

CHEMICAL HERITAGE FOUNDATION

R. STANLEY WILLIAMS

Transcript of an Interview
Conducted by

Cyrus Mody

at

Palo Alto, California

on

14 March 2006

(With Subsequent Corrections and Additions)

ACKNOWLEDGEMENT

This oral history is part of a series supported by the Center for Nanotechnology in Society (CNS), University of California, Santa Barbara, under the National Science Foundation Grant No. SES 0531184. Scholars and other people using this interview should acknowledge in all written publications. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the interviewee and interviewer and do not necessarily reflect the views of the National Science Foundation.

This oral history series is an important resource for the history of nanotechnology, documenting the lives and careers of key scientists and engineers that shaped and contributed to the contemporary practice of science and technology.

CHEMICAL HERITAGE FOUNDATION
Oral History Program
FINAL RELEASE FORM

This document contains my understanding and agreement with Chemical Heritage Foundation with respect to my participation in the audio-recorded interview conducted by

Cyrus Mody on 14 March 2006.

I have read the transcript supplied by Chemical Heritage Foundation.

1. The audio recording, corrected transcript, photographs, and memorabilia (collectively called the "Work") will be maintained by Chemical Heritage Foundation and made available in accordance with general policies for research and other scholarly purposes.
2. I hereby grant, assign, and transfer to Chemical Heritage Foundation all right, title, and interest in the Work, including the literary rights and the copyright, except that I shall retain the right to copy, use, and publish the Work in part or in full until my death.
3. The manuscript may be read and the audio recording(s) heard by scholars approved by Chemical Heritage Foundation subject to the restrictions listed below. The scholar pledges not to quote from, cite, or reproduce by any means this material except with the written permission of Chemical Heritage Foundation.
4. I wish to place the conditions that I have checked below upon the use of this interview. I understand that Chemical Heritage Foundation will enforce my wishes until the time of my death, when any restrictions will be removed.

Please check one:

a. _____

No restrictions for access.

NOTE: Users citing this interview for purposes of publication are obliged under the terms of the Chemical Heritage Foundation Oral History Program to obtain permission from Chemical Heritage Foundation, Philadelphia, Pennsylvania.

b. _____

Semi-restricted access. (May view the Work. My permission required to quote, cite, or reproduce.)

c. _____

Restricted access. (My permission required to view the Work, quote, cite, or reproduce.)

This constitutes my entire and complete understanding.

(Signature)

R. Stanley Williams
R. Stanley Williams

(Date)

February 19, 2007

This interview has been designated as **Semi Restricted Access**.

One may view the oral history with the permission of CHF.
However, the permission of the interviewee is required to quote from, cite, or reproduce
the oral history.

Please contact CHF to request permission.



Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
Philadelphia, Pennsylvania 19106



The Chemical Heritage Foundation (CHF) serves the community of the chemical and molecular sciences, and the wider public, by treasuring the past, educating the present, and inspiring the future. CHF maintains a world-class collection of materials that document the history and heritage of the chemical and molecular sciences, technologies, and industries; encourages research in CHF collections; and carries out a program of outreach and interpretation in order to advance an understanding of the role of the chemical and molecular sciences, technologies, and industries in shaping society.

R. STANLEY WILLIAMS

1951 Born in Kodiak, Alaska on 27 October

Education

1974 B.A., chemical physics, Rice University
1976 M.S., physical chemistry, University of California, Berkeley
1978 Ph.D., physical chemistry, University of California, Berkeley

Professional Experience

1978-1980 AT&T Bell Labs
Technical Staff

1980-1984 University of California, Los Angeles
Assistant Professor, Chemistry
1984-1986 Associate Professor, Chemistry
1986-1995 Professor, Chemistry

1995-present Hewlett-Packard Laboratories
Quantum Science Research group, Founding Director
Senior HP Fellow

Honors

Dreyfus Teacher-Scholar Award
Sloan Foundation Fellowship
2000 Julius Springer Award for Applied Physics
2000 Feynman Prize in Nanotechnology
2002 Scientific American 50 Top Technology Leaders
2003 Herman Bloch Medal for Industrial Research
2004 Joel Birnbaum Prize
2005 Scientific American 50 Top Technology Leaders
2007 Glenn T. Seaborg Medal

