



Robert J. Davis

Education

- Ph.D., Applied Physics, Cornell University, Ithaca NY (advisor: Edward D. Wolf)
- M.S., Applied Physics, Cornell University, Ithaca NY
- M.S., Engineering Science, Pennsylvania State University, University Park PA (Advisor: Stephen J. Fonash)
- B.S. (honors), Engineering Science, Pennsylvania State University, University Park PA

Current and Past Scientific Positions

Director, Nanotech West Laboratory / MicroMD Laboratory; Co-Director, Ohio Wright Center for Photovoltaics Innovation and Commercialization (PVIC); Associate Director, OSU Institute for Materials Research, The Ohio State University (Sept. 2005 to present).

Primary responsibility for operations, staff, and research directions at a user facility supporting the work of approximately 250 users and approximately 20 industrial companies. **Co-Director** (with Norm Stevens, University of Toledo) of the Ohio Wright Center for Photovoltaics Innovation and Commercialization, a Third Frontier Program Wright Center funded \$18.6M over three years beginning in early 2007 with the goal of advancing research, development, and commercialization in photovoltaics in the State of Ohio. One of three **Associate Directors** of the OSU Institute for Materials Research. Participating lecturer in the OSU Art and Technology Program of the Department of Art, and serves as an original member of the Proposal Review Panel for the Center for Nanophase Materials Sciences (CNMS) at the Oak Ridge National Laboratory (ORNL).

Engineering Manager, Lithography, Process Engineering, TriQuint Semiconductor, Dallas TX (2000-2005). At different times, managed the photolithography team, the electron beam lithography team, and both. Managed a group of up to 14 engineers and engineering technicians that supported five optical I-line steppers, three direct write e-beam lithography tools, two FSI robotic Workcells, three CD-SEMs, five optical contact aligners, and numerous coat and develop tracks. Product lines included 0.15 micron single- and dual-recess GaAs/AlGaAs/InGaAs pHEMT, 0.25 micron single- and dual-recess pHEMT, and optical 0.50 micron pHEMT and MESFET. Headed cross-functional teams that included Process Engineering, Product Engineering, and Manufacturing personnel in order to achieve improvements in DC yield, wafer yield, and cycle time in a space- and military-qualified production line. Participated in development and qualification of GaN/AlGaN, HVFET, and HBT processes.

Associate Director, Nanofabrication Facility, Electronic Materials and Processing Research Laboratory, Pennsylvania State University; Graduate Faculty, Department of Engineering Science and Mechanics, and Research Associate, Sensors and Systems Department, Applied Research

Laboratory (1994-2000). Primary contact to the NSF National Nanofabrication Users Network (NNUN), the predecessor to the NNIN. Part of a small group of faculty that brought the Penn State Nanofab from a new cleanroom in 1995 to a facility that served ~200 internal and external users by spring of 2000. Supervised the installation and activation of the Penn State Leica EBPG-5HR e-beam lithography tool. Advised three Ph.D students to completion of their degrees. Secured research funding through NIST ATP, NSF MRI equipment grants, and NASA Ames.

Assistant Professor (tenure-track), Electrical Engineering Department, Columbia University (1992-1994).

Visiting Scientist, IBM Thomas J. Watson Research Center, Exploratory Devices and Technologies Group, Compound Semiconductor Devices Division (1990-1992). Supervisor: Sandip Tiwari.

Graduate Research Assistant, Department of Applied and Engineering Physics, Cornell University (1984-1990). Supervisor: Edward D. Wolf. Research in the dry etching of GaAs / AlGaAs, particularly for integrated electrooptical devices.

Visiting Scientist, Max Planck Institute for Solid State Research, Stuttgart, West Germany (1984-1985). Supervisor: Hans-Ullrich Habermeier. Research in dry etch damage of silicon as measured by photoluminescence.

Graduate Research Assistant, Engineering Science and Mechanics Department, Pennsylvania State University (1983-1984). Supervisor: Stephen J. Fonash.

Undergraduate Research Assistant, Garfield Thomas Water Tunnel, Applied Research Laboratory, Pennsylvania State University (1980-1983).

Publications in Refereed Journals or Proceedings

"An Overview of the Ohio Wright Center for Photovoltaics Innovation and Commercialization", Dean M. Giolando, Robert T. Collins, and Robert J. Davis, *Technical Proceedings of the 2007 Clean Tech Conference*, CRC Press, June 2007.

Productive Nanosystems: A Nanotechnology Roadmap, published online and in print by the Foresight Institute (www.foresight.org) and the Battelle Memorial Institute, October 2007. Robert J. Davis (Ohio State) and John Randall (Zyvex, Inc.) wrote the lithography section of the roadmap and both also contributed to several other sections.

