MULTILAYER MIRRORS – POTENTIALS FOR MONOCHROMATING, COLLIMATING OR FOCUSING OPTICS

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Multilayers are increasingly used as monochromators in many fields, similar to crystals but also in wavelength regions where no crystals are available. However, being artificial structures with tuneable parameters such as composition, period thickness and period number, multilayers can be applied in numerous other applications.

The possibility to vary the period thickness laterally for example permits to adapt the required layer spacing to varying incident angles on flat, spherical and aspherical substrates and thus create monochromating and focusing or collimating optics, a task that is much more difficult to achieve with bended crystals e.g. in Johann or Johansson geometry [1]. On the other hand, by varying the layer thickness in depth, in the so-called depth graded multilayers, the monochromating properties of the multilayers can be adjusted to countless variations [2]. Broadband mirrors with bandwidths larger than 20% for energies from EUV to hard X-rays in the range of several tens of keV are prominent examples that have been simulated, fabricated and tested. Finally, small period thickness polarizers working near the Brewster angle have been manufactured and tested for energies up to ~1250 eV.

In imaging applications as well, multilayer mirrors become more common for example as monochromators for coherent hard synchrotron radiation. Here, the advantage of a higher photon flux density compared to crystal-based devices comes on the cost of stronger modifications on the beam profile. Frequently, these modifications are assumed to be related to imperfections of the substrate as well as of the multilayer coating itself. Low spatial frequency roughness leads to stripe modulations in the beam profile while high spatial frequency roughness can blur or degrade the coherence properties of the reflected beam. Selected multilayer systems have been characterized and their influence on the properties of a reflected synchrotron beam was studied [3]. The results are of crucial importance for X-ray micro-imaging where modifications on the reflected beam can drastically harm the performance of an experimental station.

References

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