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# Scanning Tunneling Microscopy III

Theory of STM  
and Related Scanning Probe Methods

Second Edition  
With 212 Figures



Springer

**Professor Dr. Roland Wiesendanger**

Institute of Applied Physics, University of Hamburg, Jungiusstrasse 11,  
D-20355 Hamburg, Germany

**Professor Dr. Hans-Joachim Güntherodt**

Department of Physics, University of Basel, Klingelbergstrasse 82,  
CH-4056 Basel, Switzerland

*Series Editors*

**Professor Dr. Gerhard Ertl**

Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6,  
D-14195 Berlin, Germany

**Professor Robert Gomer, Ph.D.**

The James Franck Institute, The University of Chicago, 5640 Ellis Avenue,  
Chicago, IL 60637, USA

**Professor Douglas L. Mills, Ph.D.**

Department of Physics, University of California,  
Irvine, CA 92717, USA

**Managing Editor: Dr.-Ing. Helmut K.V. Lotsch**

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## Preface to the Second Edition

When the first edition of *Scanning Tunneling Microscopy III* appeared, a gap in the literature on scanning probe methods (SPM) was filled because this book offered the first comprehensive overview of the theoretical background and concepts important for understanding image contrast formation and spectroscopic data. As a consequence, the first edition soon sold out and this second edition with an updating chapter, including the most recent developments in the theory on SPM, was prepared. The editors would like to thank all contributors who supplied material for the additional chapter, and those who have provided us with suggestions for further improvements. We also thank Springer-Verlag for the decision to publish this second edition in paperback, thereby making this book affordable for an even wider circle of readers.

Hamburg, January 1996

*R. Wiesendanger*

## Preface to the First Edition

While the first two volumes on Scanning Tunneling Microscopy (STM) and its related scanning probe (SXM) methods have mainly concentrated on introducing the experimental techniques, as well as their various applications in different research fields, this third volume is exclusively devoted to the theory of STM and related SXM methods. As the experimental techniques including the reproducibility of the experimental results have advanced, more and more theorists have become attracted to focus on issues related to STM and SXM. The increasing effort in the development of theoretical concepts for STM/SXM has led to considerable improvements in understanding the contrast mechanism as well as the experimental conditions necessary to obtain reliable data. Therefore, this third volume on STM/SXM is not written by theorists for theorists, but rather for every scientist who is not satisfied by just obtaining real-space images of surface structures by STM/SXM.

After a brief introduction (Chap. 1), N.D. Lang first concentrates on theoretical concepts developed for understanding the STM image contrast for single-atom adsorbates on metals (Chap. 2). A scattering-theoretical approach to the STM is described by G. Doyen (Chap. 3). In Chap. 4, C. Noguera concentrates on the spectroscopic information obtained by STM, whereas the role of the tip atomic and electronic structure in STM/STS is examined more closely by M. Tsukada et al. in Chap. 5. The tunneling time problem is still of great topical interest, not only in conjunction with STM, and will therefore be focused on in a separate Chap. 6 by C.R. Leavens and G.C. Aers. A unified perturbation theory for STM and SFM is described by C.J. Chen in Chap. 7. The important issue of tip-sample interaction in STM and related SXM methods is addressed in two separate chapters (Chap. 8 by S. Ciraci and Chap. 9 by U. Landman). Chapter 10 by G. Overney is devoted to contact-force microscopy on elastic media, whereas theoretical concepts of atomic scale friction are described by D. Tománek (Chap. 11). Finally, U. Hartmann concentrates on the theory of non-contact force microscopy (Chap. 12).

We would like to thank all the contributors who have contributed to this third volume on STM, as well as Springer-Verlag for the continuous pleasant collaboration. Hopefully, this third volume on the theory of STM/SXM will help many experimentalists to better understand their data, and will stimulate even more theorists to concentrate on still unsolved issues in the exciting and challenging field of STM and related scanning probe methods.

Hamburg, March 1993

*R. Wiesendanger  
H.-J. Güntherodt*

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# Contributors

G.C. Aers

Institute for Microstructural Sciences,  
National Research Council of Canada, Ottawa, K1A 0R6,  
Canada

C.J. Chen

IBM Research Division, T.J. Watson Research Center,  
P.O. Box 218, Yorktown Heights, NY 10598, USA

S. Ciraci

Department of Physics, Bilkent University, Bilkent 06533, Ankara,  
Turkey

G. Doyen

Institute of Physical Chemistry, Ludwig-Maximilians-University Munich,  
P.O. Box 700466, D-81304 Munich, Germany

D. Drakova

University of Sofia, 1 J. Bourchier, Sofia 1126, Bulgaria

H.-J. Güntherodt

Department of Physics, University of Basel, Klingelbergstrasse 82,  
CH-4056 Basel, Switzerland

U. Hartmann

Institute of Experimental Physics, University of Saarbrücken,  
P.O. Box 151150, D-66041 Saarbrücken, Germany

K. Hirose

NEC Fundamental Research Laboratories, Tsukuba, Ibaraki 305, Japan

XIV Contributors

N. Isshiki

Institute for Knowledge and Intelligence Science, kao Corporation,  
Bunka 2-1-3, Sumida-ku, Tokyo 131, Japan

H. Kageshima

NTT LSI Laboratories, 3-1 Morinosato-Wakamiya, Atsugi-shi,  
Kanagawa-ken, Japan

N. Kobayashi

Department of Physics, Faculty of Science, University of Tokyo,  
Hongo 7-3-1, Bunkyo-ku, Tokyo 113, Japan

U. Landman

School of Physics, Georgia Institute of Technology, Atlanta,  
GA 30332, USA

N.D. Lang

IBM Research Division, T.J. Watson Research Center,  
Yorktown Heights, NY 10598, USA

C.R. Leavens

Institute for Microstructural Sciences,  
National Research Council of Canada, Ottawa, K1A 0R6,  
Canada

W.D. Luedtke

School of Physics, Georgia Institute of Technology, Atlanta,  
GA 30332, USA

C. Noguera

Laboratoire de Physique des Solides, Associé au CNRS,  
Université de Paris Sud, F-91405 Orsay, France

G. Overney

Department of Physics and Astronomy, Michigan State University,  
East Lansing, MI 48824-1116, USA

T. Schimizu

Department of Physics, Faculty of Science, University of Tokyo,  
Hongo 7-3-1, Bunkyo-ku, Tokyo 113, Japan

**E. Siebel**

Institute of Thin Film and Ion Technology,  
Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

**D. Tománek**

Department of Physics and Astronomy and Center for  
Fundamental Materials Research, Michigan State University,  
East Lansing, MI 48824-1116, USA

**M. Tsukada**

Department of Physics, Faculty of Science, University of Tokyo,  
Hongo 7-3-1, Bunkyo-ku, Tokyo 113, Japan

**S. Watanabe**

Aono Atomcraft Project, ERATO,  
Research Development Corporation of Japan, Kaga 1-7-13,  
Itabashi-ku, Tokyo 173, Japan

**R. Wiesendanger**

Institute of Applied Physics, University of Hamburg,  
Jungiusstrasse 11, D-20355 Hamburg, Germany