

From the Editor

Diffraction



This year marks the 100th anniversary of the discovery of X-ray diffraction and the 85th anniversary of electron diffraction (see *Microscopy Pioneers*). For most of the time since their introduction, microscopists have known these two techniques as the primary phase identification methods used in conjunction with various microscopies. However, these two diffraction methods also have played enormous roles in understanding the structure of matter, as well as the nature of both X rays and electrons.

For the 17 years after Roentgen discovered X rays in 1895, there was a bitter debate over whether X rays were particles or waves. In 1912 Max von Laue suggested that, if the wave hypothesis was correct and if the wavelengths of X rays were similar to the atomic spacing, perhaps periodic arrays of atoms could be used as diffraction gratings in a manner similar to light. He asked two assistants, Walter Friedrich and Paul Knipping, to aim a beam of X rays at a crystal to determine if diffraction occurs. Even though a triclinic crystal with the lowest symmetry was selected for the experiment, beams diffracted by the crystal were detected on film. This one experiment showed that X rays should be considered as waves.

But this first X-ray diffraction photograph showed no discernable pattern in the diffracted spots, a consequence of the low-symmetry of the crystal that was used. When the target crystal was changed to zinc blende, with known cubic symmetry, the pattern of spots on the film (afterwards called a Laue diffraction pattern) was highly symmetrical. Laue's 1912 publication of the results included a scheme for the interpretation of these spots, but William L. Bragg and his father William H. Bragg thought this to be rather complicated. In the summer of 1912 they began working through Laue's data to find a simpler explanation of the phenomenon. By applying the light optical diffraction equation to X-ray diffraction, WL developed his famous Bragg's Law: $n\lambda = 2d \sin \theta$. Shortly afterward, WL determined the first atomic structure of any substance, the face-centered cubic structure of sodium chloride.

These findings in 1912 were honored with Nobel prizes for Laue in 1914 and for the Bragg father and son team in 1915. From then on, X-ray diffraction permitted numerous other discoveries, the most notable of which was the determination of the double-helix structure of DNA by Watson, Crick, and Wilkins in 1953 (1962 Nobel prize in Physiology or Medicine).

The discovery of electron diffraction took place just a few years after de Broglie hypothesized in 1924 that fast atomic particles should have wavelike properties. In 1927 Davisson and Germer successfully obtained evidence for the diffraction of electrons from a crystal. This experiment proved that electrons had wavelike properties, confirming the wave-particle duality, and was the precursor for another new method for understanding the structure of matter. The discoveries and awards associated with the early work on electron diffraction are summarized in Wil Bigelow's article in this issue's *Microscopy Pioneers* section.

Charles Lyman
Editor-in-Chief

Publication Objective: to provide information of interest to microscopists.

Microscopy Today is a controlled-circulation trade magazine owned by the Microscopy Society of America that is published six times a year in the odd months. Editorial coverage spans all microscopy techniques including light microscopy, scanning probe microscopy, electron microscopy, ion-beam techniques, and the wide range of microanalytical methods. Readers and authors come from both the life sciences and the physical sciences. The typical length of an article is about 2,000 words plus figures and tables; feature articles are longer. Interested authors should consult "Instructions for Contributors" on the *Microscopy Today* website: www.microscopy-today.com.

ISSN 1551-9295

Disclaimer

The Microscopy Society of America and the editors cannot be held responsible for opinions, errors, or for any consequences arising from the use of information contained in *Microscopy Today*. The appearance of advertising in *Microscopy Today* does not constitute an endorsement or approval by the Microscopy Society of America of any claims or information found in the advertisements. By submitting a manuscript to *Microscopy Today*, the author warrants that the article is original or that the author has written permission to use copyrighted material published elsewhere. While the contents of this magazine are believed to be accurate at press time, neither the Microscopy Society of America, the editors, nor the authors can accept legal responsibility for errors or omissions.

© Copyright 2012 by the Microscopy Society of America. All rights reserved.

Editorial Staff

Charles E. Lyman, *Editor-in-Chief*
charles.lyman@lehigh.edu
(610) 758-4249

Gennifer Levey, *Production Manager*
glevy@meridianartproduction.com
(212) 780-0315

Ron Anderson, *Executive Editor*
microscopytoday@tampabay.rr.com

Phil Oshel, *Technical Editor*
oshel1pe@cmich.edu

Stephen Carmichael, *Columnist*
carmichael.stephen@mayo.edu

Michael Davidson, *Pioneers Editor*
davidson@magnet.fsu.edu

Steven Barlow, *Education Editor*
sbarlow@sunstroke.sdsu.edu

Thomas E. Phillips, *Consulting Editor*
phillipst@missouri.edu

E. Ann Ellis, *Microscopy 101 Editor*
eann.ellis@worldnet.att.net

Paul Webster, *Calendar Editor*
pwebster@usc.edu

John Shields, *Humor Editor*
jpshield@uga.edu

Thomas Kelly, *Chief Awards Judge*
Thomas.kelly@ametec.com

Advertising Sales

M.J. Mrvica Associates, Inc.
2 West Taunton Avenue, Berlin, NJ 08009
mjmrivica@mrivica.com
(856) 768-9360

Amy Reuter, *Account Manager*
areuter@mrivica.com

Magazine website:

<http://www.microscopy-today.com>

Free subscriptions are available

Publisher

Cambridge University Press
32 Avenue of the Americas
New York, NY 10013-2473
(212) 337-5000

Circulation: 17,000

Editorial Board

Arlan Bencotter, *Lehigh University*
John Bozzola, *Southern Illinois University*
Peter Crozier, *Arizona State University*
Vinayak Dravid, *Northwestern University*
Joseph Goldstein, *University of Massachusetts*
Bryan Huey, *University of Connecticut*
John Mackenzie, *North Carolina State Univ.*
Paul Maddox, *University of Montreal*
Ania Majewska, *U. Rochester Med School*
Greg Meeker, *U.S. Geological Survey*
Joseph Michael, *Sandia National Labs*
Caroline Miller, *Indiana University*
Robert Price, *University of South Carolina*
John Reffner, *John Jay College, SUNY*
Ian Robertson, *University of Illinois*
Phillip Russell, *Appalachian State University*
Glenn Shipley, *Citizen Microscopist*
Robert Simmons, *Georgia State University*
Paul Voyles, *University of Wisconsin*
Simon Watkins, *University of Pittsburgh*
Cynthia Zeissler, *Nat. Inst. of Sci. and Tech. (NIST)*