CURRICULUM VITAE

3/7/24

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EDUCATION:

5/81 - 6/84	Ph.D., Electrical Engineering, Stanford University
9/79 - 5/81	M.S. Electrical Engineering, Stanford University
9/75 - 9/79	Honors B.A., Physics, University of Utah
9/72 - 6/73	Mathematics, Brigham Young University

EXPERIENCE:

9/20 – present	Retired from University of Utah
9/12 – 9/20	Executive Committee / Instrumentation Track Director, Professional Masters of Science and Technology graduate program, U. of Utah
9/08 - 5/09	Visiting Scientist, Agilent Technologies, Santa Clara Laboratory
8/07 – 8/08	Director of Graduate Studies, Department of Physics, U. of Utah
12/98 - 1/03	Director of Graduate Studies, Department of Physics, U. of Utah
1/01 - 12/01	Associate Chair, Department of Physics, University of Utah.
1/98 - present	Professor, Department of Physics, University of Utah.
9/90 - 12/97	Associate Professor, Department of Physics, University of Utah.
3/91 – 2002	Faculty, Center for Biopolymers at Interfaces, University of Utah.
9/84 - 9/90	Research Staff Member, IBM T.J. Watson Research Center
6/84 - 9/84	Post-doc, Stanford University, Dept.of Appl. Phys, Prof. C.F. Quate.
9/79 - 6/84	Graduate student, Stanford University, Elec.Eng., Prof. C.F. Quate.
7/80 -10/80	Summer Intern, IBM T.J. Watson Research Ctr. - Optical Storage
9/78-6/79	Teaching Assistant: Taught and graded for freshman physics lab.
9/76 - 6/79	Undergrad Research Assist., U. of Utah, Physics, Professor F. Luty

Entrepreneurial

2019-present	Founder / owner – LightWorks Metrology, LLC – a startup company which is developing interferometry based Coordinate Measuring Machines and 3D interferometer systems.
2003-present	Founder / owner - Rocky Mountain Nanotechnology, LLC, a company which manufactures Atomic Force Microscopy (AFM) probes for electrical measurements. The probes are sold all over the world to universities, high technology industry researchers and

research institutes. The company also specializes in nanoscale materials characterization by AFM and consulting, reverse engineering measurements and patent infringement analysis.

1/2017-present Entrepreneurial Faculty Scholar, U. of Utah

CONSULTING

2011-2014 – Jackson & Walker LLP, patent consulting, SPM measurements
2010-2011 - Intel Corporation, consulting, device analysis, SPM measurements
2009- 2010 – Orrick, Herrington & Sutcliffe, patent consulting
2008-2009 - Agilent Tech. - consulting on Scanning Microwave Microscope
2006-2007 - ARTIS, consulting on defense related sensor system
2006 - Cooley Godward LLP, consulting, SCM measurements
2005-2006 - White & Case LLP, consulting, SCM measurements
2003-05 - Vinson & Elkins LLP, Coudert Brothers LLP - patent consulting, SCM measurements, expert witness, expert testimony
2003-05 - Vinson & Elkins LLP, patent consulting, SPM measurements
1997-98 - Stanford University, EE Dept., Prof. C. Quate - Nano-lithography Project
1995-96 - Evans and Sutherland, consulting on laser based display
1993 - Fitzpatrick, Cella, Harper & Scinto, consulting on patent interference
1991-92 - Sarcos - consulting on sensor strategies for displacement sensing

HONORS / STATS

Entrepreneurial Faculty Fellow, University of Utah 2017-present
Fellow, American Physical Society (FIAP), 2009.
Semiconductor Research Corporation Inventor Recognition Award, 2005.
Semiconductor Research Corporation Inventor Recognition Award, 2003.
Semiconductor Research Corporation Inventor Recognition Award, 1998.
Associate Editor of the Journal of Vacuum Science and Technology, 2000-2003.
IBM Research Division Award, 1989.
Phi Beta Kappa, Mortar Board, Phi Kappa Phi.
Outstanding Undergraduate Physics Graduate, University of Utah, 1979.