"Interlayer and Intershot Charging-Induced Pattern Distortion on GaAs Substrates Exposed with a High Throughput Shaped Beam Electron Beam Lithography System", A. Bross, R. Davis, T. Toyama, and J. Beene, *Proceedings of the 2004 Conference on Compound Semiconductor Manufacturing Technology*, Miami FL (2004).

"Design, Fabrication, and Measurement of High-Sensitivity Piezoelectric Microelectromechanical Systems Accelerometers", Li-Peng Wang, Richard A. Wolf Jr., Yu Wang, Ken K. Deng, Lichun Zou, Robert J. Davis, and Susan Trolier-McKinstry, *J. Microelectromech. Sys.* **12**, pp. 433-439 (2003).

"Microelectromechanical systems (MEMS) accelerometers using lead zirconate titanate thick films", L.-P. Wang, K. Deng, L. Zou, R. Wolf, R.J. Davis, S. Trolier-McKinstry, *IEEE Elect. Dev. Lett.*, **23**, pp. 182-184 (2002).

"Wet-Etch Patterning of Lead Zirconate Titanate (PZT) Thick Films for Microelectromechanical Systems (MEMS) Applications", L.-P. Wang, R. Wolf, Q. Zhou, S. Trolrier-McKinstry, and R.J. Davis, *Mat.Res.Soc. Proc.* **657**, pp. 142-146 (2000).

"Self-Assembled Monolayer Electron Beam Resists", D.L. Allara, C.A. Mars, K. Sesdhadri, R.J. Davis, and M. Garrett, *Mat. Res. Soc. Proc.* **584**, pp. 170 (1999).

"Intelligent Nanofabricated Sensors for Shipboard Applications", Robert J. Davis, *Proc. of the ASNE Intelligent Ships Symposium III* (1996).

"Steady-state damage profiles due to reactive ion etching and ion-assisted etching", Robert J. Davis and Pankaj Jha, *J. Vac. Sci. Technol.* **B13**, pp. 242-246 (1995).

"High efficiency and low threshold current strained V-groove quantum wire lasers", Sandip Tiwari, G. David Pettit, Keith R. Milkove, Françoise Legoues, Robert J. Davis, and Jerry M. Woodall, *Appl. Phys. Lett.* **64**, pp. 3536-3538 (1994).

"203 uA threshold current strained V-groove lasers", S. Tiwari, G.D. Pettit, K.R. Milkove, R.J. Davis, J.M. Woodall, and F. Legoues, *Elect. Dev. Meeting Tech. Digest*, pp. 859-862 (1992).

"Image Potentials And Dry Etch Directionality In Integrated Optoelectronics", R.J. Davis and S. Tiwari; *Proc. of the 1991 IEEE LEOS Summer Topical Meeting on Microfabrication for Photonics and Optoelectronics*, pp. 30-31 (1991).

"Image potentials and the dry etching of submicron trenches with low-energy ions", Robert J. Davis, *Appl. Phys. Lett.* **59**, pp. 1717-1719 (1991).

"Chemically assisted ion beam etching of gallium arsenide and related optoelectronic structures: applications, experiment, and a simple model", Robert J. Davis, Ph.D. dissertation in Applied Physics, Cornell University (1991).

"A simple model of the chemically assisted ion beam etching yield of GaAs with Cl₂ at medium current densities", Robert J. Davis and Edward D. Wolf, *J. Vac. Sci. Technol.* **B8**, pp. 1798-1803 (1990).

"Masking considerations in chemically assisted ion beam etching of GaAs / AlGaAs structures", A. Behfar-Rad, S.S. Wong, R.J. Davis, and E.D. Wolf, *J. Electrochem. Soc.* **136**, pp. 779-782 (1989).

"High-power AlGaAs/GaAs single quantum well lasers with chemically assisted ion beam etched mirrors", P. Tihanyi, D.K. Wagner, H.J. Vollmer, A.J. Roza, C.M. Harding, R.J. Davis, and E.D. Wolf. *Electron. Lett.* **23**, 772 (1987).

"High-power AlGaAs/GaAs single quantum well lasers with chemically assisted ion beam etched mirrors", P. Tihanyi, D. K. Wagner, A. J. Roza, H. J. Vollmer, and C. M. Harding, R. J. Davis and E. D. Wolf, *Appl. Phys. Lett.* **50**, pp. 1640-1641 (1987).

