Design of wideband multilayer mirrors with reduced sensitivity to random layer thickness fluctuations

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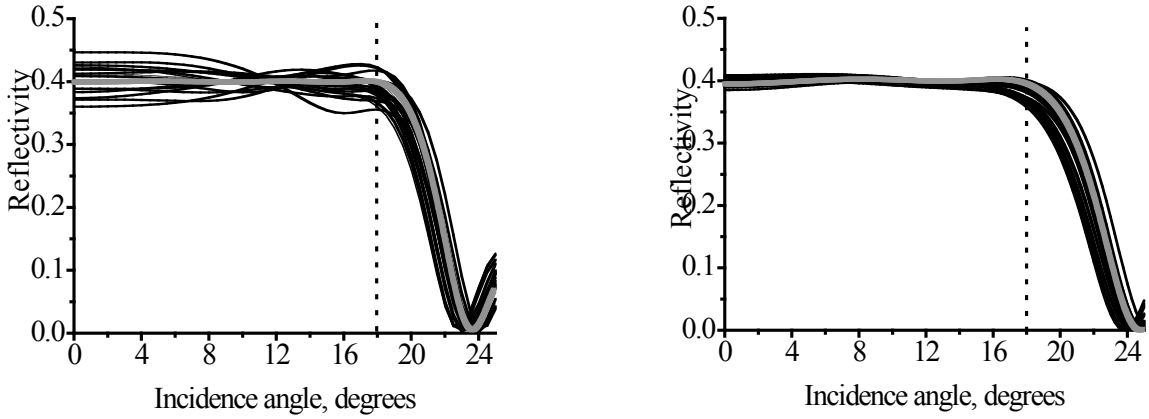
The interference nature of X-ray or EUV reflection from a multilayer mirror, resulting in a narrow spectral and angular reflectivity bandpass, sometimes limits the possibilities of this class of optics. The obvious way of widening the reflectivity bandpass consists in producing a gradual variation of the layer period with the depth of the multilayer structure. For many applications, for example in EXAFS experiments or in EUV lithography, it is important to apply a multilayer mirror which provides, in parallel to a wide spectral or angular bandpass, a given (e.g. constant) reflectivity profile. However, there are many different physical and technological factors influencing strongly the reflectivity of such a wideband multilayer mirror. One of them is random fluctuations of layers arising during deposition of the multilayered structure. An example is given in the left graph. Here the grey curve shows the reflectivity of Mo/Si mirror designed for a constant value of R in the [0, 18^0] interval of the incidence angle at 13.5 nm wavelength: this design has no layer fluctuations. The thin black curves were calculated for different sets of random layer fluctuations introduced into this design. As seen, the reflectivity plateau is deformed essentially which is unacceptable for many applications.



In the present work we analyze an approach to decrease the sensitivity of the reflectivity curve for this type of random fluctuations of layer thickness. The approach is based on a minimization of the specific merit function and allows to design a multilayer structure with a particular depth-distribution of layers providing far more stability of the reflectivity plateau with respect to random layer fluctuations. The result of such a design is illustrated in the right graph, where black curves were calculated with the use of the same sets of random layer fluctuations as in the left graph. The difference between graphs is evident.

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