This article was downloaded by: [University of Hamburg]

On: 04 April 2013, At: 08:45

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK

Synchrotron Radiation News

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/gsrn20>

X-ray Microscopy and Microtomography

Henry Chapman ^a, Janos Kirz ^b & Marco Stampanoni ^c

^a DESY & Hamburg University

^b ALS

^c ETH Zurich & Paul Scherrer Institut

Version of record first published: 22 Mar 2013.

To cite this article: Henry Chapman, Janos Kirz & Marco Stampanoni (2013): X-ray Microscopy and Microtomography, Synchrotron Radiation News, 26:2, 2-3

To link to this article: <http://dx.doi.org/10.1080/08940886.2013.771061>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.tandfonline.com/page/terms-and-conditions>

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

SRN

Synchrotron Radiation News
ISSN 0894-0886 is published bi-monthly.
Codon Code: SRN EFR

Heather Wagner, *Managing Editor*
Maureen Williams, *Advertising Manager*
Rebecca Corpier, *Production Manager*
Patrick Hufnagle, *Designer*

Editorial Services
Synchrotron Radiation News
1231 Hawk Ridge Road
Lafayette, CO 80026, USA
E-mail: HLWagner@comcast.net

Advertising Services
Maureen Williams
PO Box 449
Point Pleasant, PA 18950, USA
Tel: +1 623 544 1698
E-mail: mwilliams@cisaz.com

Circulation and Subscriptions
Taylor & Francis Group, LLC
325 Chestnut Street, Ste. 800
Philadelphia, PA 19106, USA
Tel: +1 215 625 8900
Fax: +1 215 625 8914

The following subscriptions are available:
Vol. 26 (2013), six issues.

Individual, print only:
\$165/£99/€130

Institutional, print+online:
\$1,221/£739/€974

<http://tandfonline.com/toc/gsrn20/current>

The opinions expressed in *Synchrotron Radiation News* are not necessarily those of the editors or publisher.

X-ray Microscopy and Microtomography

It has been almost a decade since the first special issue on X-ray microscopy, organized by Günter Schmahl (*SRN*, Vol. 16, No. 3, 2003). That was a time of rapid expansion of scanning X-ray microscopes (STXM) and transmission microscopes (TXM). The special issue included articles on soft X-ray microscopes at BESSYII, ALS, NSLS, Aarhus, Ritsumeikan, Elettra, and on hard X-ray microscopes at ESRF, SPring-8, and the APS.

Most of these instruments used zone plates to achieve high resolution, have thrived ever since, and many more have come on-line. Microscopes are now operating, or being commissioned at almost every light source around the world. X-ray microscopy has become a broadly utilized technique, with journal articles describing results appearing almost weekly. There are even commercial suppliers selling X-ray microscopes to be used at light

Figure 1: Common geometries for X-ray microscopy. (A) Parallel-beam, transmission microscope, relying on free-space propagation of the transmitted wave through the sample measured with a high-resolution detector; (B) full-field transmission microscope, where a real magnified X-ray image is formed with an objective lens; (C) coherent diffractive microscopy, where a detector and algorithm replace the TXM objective lens; and (D) scanning microscopy, where the transmission, fluorescence, or diffraction signal is mapped as a function of the rastered sample position.

sources, or at any home laboratory. There is a specialized International Conference on X-ray Microscopy that is held every two years, with the most recent one held in Shanghai in August 2012. Several review articles provide an overview of the field [1–5].

Rather than elaborating on the developments and successes in these traditional forms of X-ray microscopy, we decided to emphasize those developments that are rather different in this special issue of *SRN*. In fact, three of the articles in this issue do not use high-resolution focusing elements. The article by Schwyn et al. describes the recording of a tomographic movie. It is not a Hollywood blockbuster, but it breaks new ground in high-speed X-ray microimaging. The article by Menzel et al. introduces ptychography, a form of diffractive imaging that is rapidly gaining popularity, and has already demonstrated spatial resolution that is substantially beyond the limits set by available optics. Martin and Loh describe “diffract and destroy,” a novel form of diffractive imaging practiced at free electron lasers, while Kirian and Saldin describe an approach for “single particle imaging” where coherent diffraction patterns from many identical objects are used to obtain a three-dimensional image. Trace element mapping at high spatial resolution is the subject of the article by Vogt and Lanzirotti.

There are several ways to build an X-ray microscope, as summarized in Figure 1. For fast, 3D imaging at resolutions on the order of 1–2 microns, no X-ray lenses are required. Schwyn et al. use a parallel beam from the source to directly illuminate the sample and to “imprint” its projection on a scintillating screen, which is then imaged with a high-quality optical microscope to a high-speed detector. Higher resolution than possible with visible light microscopes can be achieved

using an X-ray objective lens, such as a diffractive zone plate. Our issue does not highlight one of these TXMs, but the diffractive imaging described in the articles by Martin and Loh and Kirian and Saldin replaces the lens in a TXM by a phasing algorithm, requiring coherent illumination. The STXM uses the high-resolution lens as a probe-forming optic, which is scanned across the object and the image is the map of transmission (or fluorescence, as described by Vogt and Lanzirotti) as a function of probe location. By reciprocity, the STXM and TXM can give equivalent images. A pixel in the TXM detector becomes a source-point location of the STXM scan, and the angular illumination of the condenser becomes the STXM detector response. These forms of imaging are all beautifully put on equal footing in ptychography, described by Menzel et al., where coherent diffraction patterns are recorded at many scan positions and algorithms unravel the entire imaging process to separate the sample transmission from the aberrations of the microscope. Tomography can be achieved in all cases by recording images of various views of the sample.

None of these new forms of microscopy would be possible without new generations of detectors, high-speed, high-volume data acquisition, and computing power that was only dreamed about a decade ago. With many old and new forms of X-ray microscopy being pursued today, this is a very exciting time for the field. ■

References

1. B. Kaulich, P. Thibault, A. Gianoncelli, and M. Kiskinova, *J. Phys.: Condens. Matter* **23**, 083002 (2011).
2. A. Sakdinawat and D. Attwood, *Nature Photonics* **4**, 840 (2010).
3. H. N. Chapman and K. A. Nugent, *Nature Photonics* **4**, 833 (2010).
4. R. Falcone, C. Jacobsen, J. Kirz, S. Marchesini, D. Shapiro, and J. Spence, *Contemporary Physics* **52**, 293 (2011).
5. J. Spence, U. Weierstall and H. Chapman, *Rep. Prog. Phys.* **75**, 102601 (2012).

HENRY CHAPMAN
DESY & Hamburg University

JANOS KIRZ
ALS

MARCO STAMPANONI
ETH Zurich & Paul Scherrer Institut

MB SCIENTIFIC AB

GIVES YOU THE SOLUTION!

Launched Products

Sub-meV PES analyser: MBS A-1

Super intense He lamp: MBS L-1

Spin detector: MUSPIN

etc.

for Detailed information Contact Us;

MB SCIENTIFIC AB

Seminariegatan 29B, SE-752 28, Uppsala, SWEDEN

Tel: +46 18 290960

Fax: +46 18 572683

info@mbscientific.se

www.mbscientific.se