

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)

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## 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.

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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.



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