ABSTRACT

R. Stanley Williams begins the interview by discussing his childhood and Sputnik's influence on his decision to study science. Then Williams described his early predisposition towards chemistry and learning from both his father and books from the library. After a positive experience in high school, Williams found himself not as prepared in comparison to his peers at Rice University. Williams worked hard to catch up, and was mentored in microwave spectroscopy by Professor Robert Curl. After obtaining his undergraduate degree, Williams worked at Hewlett-Packard for a summer through Robert Curl's connections. At HP Williams worked on photoelectron spectrometers and made some notable contributions. Next Williams worked on photoemission while pursuing his graduate degree at the University of California at Berkeley. After receiving his Ph.D., Williams accepted a position at Bell Laboratories as staff scientist—his research there involved using photoemission to study surface chemistry. Disliking the corporate culture at Bell, Williams moved to University of California at Los Angeles after one year. At UCLA Williams started from scratch and very quickly built up a large research lab. Throughout his stay at UCLA, Williams' research topic ranged from photoemission, ion scattering, STM, and finally AFM. After an earthquake in 1994 destroyed most of his instruments, Williams returned to HP and started a research initiative that eventually evolved into the Quantum Science Research Laboratory [QSR]. QSR's four research areas include: nano electronics; nano photonics; nano mechanics; and nano architecture. Williams concludes the interview by offering his thoughts on outside collaboration and funding, the importance of micro-electro-mechanical systems [MEMS] to HP, and how he views QSR in relations to other research institutions.

INTERVIEWER

Cyrus Mody is an Assistant Professor of History at Rice University. Prior to that position he was the manager of the Nanotechnology and Innovation Studies programs in the Center for Contemporary History and Policy at the Chemical Heritage Foundation. He has a bachelor's degree in mechanical and materials engineering from Harvard University and a Ph.D. in science and technology studies from Cornell. He was the 2004-2005 Gordon Cain Fellow at CHF before becoming a program manager. Mody has published widely on the history and sociology of materials science, instrumentation, and nanotechnology.

TABLE OF CONTENTS

- 1 Family History and Early Life Experiences
Early disposition towards science. Growing up in South Texas and interest in chemistry.
- 3 Education
High school experience. Undergraduate degree at Rice University. Catching up in classes and studying privately. Being mentored by Robert Curl. Summer position at Hewlett-Packard.
- 13 Graduate work at University of California at Berkeley
Photoemission work and controversies. Stanford Synchrotron facility experience. Funding and fellowships.
- 20 Working at Bell Laboratories
Deciding to be a staff scientist at Bell Labs. Research on photoemission, ion scattering, and STM. Thoughts on corporate politics at Bell Labs. Transition to UCLA.
- 27 Career at University of California at Los Angeles
Building a new lab and learning to write proposals and grants. Difference between industry and academia. Continuing STM research. Expanding research group laboratory space. Efforts to start a research center. Dealing with funding problems and changing research direction. Constructing STM and AFMs. Learning about bulk thermodynamics.
- 44 Career at Hewlett-Packard
Northridge Earthquake destroying UCLA lab equipment. Accepting HP Lab offer. Setting up instruments and research group. Agilent spinoff and last minute decision to stay with HP. Difference between HP and Bell Labs and thoughts on technology transfer. Origins of the Quantum Science Research Group [QSR] and its research areas. Outside collaborations and funding.
- 57 Concluding Thoughts
MEMS research and view of QSR in relations to other research institutions.
- 59 Notes
- 60 Index

NOTES

1. J. A. Yarmoff, D. M. Cyr, J. H. Huang, S. Kim, R. S. Williams, "Impact-collision ion-scattering spectroscopy of Cu(110) and Cu(110)-(2×1)-O using 5-keV $^6\text{Li}^+$," *Physical Review B* 33 (1986): 3856-3868.
2. R. S. Williams, R. S. Daley, J. H. Huang, R. M. Charatan, "Initial-Stages of Metal-Semiconductor Interface Formation – Au and Ag on Si(111)," *Applied Surface Science* 41-2 (1989): 70-74.
3. a. R. J. Wilson, S. Chiang, "Structure of the Ag/Si(111) Surface by Scanning Tunneling Microscopy," *Physical Review Letters* 58 (1987): 369-372.
b. E. J. Vanloenen, J. E. Demuth, R. M. Tromp, R. J. Hamers, "Local Electron-States and Surface Geometry of Si(111) – (Square-Root 3 x Square-Root 3) Ag," *Physical Review Letters* 58 (1987): 373-376.
4. M. Katayama, R. S. Williams, M. Kato, E. Nomura, and M. Aono, "Structure analysis of the Si(111) root 3 × root 3 R30°-Ag surface," *Physical Review Letters* 66 (1991): 2762-2765.
5. E. A. Eklund, R. Bruinsma, J. Rudnick, R. S. Williams, "Submicron-Scale Surface Roughening Induced by Ion-Bombardment," *Physical Review Letters* 67 (1991): 1759-1762.