"High-power AlGaAs/GaAs single quantum well lasers with etched facets", P. Tihanyi, D. K. Wagner, A. J. Roza, H. J. Vollmer, and C. M. Harding, and R. J. Davis, *Technical Digest of the 1987 Conference on Lasers and Electrooptics (CLEO)*.

"Low threshold ridge waveguide single quantum well laser processed by chemically assisted ion beam etching", L. Zhu, G. Feak, R. Davis, and J. Ballantyne, *IEEE J. Quant. Elect.* **23**, pp. 309-312 (1987).

"Photoluminescence detection of impurities introduced in silicon by dry etching processes", J. Weber, R.J. Davis, H.-U. Habermeier, W.D. Sawyer, and M. Singh, *Applied Physics* **A41**, p. 175-178 (1986).

"Photoluminescence of low-energy ion bombarded silicon", R. J. Davis, H.-U. Habermeier, and J. Weber, *Appl. Phys. Lett.* **47**, pp. 1295-1297 (1985).

"The characterization, reduction, and understanding of ion beam etching damage of silicon", Robert J. Davis, M.S. thesis in Engineering Science, Penn State University (1985).

"Dependence of low energy ion beam exposure effects in silicon on ion species, exposure history, and material properties", R.J. Davis, A. Climent, and S.J. Fonash, *Nucl. Inst. Methods* **B8** pp. 831-835 (1985).

"The effect of beam species and anneal history on silicon surface damage induced by ion beam etching", R.J. Davis, R. Singh, S.J. Fonash, P.J. Caplan, and E.H. Poindexter, in **Thin Films and Interfaces II**, *Mat. Res. Soc. Proceedings* **25**, J.E.E. Baglin et al. (editors), pp. 607-612 (1984).

"A laser light scattering system for particle detection in a water tunnel". M.L. Billet, R.J. Davis, and R. Moyer, *Proc. of the ASME Cavitation and Multiphase Flow Forum*, pp. 30-31 (1984).

"A statistical analysis of a laser light scattering system". Robert J. Davis, honors thesis in Engineering Science, Penn State University (1983).

Conference and Other Talks (Selected)

Talks not directly covered in published proceedings listed above

"A Comparison of Nanotechnology-Enabled Photovoltaic Technologies with Near-Term Commercialization Potentials", invited talk given at the *Productive Nanosystems: Launching the Technology Roadmap* Conference, Society of Manufacturing Engineers, Arlington VA, 09-10 Oct. 2007.

"An Overview of the Wright Center for Photovoltaics Innovation and Commercialization", Robert J. Davis, invited talk given at the First Annual Meeting on the Ohio Alternative Energy Supply Chain, Dayton OH, 20 June 2007.

"Introduction to Micro- and Nanolithographic Pattern Generation and Transfer", Robert J. Davis, invited talk given at the *Technology Expanding the Horizon Symposium*, Art and Technology Program, Wexner Center, Ohio State, 30 March 2007.

"An Overview of the Nanotech West Laboratory of The Ohio State University", Robert J. Davis, invited talk given at the Sensors Directorate of the Wright Patterson Air Force Base, Dayton OH, 14 March 2007.

"Basics of Nanoscale Lithographic Pattern Transfer Methods", talk given at the Ohio State University Nanotechnology in Biomedical Research Journal Club, 13 Dec. 2005.

"Piezoelectric Films for MEMS Applications," Susan Trolier-McKinstry, R. J. Davis, S. Gross, E. Hong, J. Lei, R. G. Polcawich, J. F. Shepard, Jr., L.-P. Wang, R. Wolf, F. Xu, T. Yoshimura, Q. Zhang, Q. Zhou, K. Deng and L. Zhou, C. Freidhoff, S. Krishnaswamy, and D. Machuga, Invited presentation at the Panamerican Advanced Study Institute on Science and Technology of Ferroelectric Materials, Sept. 23 - Oct. 2, 2002, Rosario, Argentina.

"Piezoelectric Films for MEMS Applications," Susan Trolier-McKinstry, R. J. Davis, S. Gross, E. Hong, J. Lei, R. G. Polcawich, J. F. Shepard, Jr., L.-P. Wang, R. Wolf, F. Xu, T. Yoshimura, Q. Zhang, Q. Zhou, K. Deng and L. Zhou, C. Freidhoff, S. Krishnaswamy, and D. Machuga, Invited presentation at the International Symposium on Electrets 11, Oct. 1 - 3, 2002, Melbourne, Australia.

