X-Ray Phase Imaging with Grating Interferometers

Weitkamp T.[1*], Diaz A.[1], Pfeiffer F.[1], Cloetens P.[2], Stampanoni M.[1], Bunk O.[1], David C.[1]

[1]Paul Scherrer Institut, 5232 Villigen PSI, Switzerland, [2]European Synchrotron Radiation Facility, B.P. 220, 38043 Grenoble Cedex, France, E-mail: timm.weitkamp psi.ch

Hard X-ray grating interferometry is a relatively new method for wavefront sensing and phase radiography [1-4] in the energy range between between 8 and 30 keV. Different measurement modes such as phase stepping (Fig. 1) or moiré interferometry can be used to obtain quantitative phase maps of X-ray wavefronts and/or objects in the beam, and the combination with tomography allows three-dimensional reconstruction of the X-ray refractive index of samples.

While the spatial resolution of the technique can be as good as a few micrometers, the true promise of grating interferometry is to provide better images and new information where other phase-imaging methods cannot easily be used. This is at large fields of view, and with full-field beams of wider cross section than is usually available at synchrotron sources. X-ray tube generators such as those used in medical diagnostic imaging provide such wide beams, and many problems that impede the use of other phase-radiography methods with radiation from tube sources do not occur in a grating interferometer.

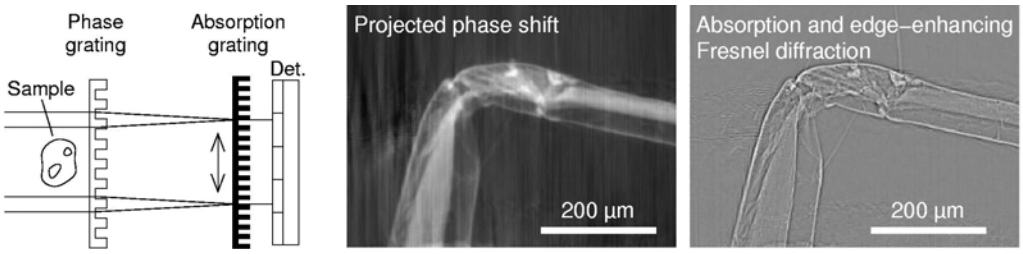

Figure1: Grating radiography. ***Left:*** Schematic setup. ***Center:*** detail of a reconstructed phase projection of a spider's leg, obtained from a phase-stepping scan (14.4 keV). ***Right:*** non-interferometric image containing absorption and edge-enhancing Fresnel diffraction contrast, extracted from the same data set.

However, in order to estimate whether the use of grating-interferometric radiography at laboratory sources is realistic, many questions remain to be answered. These include the following: How chromatic is a grating interferometer? What limits the photon-energy range accessible to grating interferometry? Can the device be used with illumination by a strongly curved wavefront? Can a tube source provide the coherent flux needed? What are the requirements on detector resolution?

The presentation will address these questions after an introduction into image formation and measurement modes.

References

[1] - C. David, B. Nöhammer, H. H. Solak, and E. Ziegler, Appl. Phys. Lett. **81**, 3287 (2002).
[2] - A. Momose, Jpn. J. Appl. Phys. **42**, L866 (2003).
[3] - T. Weitkamp, A. Diaz, B. Nöhammer, F. Pfeiffer, T. Rohbeck et al., Proc. SPIE **5535**, 137 (2004).
[4] - T. Weitkamp, B. Nöhammer, A. Diaz, C. David, and E. Ziegler, Appl. Phys. Lett. **86,** 054101 (2005) [and Erratum, Appl. Phys. Lett. **86,** 119902 (2005)].