PATENTS (Issued & applications filed):

17. “Interferometry System and Methods,” C.C. Williams, US patent filed 11/22/2019.

16. “Interferometry System and Associated Methods,” C.C. Williams, US patent 10,514,250 issued 12/24/19 (also nationalized in Europe).

15. “Interferometry System and Associated Methods,” C.C. Williams, US patent 10,422,630, issued 9/24/19.

14. “Method for Height Control for Single Electron and Dynamic Tunneling Force Microscopy,” C.C. Williams and J.P. Johnson inventors, US patent #9,052,337 Issued 6/9/2015.

13. “Measurement of Depth and Energy of Buried Trap States in Dielectric Films by Single Electron Tunneling Force Spectroscopy,” C.C. Williams and J.P. Johnson inventors, US patent 9,052,339, issued 6/9/2015.

12. “Method and apparatus for determining dopant density in semiconductors,” C.C. Williams, US Patent #8,315,819, Issued 11/20/12.

11. “Scanning Probe Characterization of Surfaces,” C.C. Williams and E. Bussmann, US patent #7,420,106, issued 9/2/2008.

10. “Scanning Tunneling Charge Transfer Microscope”, C.C. Williams, US Patent #6,583,412, issued 6/24/2003.

9. “Method for Improving Spatial Resolution and Accuracy in Scanning Probe Microscopy”, C.C. Williams and J.S. McMurray, US Patent #6,210,982, issued 4/3/2001.

8. “Micromachined Probes for Nanometer Scale Measurements and Methods of Making such Probes”, C.C. Williams, R.C. Davis and P. Neusil, US Patent #5,969,345, Issued 10/19/99.

7. “Quantitative 2D Dopant Profile Measurement and Inverse Modeling by Scanning Capacitance Microscopy”, C.C. Williams and Y. Huang, US Patent 5,523,700. Filed 3/95.

6. “Scanning capacitance - voltage microscopy,” J. A. Slinkman, H.K. Wickramasinghe and C.C. Williams, US Patent 5,065,103. Filed 9/91.

5. “Apertureless Near Field Optical Microscope”, H.K. Wickramasinghe and C.C. Williams, US Patent 4,947,034. Filed 4/89.

4. “Particulate Inspection of Fluids using Interferometric Light Measurements,” J.S. Batchelder, D.M. DeCain, M.A. Taubenblatt, H.K. Wickramasinghe and C.C. Williams, US Patent 5,061,070. Filed 4/88.

3. “Particulate Inspection of Fluids using Interferometric Light Measurements,” J.S. Batchelder, D.M. DeCain, M.A. Taubenblatt, H.K. Wickramasinghe and C.C. Williams, European Patent, Filed 4/88.

2. “Scanning Thermal Profiler,” H.K. Wickramasinghe and C.C. Williams, US Patent

No. 4,747,698. Filed 4/86.

1. “Methods and Apparatus for Non-Destructive Testing Using Acousto-Optic Laser Probe,” C.C. Williams, US Patent No. 4,666,308. Filed 10/84.

PUBLICATIONS:

2019 M. Teferi1, H. Malissa, Anna B. Morals-Vilches, C. T. Trinh, L. Korte, B. Stannowski, C. C. Williams, C. Boehme, K. Lips, “Close to bandgap open circuit voltages of silicon heterojunction solar cells resolved on the atomic scale,” submitted to Nature Energy.

2017

106. K. Ambal, C.C. Williams and C. Boehme, “In situ absolute magnetometry in a UHV scanning probe microscope using conducting polymer-thin film,” J. Vac. Sci. Technol. A **35**, 021602 (2017).

2016

105. K. Ambal, P. Rahe, A. Payne, J. Slinkman, C.C. Williams and C. Boehme, “Electrical coupling through individual pairs of phosphorus donor atoms and silicon dangling bonds,” Sci. Reports (Nature), (published online, January 13, 2016).

104. “Philipp Rahe, Ryan P. Steele and Clayton C. Williams, “Consecutive Charging of a Molecule-on-Insulator Ensemble Using Single Electron Tunneling Methods,” Nano Lett. 16, 911–916 (2016).

