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A high-precision self-adapted optical structure

Z. B. Wang, Wenbing Yun, and Tuncer M. Kuzay
Experimental Facilities Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois

Third-generation synchrotron x-ray facilities, such as the Advanced Photon Source, generate a very high heat flux in a very small area. When an optical component is subjected to a heat load, there will be thermal deformation caused by a temperature increase. For a plate-like structure, the temperature difference over the thickness causes bending and the average temperature increment causes axial deformation. For an optical element, the slope change due to bending is the main reason for the degradation of functionality in the optical component. In order to preserve photons, optical components have to be designed to have very small thermal deformation or small change of slope in the surface. Typically the change of slope is limited to a few microradians. There are many ways to control the thermal deformation, such as cryogenic cooling, inclined geometry, liquid-metal cooling, pin-posts or microchannels, using a high-thermal-conductivity material (such as diamond), etc. Any of these methods can be used for different applications. The disadvantages associated with these techniques are that they are expensive to manufacture, structurally complex, and the performances are often heat load dependent, i.e., adjustment has to be made if the heat load intensity changes.

In this paper we present a novel, self-adapted, smart structure, for which the performance is independent of heat load. It is self adapting because an originally flat optical surface remains essentially flat independent of heat load changes. The structure is simple and can be used in optical components that require one-dimensional and two-dimensional stability by design. The method is eminently applicable for high precision optical components.

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