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Search for Optimum Structural Parameters of multilayer Soft X-Ray reflectors by Computer Simulation

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The development of soft x-ray mirrors with a high reflectivity at near normal incidence is of importance in several applications, such as the projection XUV lithography, x-ray laser cavity, x-ray microscope, x-ray telescope, x-ray monochromator and so on. Thanks to advance in deposition techniques, the direct control of the thickness of each layer down to a few nanometer has been possible.

Therefore, searching for material pairs and their optimum parameters is indispensable to have a good reflector in soft x-ray region. In this paper, we searched the pairs of materials and the structural parameters of multilayers by recursive method for the highest reflectivity in 3 to 30nm.

First, we have chosen the wavelength at which lasing actions have been observed. For the selection of materials composing a multilayer, we used the database of the atomic scattering factors by Henke et al. Among the 92 elements in this database, we excluded the elements not suitable for a deposition, such as radio-active and non-solid state at room temperature. And the elements which have an absorption edge in the neighborhood of a selected wavelength are also excluded, because refractive index is not clear in this region.

According to the Fresnel equation, the reflectivity at boundary is proportional to the square of the difference in the indices of refraction. The absorption of soft x-ray in a material is described by the imaginary part of refractive index. So we select two materials which have large difference in real part of refractive index and have small imaginary parts of refractive index.

We find the optimum thickness and ratio (d_{opt} and γ_{opt}) that give a saturated maximum reflectivity, R_{max}, which will be presented in this paper. And compared the performance of multilayer mirrors having optimum parameters calculated by us.