

Collector optics for the “water window”

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Abstract

The development and production of high performance multilayer mirrors for the “water window” region of soft X-rays (2.4 - 4.4 nm) is a challenge for modern technology because multilayers for normal incidence optics have single layer thicknesses in the atomic range of about one nanometer.

Recently, a considerable reflectivity improvements of short period Cr/Sc, Cr/Ti and Cr/V multilayers were shown due to using B₄C-interlayers¹. Motivated by this success we have studied the application of different interlayer materials for short period multilayers. The optimization of the multilayer design and deposition process resulted in a reflectivity of 25.2 % @ 3.12 nm (N = 330) and 14.5% @ 2.42 nm (N = 400). Further enhancement of optical performance as well as an extremely high thermal stability (up to 500°C) of Sc- and V- based multilayers will be discussed.

Sc-based and V-based multilayer mirrors with diffusion barriers were designed for the wavelengths of 3.374 nm and 2.488 nm and deposited by magnetron sputtering on spherical substrates with a diameter of 58 mm. The optimization of the multilayer design and deposition process resulted in a uniform reflectivity of more than 4.0 % @ 3.374 nm and about 1.0% @ 2.478 nm.

Improvement in imaging contrast of one specific element can be carried out by measuring the transmission at two different wavelengths. The required wavelengths from the plasma spectrum can be filtered by a collector mirror reflecting two different wavelengths. The realization of such a special collector optics ($\lambda_1 = 3.435$ nm and $\lambda_2 = 3.745$ nm) on a spherical substrate with a diameter of 80 mm for high-contrast analyses of calcium ($\lambda_{Ca} = 3.582$ nm) is shown in Fig. 1. The optimization of the multilayer design and deposition process resulted in reflectivities of 4.0 % and 3.5 % at the required wavelengths of 3.435 nm and 3.745 nm respectively.

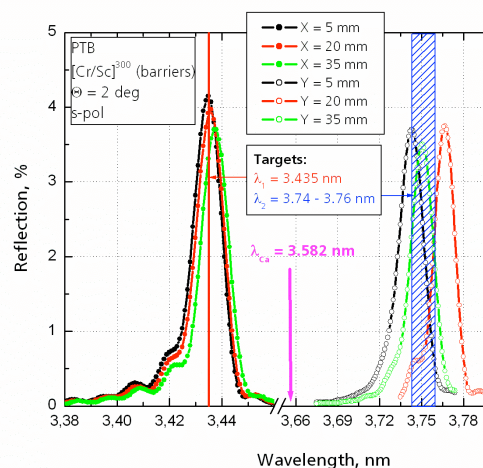


Fig. 1. Measured reflectivities for two Cr/B₄C/Sc multilayers designed at $\lambda_1 = 3.435$ nm and $\lambda_1 = 3.745$ nm and deposited on one spherical substrate with diameter of 80 mm.

¹ E.M. Gullikson, F. Salmassi, A.L. Aquila and F. Dollar, "Progress in short period coatings for water window application", Materials of the 8th International Conference on PXRMS, 2006.