2015

103. R. Wang and C.C. Williams, “Dynamic tunneling force microscopy for characterizing electronic trap states in nonconductive surfaces,” Rev. Sci. Inst. 86, 093708 (2015)

102. K. Ambal, A. Payne, D.P. Waters, C.C. Williams and C. Boehme, “Spin-Relaxation Dynamics of E’ Centers at High Density in SiO2 Thin Films for Single-Spin Tunneling Force Microscopy,” Phys. Rev. Appl. 4 024008 (2015).

101. A. Payne, K. Ambal, C. Boehme and C.C. Williams, “An atomic resolution, single-spin magnetic resonance detection concept based upon tunneling force microscopy,” Phys. Rev B 91, 195433 (Feb 2015).

2014

100. R. Wang, S.W. King and C.C. Williams, “Atomic scale trap state characterization by dynamic tunneling force microscopy, Appl. Phys. Lett. 105, 052903 (2014).

2013

99. C.C. Williams, “Atomic scale imaging of dielectric point defects,” Chapter of book entitled <u>Fundamentals of Picoscience</u>, Taylor and Francis Group, LLC, published 2013.

2011

98. D. W. Winslow and C.C. Williams, “Local density of trap states in SiO_2 and Si_3N_4 films studied by single electron tunneling force spectscopy,” J. Appl. Phys. 110, 114102 (2011).
97. D.W. Winslow, J.P. Johnson and C.C. Williams, “Nanometer scale study of HfO_2 trap states using single electron tunneling force spectroscopy,” Appl. Phys. Lett. 98, 172903 (2011).
96. J.P. Johnson, D.W. Winslow and C.C. Williams, “Measurement of depth and energy of buried trap states in dielectric films by Single Electron Tunneling Force Spectroscopy,” Appl. Phys. Lett. 98, 052902 (2011).

2010

95. N. Zheng, J.P. Johnson, C.C. Williams and G. Wang, “Electronic characterization of individual monolayer protected Au clusters by single electron tunneling force spectroscopy,” Nanotechnology 21, 295708 (2010).

2009

94. J.P. Johnson and C.C. Williams, “Atomic scale imaging and spectroscopy of individual trap states by force detected dynamic tunneling,” Nanotechnology 20, 055701 (2009).

2007

93. N. Zheng, C.C. Williams[*] and E.G. Mishchenko, “A three-dimensional model of single electron tunneling between a conductive probe and a localized electronic state in a dielectric,” J. Appl. Phys. 101, 093702 (2007). (selected for publication in Virtual Journal of Nanoscale Science and Technology, 5/14 (2007).

2006

92. E. Bussmann, N. Zheng and C.C. Williams, “Imaging of Localized Electronic States at a non-conducting Surface by Single Electron Tunneling Force Microscopy” Nano Letters, 6 2577 (2006). (also highlighted in the “Research News” section of Materials Today, December, Volume 9 2006).
91. E. Bussmann and C.C. Williams, “Single Electron Tunneling Force Spectroscopy of an Individual Electronic State in a non-conducting Surface,” Appl. Phys. Lett. 88, 263108 (2006).

2005

90. E. Bussmann, N. Zheng and C.C. Williams, “Single electron manipulation to and from a silicon dioxide surface by electrostatic force microscopy,” Appl. Phys. Lett. 86, 163109 (2005).

2004

89. L. J. Klein and C. C. Williams, “Instability induced tunneling and repeatable charge injection to SiO_2 surfaces by Electrostatic Force Microscopy,” J. Appl. Phys. 96, 3328 (2004).
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surfaces measured by frequency detection electrostatic force microscopy, Appl. Phys. Lett. 85, 2538 (2004).

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2003

84. “E. Bussmann, L.J. Klein, and C.C. Williams, “Ultra-sharp Platinum Tips for High Resolution in Scanning Capacitance Microscopy, Proceedings of the Seventh International Workshop on: Fabrication, Characterization, and Modeling of Ultra-Shallow Doping Profiles in Semiconductors,” Santa Cruz, California, April 27-May1, p. 207, 2003.