"Piezoelectric Films for MEMS Applications", Susan Trolier-McKinstry, V. Bornand, R. J. Davis, J. H. Park, S. Tadigadapa, L.-P. Wang, R. Wolf, T. Yoshimura, Q. Zhang, and Q. Zhou, K. Deng and L. Zhou, C. Freidhoff, S. Krishnaswamy, D. Machuga, and F. Djuth, Invited presentation at the 1st International Symposium on Advanced Materials for Next Generation: 'Prelude to Functional-Integrated Materials', Nara, Japan, May 27, 2002.

"Piezoelectric Films for MEMS Applications," S. Trolier-McKinstry, V. Bornand, R. J. Davis, J.-P. Maria, J. H. Park, C.A. Randall, J. F. Shepard, S. Tadigadapa, L-P. Wang, F. Xu, T. Yoshimura, Q. Zhang, Z. Zhang, K. Deng and L. Zhou, Invited talk at the Gordon Research Conference in Ceramics, August 12 - 16, 2002, New Hampshire.

"Piezoelectric Films for MEMS Applications," S. Trolier-McKinstry, V. Bornand, R. J. Davis, J. H. Park, S. Tadigadapa, L-P. Wang, R. Wolf, T. Yoshimura, Q. Zhang, and Q. Zhou, K. Deng and L. Zhou, C. Freidhoff, S. Krishnaswamy D. Machuga, and F. Djuth, Invited presentation at MRS Workshop on MEMS, April 2002, San Francisco, CA.

"Microelectromechanical Systems (MEMS) Accelerometers Using Lead Zirconate Titanate Thick Films," L-P. Wang, R. Wolf, K. Deng, L. Zou, Y. Wang, P. Wlodkowski, R. J. Davis, and S. Trolier-McKinstry, poster presentation at the US-Japan Meeting on Dielectric and Piezoelectric Ceramics, Sept. 26 - 29, 2001, Providence, RI.

"MEMS Accelerometers Using PZT Films," R. Wolf, S. Trolier-McKinstry, Y. Wang, L-P. Wang, R. Davis, K. Chandra, K. Deng, W. Shanks, T. Brooks, oral presentation at the 12th International Symposium on the Applications of Ferroelectrics, July 31 - Aug. 2, 2000.

"MEMS Accelerometers Using Lead Zirconate Titanate Piezoelectric Films," R. Wolf, S. Trolier-McKinstry, Y. Wang, L-P. Wang, R. J. Davis, K. Chandra, K. Deng, W. Shanks, T. Brooks, poster presentation, ONR Transducer Meeting, University Park, PA April 11 - 13, 2000.

"Nanofabrication: A Growing Field of Shrinking Sizes", Penn State IEEE Monthly Lecture, Dec. 1998; Penn State Engineering Science and Mechanics weekly Department seminar, Oct. 1999.

"Three novel MEMS devices; design and initial reports on fabrication", Robert J. Davis, invited talk at Sandia National Laboratories, Albuquerque NM, 1998.

"Texture development and electrical properties of the sol-gel derived lead zirconate titanate thick films", F. Chu, S. Trolier-McKinstry, R.J. Davis and S. Corbett, Mat. Res. Soc. Fall Meeting, Symposium U13, Boston, MA, 1997.

"Chemically assisted ion beam etching and the production of novel electrooptic devices in GaAs / AlGaAs", Robert J. Davis, Brown University Engineering Department, 1994.

"Steady-state solutions of moving boundary damage diffusion equations in reactive ion etching", Robert J. Davis and Pankaj Jha, American Vac. Society Fall Meeting, Denver CO (Oct. 1994).

"A simple model of the chemically assisted ion beam etching yield of GaAs with Cl₂ at medium current densities", Robert J. Davis and Edward D. Wolf, Electron, Photon, and Ion Beams Conference, San Antonio, 1990.

“Chemically assisted ion beam etching of gallium arsenide and related optoelectronic structures: applications, experiment, and a simple model”, Robert J. Davis, invited talk given at IBM Thomas J. Watson Research Center, Yorktown Heights, NY, 1990; Raytheon Research Laboratories, Lexington MA, 1990; Bell Laboratories, Murray Hill NJ 1989; Annual Meeting of the Upstate NY Division of the American Vacuum Society, 1989.

“Photoluminescence of Low-Energy Ion Bombarded Silicon”, J. Weber and R.J. Davis, Gordon Conference on Point Defects in Silicon, New Hampshire (1984).

“Photoluminescence of Low-Energy Ion Bombarded Silicon”, Robert J. Davis, J. Weber, and H.-U. Haberman, Arbeitskreis für Punktdefekte im Silizium (*Workshop on Point Defects in Silicon*), Stuttgart, Germany (1984).

