Characterizing x-ray mirrors in reciprocal space: Results from the NIST X-ray Optics Evaluation Double-Crystal Diffractometer

Gil D.L., Windover D., Henins A., Cline J.

Ceramics Division
National Institute of Standards and Technology
100 Bureau Drive, Stop 8520
Gaithersburg, MD 20899-8520
david.gil@nist.gov

In the last decade, multilayer x-ray optics have rapidly become ubiquitous on laboratory instruments. Parabolic graded multilayers, in particular, decrease beam divergence and so can dramatically increase the intensity of the source for many experiments. Although the spatial profiles produced by these multilayers have been studied by simulation methods and by observing the beam, their energy/divergence characteristics are less well-known. A study using a single-axis diffraction experiment has shown that for high-accuracy lattice parameter determination these effects must be taken into account.[1]

To study the characteristics of the beam produced by these multilayers with respect to both angle and wavelength, NIST has constructed the X-ray Optics Evaluation Double Crystal Diffractometer. This instrument consists of a motorized six-axis stage to position the optic being studied in all its degrees of freedom, followed by two optically encoded rotation stages each with a three-bounce silicon (440) monochromator channel optic. This allows for an SI-traceable, high-accuracy reciprocal space map (RSM) of the optic to be taken for a given position of the mirror, as shown in Figure 1. Thus the effects of alignment on the energy/divergence character of the beam can be completely profiled.

We present results of a Quasi-Monte Carlo study of the sensitivity of the total reflected intensity from a parabolic graded multilayer to its position in the six-axis alignment space; in addition, we present results on the analysis of RSM sensitivity to alignment.

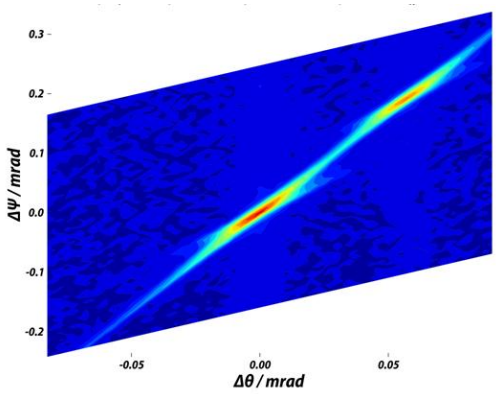

Figure 1: Reciprocal space map of beam produced by a parabolic graded multilayer in the region of the Cu-Kα characteristic lines.

References

[1] – H. Toraya and H. Hibino, J. Appl. Cryst. **33**, 1317 (2000).