Multilayer-based X-ray optics for advanced light source applications

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Abstracts: *Recent developments of high efficiency X-ray multilayer optics and imaging systems in the Institute of Precision Optical Engineering in Tongji University are discussed here. Pd-based multilayers working at the wavelength region of 8-12 nm were developed with a maximum reflectance of 47% at near normal incidence. Cr/V multilayer polarizers working near the wavelength of 2.44 nm in the water window region were fabricated with a high s-polarized reflectance of 24.3%. Multilayer coated blazed grating demonstrates an almost 10 times higher efficiency than the traditional single layer grating at 2-4 keV region. Related X-ray imaging systems for plasma diagnostics will also be discussed.*

Multilayer coatings are vital optical components in the EUV and X-ray wavelength range which enable the reflection beyond the total reflection region. The multilayer mirrors and related optics have experienced significant development in the past years through the improvement of different deposition techniques, a better understanding of the layer growth physics, and the combination with two-, three-dimensional microstructures.

In this report, new developments of X-ray multilayer mirrors and gratings in the Institute of Precision Optical Engineering (IPOE) in Tongji University, China, will be discussed. Pd-based multilayers, like Pd/B_4C and Pd/Y, are ideal material combinations for the 8-12 nm region. They have been successfully fabricated which exhibit a maximum experimental reflectance of 47% at 9.9 nm under 5 degree near normal incidence. Cr/V is the most promising candidate working near the V-L edge (2.42 nm) in the water window region. A Cr/V multilayer polarizer has been demonstrated with a record reflectance of 24.3% (s-polarization) under the grazing incidence angle of 42 degree. Besides the conventional planar mirrors, the multilayer structure has also been combined with gratings, particularly the multilayer coated blazed grating, for high efficiency monochromator in the energy range of 1-4 keV. Through the collaboration with Helmholtz Zentrum Berlin (Germany) and University of Twente (the Netherlands), a high efficiency of 35% -55% was achieved from 2 keV to 4 keV, which is almost 10 times higher than the traditional single layer gratings. Based on the multilayer technology, normal incidence and grazing incidence microscopes were developed in our group for plasma diagnostics. A spatial resolution of several microns down to 100 nm can be obtained.