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2002

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2001

81. L. J. Klein and C.C. Williams, “Single electron tunneling detected by electrostatic force,” Appl. Phys. Lett., 79, 1828 (2001). (*article also appeared in Nature’s Physics Portal web site, September 2001).

80. C.C. Williams, J.S. McMurray and V.V. Zavyalov, “Quantitative characterization and imaging performance evaluation of an improved SCM capacitance sensor for 2D dopant profiling,” Proceedings of the 6th International Workshop on: Fabrication, Characterization and Modelling of Ultra-Shallow Doping Profiles in Semiconductors, Napa Valley, California, April 22-26, p. 199, 2001.

79. R. Davis and C. C. Williams, “An Optical Dipole Model for Photo-detection in the Near-field,” J. Opt. Soc. Am. A **18**, 1543 (2001).

2000

78. V.V. Zavyalov, J.S. McMurray, S.D. Stirling, C.C. Williams and H. Smith, “2D dopant and carrier profiles obtained by Scanning Capacitance Microscopy on an actively biased cross-sectioned MOSFET device,” J. Vac. Sci. Tech. B 18, 549 (2000).

77. V.V. Zavyalov, J.S. McMurray and C.C. Williams, “Noise in Scanning Capacitance Microscopy Measurements, “ J. Vac. Sci. Technol. B 18, 1125

(2000).

76. L.J. Klein, C.C. Williams and J. Kim, “Electron Tunneling Detected by Electrostatic Force,” Appl. Phys. Lett., 77, 3615 (2000).

1999

75. V.V. Zavyalov, J.S. McMurray and C.C. Williams, “A Scanning Capacitance Microscope Methodology for Quantitative Analysis of P-N Junctions,” J. Appl. Phys. **85**(11), 7774 (1999).

74. C.C. Williams, “2D dopant profiling by Scanning Capacitance Microscopy,” Annu. Rev. Mater. Sci. **29**, 471 (1999). **(*Invited)**

73. V.V. Zavyalov, J.S. McMurray, S.D. Stirling, C.C. Williams and H. Smith, “2D dopant and carrier profiles obtained by Scanning Capacitance Microscopy on an actively biased cross-sectioned MOSFET device,” proceedings of the 5th International Workshop of the Measurement, Characterization and Modeling of Ultra-shallow Doping Profiles in Semiconductors, Research Triangle Park, NC March 28-31, (1999).

72. V.V. Zavyalov, J.S. McMurray and C.C. Williams, “Advances in Experimental Technique for Quantitative Two Dimensional Dopant Profiling by Scanning Capacitance Microscopy,” Rev. Sci. Inst., **70** (1), 158 (1999).

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71. J.S. McMurray, J. Kim and C.C. Williams, "Direct Comparison of 2-Dimensional Dopant Profiles by Scanning Capacitance Microscopy with TSUPREM4 Process Simulation," J. Vac. Sci. Tech. B. **16**(1), 344 (1998).

70. J. Kim, J. S. McMurray, C. C. Williams, and J. Slinkman, “Two Step Dopant Diffusion Study Performed in Two Dimensions by Scanning Capacitance Microscopy and TSUPREM IV,” J. of Appl. Phys., **84**(3), 1305 (1998).

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68. J. Kim, J.S. McMurray, C.C. Williams and J. Slinkman, “2D Dopant diffusion study by Scanning Capacitance Microscopy and TSUPREM4 process simulation,” Characterization and Metrology for UISI Technology, Eds. D.G. Sieler, A.C. Diebold, W.M. Bullis, J.J. Shaffner, R. McDonald and E.J. Walters, Publisher: American Institute of Physics, Woodbury, NY, USA , p. 720 (1998).

67. J.S. McMurray and C.C. Williams, “Inverse modeling applied to Scanning Capacitance Microscopy for improved spatial resolution and accuracy,” Characterization and Metrology for UISI Technology, Eds. D.G. Sieler, A.C. Diebold, W.M. Bullis, J.J. Shaffner, R. McDonald and E.J. Walters, Publisher: American Institute of Physics, Woodbury, NY, USA, p. 731 (1998).