Conference Sessions Organized

“Thin-Film Photovoltaic Activities in Ohio: An Overview of the Wright Center for Photovoltaics Innovation and Commercialization”, a forum of the Solar 2007 Conference of the American Solar Energy Society, jointly organized and moderated by Robert Collins of U. Toledo and Robert J. Davis of Ohio State, Cleveland OH, September 2007.

Graduate Students Advised

Li-Peng Wang, Ph.D., Engineering Science, Pennsylvania State University (2001). Co-advised with Prof. Susan Trolier-McKinstry. Formerly at Intel R&D, Santa Clara CA; currently at TricornTech, a bioMEMS startup in San Jose CA.

Terry Kuzma, M.S., Engineering Science, Pennsylvania State University (2000). Currently Instructor in Nanofabrication Manufacturing Technology, Penn State.

Yu Wang, Ph.D., Engineering Science, Pennsylvania State University (2000). Formerly at Maxim Semiconductor Products, Santa Clara, CA (deceased).

Farhat Quli, Ph.D., Materials Science, Pennsylvania State University (1999). Co-advised with Dr. Jogender Singh. Currently at SensArray Inc., Santa Clara CA.

Jae Choe, M.S., Applied Physics, Columbia University (1994). Continued to finish Ph.D. under Prof. Irving Herman at Columbia and is now at Army Research Laboratories, Adelphi MD.

Pankaj Jha, M.S., Applied Physics, Columbia University (1994). Currently employed on Wall Street, New York, New York.

Proposals Funded

“**Wright Center for Photovoltaics Innovation and Commercialization**”, Ohio Third Frontier Program, Ohio Department of Development, \$18.6M over period 2/27/07 to 2/26/10, Prof. Robert Collins (U. Toledo) and Dr. Robert J. Davis (OSU) as Co-Directors. OSU share: \$6.9M with approximately \$1M in matching funds.

“Smart Piezoelectric-Based MEMS Accelerometers with Wireless Interface for Industrial Applications” – NIST ATP award with Wilcoxon Research, Gaithersburg MD as lead, R.J. Davis and S. Troler-McKinstry as primary subcontractors. Total award amount: \$1.89M over period 10/1/1998 to 9/30/2001.

“Novel Silicon MEMS Technology Development”, R.J. Davis, thrust PI; T.R. Govindan, Applied Research Laboratory, Penn State, PI; NASA Ames; approx. \$320k over three years (1996-2000).

“Instrumentation to Enable and Enhance Three-Dimensional Nanofabrication Capabilities in the National Nanofabrication Users Network”, Robert J. Davis, PI, National Science Foundation award 9601886, \$480,860.00 on behalf of the National Nanofabrication Users Network.

“Nanofabrication of Sensors” R.J. Davis, research thrust leader in ONR MURI on Condition-Based Maintenance; David Hall, overall PI. \$310k over three years in this area, 10/1/95-9/30/98.

“High-Speed Electrooptic Testing”, R.J. Davis, PI, DARPA award in High-Speed Multichip Modules, approx. \$230k over two years, Columbia Univ. (10/1/92-9/30/94 – formerly an award to D.H. Austin).

Courses Taught

Course	Department	Level	Year(s)	Description	Notes
Engineering Applications of Materials, Eng. Sci. 314	Engineering Science and Mechanics, Penn State	Undergraduate	Summer 1997	Introduction to materials with an emphasis on electronic, optic, and magnetic properties; on the level of Solymar and Walsh <i>Lectures on the Electrical Properties of Materials</i> , 6 th edition.	Team-taught; average class size 35 students
Introduction to Microfabrication, EE 4944	EE, Columbia	Graduate (open to undergrads)	Spring 1991, 1992	Basics and physical principles behind micro- and nanofabrication processing; on the level of S.M. Sze, <i>Semiconductor Devices: Physics and Technology</i> , augmented by substantial material provided by the instructor	Course also taken in 1992 by video at Intel – AZ; average class size 10 students
Circuit Analysis, EE 3201	EE, Columbia	Undergraduate	Fall 1991, 1992	Circuit Analysis, intro to circuits for EE majors, on the level of <i>Electric Circuits</i> , J. Nilsson	Average class size 60 students

Honors and Awards

Editorial Board, *Materials Science in Semiconductor Processing*, Elsevier, 1998
to present

Secretary, US Chapter of the Leica Electron Beam Users Group (1997-2000)

IBM Graduate Fellow at Cornell, 1986-1987.

University Scholar, Penn State University (1980-1983)

Eisenberg Engineering Student Award, Penn State (1980)