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Thermal Stability of Multilayers for Use with High X-ray Intensities

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Extreme focusing of XFEL beams is required to achieve power densities needed for applications like single-particle imaging or studies of nonlinear physics. However, focusing optics needs to have high radiation hardness and minimal absorption. We are developing multilayer Laue lenses (MLLs), diffraction-based X-ray optics with which we can focus X-rays to nanometer spot sizes. However, these multilayer-based lenses have so far included high atomic number materials such as tungsten or tungsten carbide. Numerical simulations predict that for high incident fluxes and pulse repetition rates these MLLs suffer from high heat load. Using materials with low atomic numbers would significantly decrease this heat load. In this presentation we will present our numerical and experimental study on screening various multilayer material pairs that could be used in MLLs for focusing XFEL beams. The most promising multilayer pair was then studied in more detail. This included annealing studies of different periods and material ratios using different heating rates. The annealing experiments indicate that MLLs made of lower atomic number multilayers are expected to withstand XFEL conditions with no deteriorations for an XFEL beam with an energy of 1 mJ per pulse, photon energy of 17.5 keV, and a repetition rate of 10 kHz.

I plan to submit also conference proceedings

No

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