INDEX

A

Agilent Laboratories, 47
Agilent Technologies, Inc., 47, 51
ALGOL, 7
American Chemical Society, 19, 30
American Physical Society, 19, 24
American Vacuum Society, 19
AT&T Corporation, 48
Awschalom, David D., 54

B

Barabási, Albert-László, 37
Beckman, Arnold O., 10
Bell Laboratories, 9, 20-27, 39, 47-49, 54
Binnig, Gerd, 24
Bratkovski, Alexandre, 46
Brooks, Philip R., 8, 20
Burrus, C. Sidney, 8

C

California, 9, 10, 21, 32, 52
 Bay Area, 10, 19
 Deer Creek, 46-47
 Mountain View, 10
 Palo Alto, 9-10
California Institute of Technology, 20
Chen, Yong, 46
Curl Jr., Robert F., 1, 5-11, 13, 20, 22
Cutler, Leonard S., 45

D

DARPA. *See* United States, Defense Advanced Research Projects Agency [DARPA]
Department of Defense. *See* United States, Department of Defense
Department of Energy. *See* United States, Department of Energy

E

Edmonton, Alberta, 53
Eklund, Elliot A., 36, 59
Emory University, 37
England, 18
Europe, 20

F

Fadley, Charles S., 12
Family, Fereydoon, 37, 41
Father
 Williams, Bobby L., 1
Feldman, Leonard C., 22, 39
FORTRAN, 7

G

Georgia Institute of Technology, 37
Germany, 18
Gordon Research Conference, 37, 41
Gulf War, 29-30, 32, 41

H

Harvard University, 20, 53
Heath, James R., 54
Hewlett, William R., 10, 48
Hewlett-Packard, 2, 8-11, 20, 31-32, 41, 44-52, 55, 57-58
 Quantum Science Research, 47, 49, 52, 54, 57
Hollenhorst, James N., 45
Hu, Evelyn L., 54

I

IBM Corporation, 26, 28, 35, 39, 45, 48-49
 San Jose, 35
 Yorktown, 35
International Technology Roadmap for Semiconductors [ITRS], 50

J

Japan, 28, 34
Jet Propulsion Laboratories, 44

K

Kaiser, William J., 44
Kamins, Theodore I., 46, 50
Kavanaugh, Karen, 44
Kilpatrick, John E., 8
Kuekes, Philip J., 55

L

Lampman, Richard H., 47
Lawrence Berkeley National Laboratory, 16, 19, 25, 52

Molecular Foundry, 52

M

Mandelbrot, Benoit B., 41
Massachusetts Institute of Technology, 53
Medeiros-Ribeiro, Gilberto, 46, 54
Morehouse, Charles C., 45

N

National Science Foundation, 9, 19-20, 29-31, 38, 56
Navy. *See* United States, Navy
Nelson, David L., 30-31
Netherlands, 34
New Jersey, 21, 26
 Murray Hill, 9, 20
NIST. *See* United States, National Institute of Standards and Technology [NIST]
Nobel Prize, 39
Northridge earthquake, 40, 44, 47

O

Office of Naval Research, 29-32, 36-40
Ohlberg, Douglas A. A., 46

P

Packard, David, 10, 45
Pazik, John, 30
Petroff, Pierre M., 54
Petroleum Research Fund, 27
Physical Review Letters, 28, 35, 39
Pitzer, Kenneth S., 13

Q

QSR. *See* Hewlett-Packard, Quantum Science Research

R

Research Corporation, 27
Rice University, 1, 3-10, 19-21
 Lovett College, 5
Rohrer, Heinrich, 24

S

Scholastic Aptitude Test, 4
Shirley, David A., 9, 12-13, 16, 18, 22

Siegbahn, Kai, 12
Small Times, 50
Spicer, William E., 18
Sputnik, 1, 2
Stanford University, 9, 17-19, 53
 Stanford Synchrotron Radiation Laboratory, 18
 Stanford Synchrotron Radiation Project, 9
Stöhr, Joachim, 15
Sweden, 12

T

Texas, 4, 10
 Harlingen High School, 8
 Harlingen Public Library, 3
 Houston, 1
 South Texas, 1-2, 10

U

Union Carbide Corporation, 39
United States, 3, 34, 39, 45
 Defense Advanced Research Projects Agency [DARPA], 31-32, 56, 57
 Department of Defense, 31, 39, 41, 44
 Department of Energy, 19, 31
 National Institute of Standards and Technology [NIST], 32
 Navy, 3, 32
 Patent Office, 49
University of Alberta, 53
University of California, 32
 Berkeley, 1-2, 8-9, 12-14, 17, 19-21, 25, 31, 52
 Center for Information Technology Research in the Interest of Society [CITRIS], 52
 Los Angeles, 8, 21-23, 25, 27-34, 41, 44-46, 52, 54-55
 California NanoSystems Institute [CNSI], 52
 San Diego, 44
 Santa Barbara, 52, 54
University of Cambridge, 5
University of Oxford, 5

V

Vietnam, 1, 8

W

Wang, Kang L., 30
Washington, D.C., 29, 31
Wehner, Paul S., 15

Welch Foundation, 4

Z

Zangwill, Andrew, 37, 41