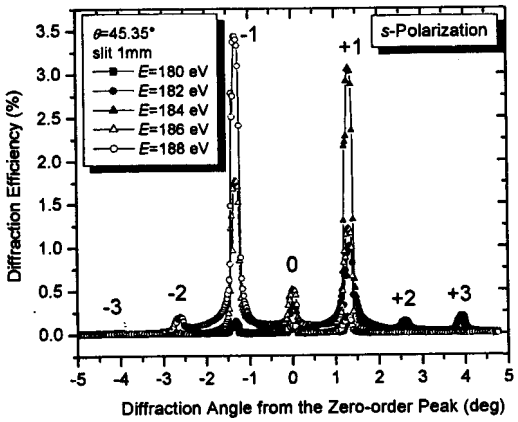

Fig. 1. The efficiency of the multilayer-coated grating measured at 45.35° for *s*-polarized radiation.

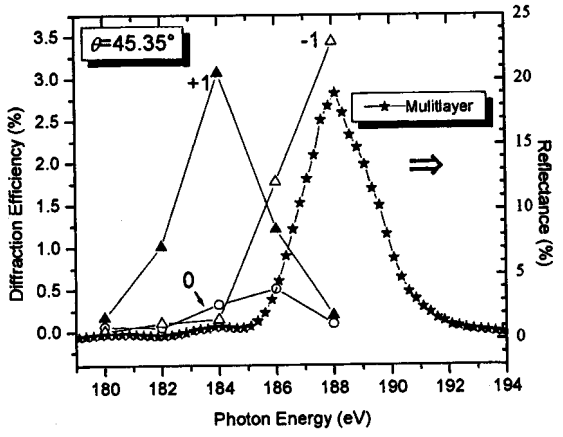

Fig. 2. The grating efficiency in the +1, 0, and -1 grating orders plotted vs. photon energy at 45.35°.

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