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Development and characterization of W/SiC aperiodic multilayer coatings for hard X-rays

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In the hard X-ray domain, the presence of atomic resonances and significant absorption in all materials imposes the use of reflective optical components. Bragg mirrors which consist in a periodic stack of two (or more) different material layers can reflect a given wavelength with high efficiency and a relatively narrow bandwidth, due to the multiple constructive interferences inside the multilayer. Besides, the refractive index value being inferior to 1 for these wavelengths, total external reflection is possible below a certain angle called the critical angle. Thus, the lower the grazing angle of a multilayer mirror is, the higher the reflected intensity will be. And a deviation from the periodicity of the stack allows us to increase a spectral bandwidth, though at the expense of reflectivity. These are aperiodic multilayers. Such optical components are required for many applications, such as plasma diagnosis, astronomy, synchrotron beamlines, lithography, or medical diagnosis.

In this presentation, we study the case of W/SiC multilayers for different energies in the hard x-ray range. The W/SiC multilayers are known to have a low roughness and interdiffusion[1,2] making them suitable for the design of efficient reflective coatings with required spectral profile. The high contrast in Z for these materials also allows us to have a good compromise between the reflectivity, the bandwidth, and the number of bilayers used. Different coatings have been optimized and deposited for energies in the range 8 keV to 20 keV (with bilayers thickness ranging from 10 nm to 3 nm). All coatings have been characterized by grazing incidence x-ray reflectometry at Cu k-alpha (8.048 keV) source in our lab. The experimental results are in good agreement with theoretical models.

[1] David L. W., Soizik D,. Charles J.H., Jason K., Veijo H., Eric Z., Finn E. C., C. M. Hubert C., Fiona A. H, William W. C., “W/SiC X-ray multilayers optimized for use above 100 keV”, Applied Optics 42(13):2415-21 (2003)

[2] Maury H., Bridou F., Troussel P., Meltchakov E., Delmotte F., "Design and fabrication of supermirrors for (2-10 keV) high resolution X-ray plasmas diagnostic imaging", Nucl. Instr. and Meth. in Phys. Res. A 621, 242-246 (2010)