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Energy Calibration in the Carbon Window Region at BL-11D

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Recently BL-11D has been equipped with a new reflectometer to be a VUV and soft X-ray reflectometry beamline. To measure spectral reflectances here, however, the monochromator performance has not been enough. A brief description on the monochromator is given below.

The beamline BL-11D was constructed in 1996 for photoelectron spectroscopy. The monochromator is of a negative incidence-length varied deviation-angle type composed of a cylindrical mirror Mf, a plane mirror Mp and a spherical grating G. Two gratings G1 and G3 are mounted for soft X-ray and VUV regions, respectively. The photon energy scanning is made by changing the Mp and G angles. The designed G1 and Mp rotation angles as functions of photon energy are plotted in Fig. 1 by thick blue and red curves, respectively. The output photon energy was calibrated by photoelectron spectroscopy data in 300 – 700 eV and data points were fitted by fourth polynomials as plotted in Fig. 1 by dotted curves. The monochromator accepts only polynomial functions and has been actually operated along the dotted curves. Abnormal behaviours were found outside 300 – 700 eV. The C 1*s*-π^* absorption (285.5 eV) appeared at 299 eV for example. The situation is similar in VUV region covered by G3. It has been a serious problem that the monochromator did not work in the intermediate region 200 – 300 eV.

For reflectance measurements on our multilayer mirrors used in the carbon window region the monochromator has been tuned up at limited energy range of 250 – 300 eV.

The designed G1 and Mp rotation angles were fitted to fourth polynomials at 250 – 300 eV. The result are plotted in Fig. 1 by thin curves. This G1-Mp combination seems to work well through 200 – 350 eV. The spectral reflectance of a Cr/C multilayer was measured at various angles of incidence. The sample was deposited by ion beam sputtering. The period thickness, the C layer thickness to period thickness ratio and the period number are 3.06 nm, 0.32 and 200, respectively. Spectral reflectances calculated using optical constants from CXRO are plotted in Fig. 2. Above the C *K*-edge the ordinate is magnified by 10. Angles of incidence were chosen so that the interval of scattering vectors should be constant. The measured reflectances are plotted in Fig. 3. The good agreement between Figs. 2 and 3 shows a good spectral accuracy of the monochromator.

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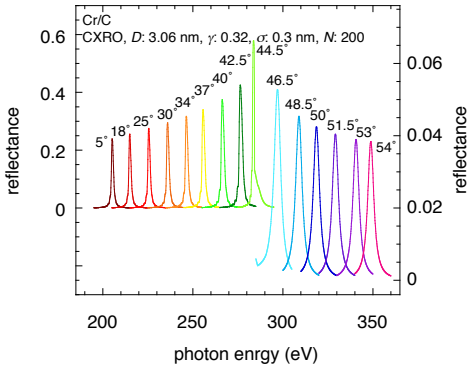

Fig. 2: Calculated spectral reflectances of a 3.06 nm period thickness Cr/C multilayer.

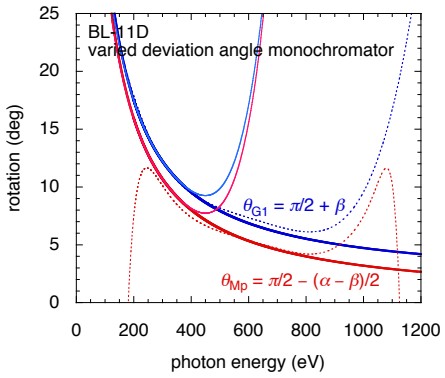

Fig. 1: Designed (thick), usually used (dotted) and the present (thin) rotation angles of G1 and Mp.

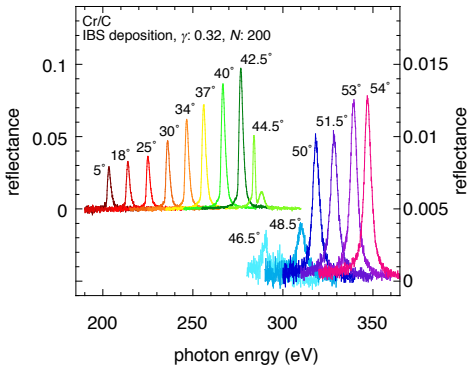

Fig. 3: Measured spectral reflectances of a Cr/C multilayer deposited by ion beam sputtering.