66. V.V. Zavyalov, J.S. McMurray and C.C. Williams, “Surface and tip characterization for quantitative 2D dopant profiling by Scanning Capacitance Microscopy,” Characterization and Metrology for UISI Technology, Eds. D.G. Sieler, A.C. Diebold, W.M. Bullis, J.J. Shaffner, R. McDonald and E.J. Walters, Publisher: American Institute of Physics, Woodbury, NY, USA, p. 731 (1998).

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Two-dimensional Test Structures Fabricated at Texas Instruments," Characterization and Metrology for ULSI Technology, Eds. D.G. Seiler, A.C. Diebold, W.M. Bullis, J.J. Shaffner, R. McDonald and E.J. Walters, Publisher: American Institute of Physics, Woodbury, N.Y., USA, p. 741 (1998).

1997

64. T. Clarysse, M. Caymax, P. De Wolf, T. Trenkler, W. Vandervorst, J. S. McMurray, J. Kim, C.C. Williams, J.G. Clark and G. Neubauer, "Epitaxial Staircase Structure for the Calibration of Electrical Characterization Techniques," Proceedings of Fourth International Workshop on the measurement, characterization and modeling of ultra-shallow doping profiles in semiconductors, Research Triangle Park, NC, April 6-9, p.30.1 (1997).
63. J.S. McMurray, J. Kim and C.C. Williams, "Quantitative measurement of two-dimensional dopant profile by cross-sectional scanning capacitance microscopy," J. Vac. Sci. Tech. B15, 1011 (1997).
62. J.S. McMurray, J. Kim and C.C. Williams, "Direct Comparison of 2-Dimensional Dopant Profiles by Scanning Capacitance Microscopy with TSUPREM4 Process Simulation," Fourth International Workshop on the measurement, characterization and modeling of ultra-shallow doping profiles in semiconductors, Research Triangle Park, NC, April 6-9, p.54.1 (1997).
61. R. Alvis, C.C. Williams, J. McMurray and J. Kim, "Scanning Capacitance Microscopy: Emerging Metrology Tool for Quantitative Two-Dimensional Dopant Profiling," Future Fab International, p.345 (1997).
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59. J-K. Leong, C.C. Williams and J.M. Olson, "Evidence of Internal Fields in Two-variant Ordered $GaInP_2$ by Near-field Scanning Optical Microscopy," Phys. Rev. B, 56, 1472 (1997).

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58. J-K. Leong, C.C. Williams, J.M. Olson and S. Froyen, "Evidence for Internal Electric Fields in Two Variant Ordered GaInP Obtained by Scanning Capacitance Microscopy," Appl. Phys. Lett. 69, 4081 (1996).
57. R.C. Davis and C.C. Williams, "Nanometer Scale Absorption Spectroscopy by Near-field Photodetection Optical Microscopy," Appl. Phys. Lett., 69(9) 1179 (1996).
56. J-K. Leong, J. McMurray, C.C. Williams and G.B. Stringfellow, "Spatial Mapping of Ordered and Disordered Domains of GaInP by Near-field Scanning Optical Microscopy and Scanning Capacitance Microscopy," J. Vac. Sci. Technol. B, 14(4) 3113 (1996).
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1995

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1994

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1993

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1992

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30. C.C. Williams, "Scanning Capacitance Microscopy," Abstract in APS Bulletin, Vol. 36, 490 (1991). **(*Invited)** - APS March meeting
29. C.C. Williams, J. Slinkman, D.W. Abraham and H.K. Wickramasinghe, "Nanoscale Surface Characterization by Scanning Capacitance Microscopy," AIP Conference Proceedings 241, Scanned Probe Microscopy, Santa Barbara, California, Jan 6-11, 337 (1991).
28. C.C. Williams and H.K. Wickramasinghe, "Scanning Chemical Potential Microscope: A New Technique for Atomic Scale Surface Investigation," J. Vac.

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26. J. Slinkman, C.C. Williams, D.W. Abraham, and H.K. Wickramasinghe, "Lateral Dopant Profiling in MOS Structures on an 100 NM Scale using Scanning Capacitance Microscopy," International Electron Devices Meeting, San Francisco, CA, Dec 9-12, (1990).
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1989

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