Coherence Preserving Reflecting and Crystal Optics

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Perfect preservation of x-ray coherence requires x-ray mirrors with atomic scale smoothness. The SPring-8 is collaborating with the Osaka group for producing better x-ray mirror. Image profiles of the reflected x-ray beam with coherent illumination are well reproduced by combining a calculation based on numerical Fresnel-Kirchhof integration with surface figure data measured with micro-stitching interferometry. Since figuring methods developed by the Osaka group are numerically controllable, we can correct the surface figure to a limit posed by the metrology. An elliptical mirror gave a nearly diffraction-limited focus line of 200 nm width. Kirkpatric-Baes combination of two elliptical mirrors gave a point focus of 200×200 nm^2. After making some figure correction, the focal spot size was reduced to 90×180 nm^2. Up to now, we do not make any coating on mirror surface. If we can coat heavy metals to increase the numerical aperture without degrading the surface figure, the calculated focal size in ideal case will be down to 30×60 nm^2.

We have given an integral-form solution of time-dependent Takagi-Taupin equation for perfect crystal, and discussed propagation of coherence through dynamical x-ray diffraction. This has led to a simple method of measuring the modulus of mutual coherence function. One important conclusion is that we cannot always longitudinal and transverse coherence components. We will report the present status of synthetic diamond crystals in Japan and discuss some issues on diamond crystals in view of coherence preservation.