

19 February 2018

CURRICULUM VITAE – Alan C. Seabaugh, Professor of Electrical Engineering

Department of Electrical Engineering, 275 Fitzpatrick Hall
University of Notre Dame, Notre Dame IN 46556-5637

www.nd.edu/~nano
seabaugh.1@nd.edu
(574) 631-4473

Education:

B.S.E.E. (1977), M.S.E.E. (1979), Ph.D.E.E. (1985)
Electrical Engineering, University of Virginia, Charlottesville, Virginia
M.S. thesis: GaAs liquid phase epitaxy for millimeter wave Schottky diodes
Advisor: Robert J. Mattauch
Ph.D. thesis: Transient photoresistance spectroscopy of deep levels in high resistivity semiconductors
Advisor: James D. Oliver

Professional Experience:

University of Notre Dame, Department of Electrical Engineering

Frank M. Freimann Professor of Electrical Engineering (2015 –)
Director, Notre Dame Center for Nano Science and Technology (NDnano) (2018 –)
www.nd.edu/~ndnano
Assoc. Director, NDnano (2000 –2013)
Frank M. Freimann Director, STARnet Center for Low Energy Systems Technology (LEAST)
least.nd.edu/ (2013 – 2017)
Frank M. Freimann Director of the Midwest Institute for Nanoelectronics Discovery (MIND)
mind.nd.edu (2010 – 2013)
Professor of Electrical Engineering, University of Notre Dame (1999 – 2015)

Raytheon, Dallas (1997 –1999)

Senior Fellow (1999)

Texas Instruments (1986 –1997)

Distinguished Member Technical Staff (1997)
Senior Member Technical Staff (1991 – 1997)
Member Technical Staff (1986 – 1991)

University of Texas at Dallas

Visiting Lecturer: EE3301 Electrical Network Analysis (1987)
EE6320 Semiconductor Device Theory (1988, 1996)
EE3310 Electronic Devices (1989)
EE6321 Advanced Semiconductor Device Theory (1997)

National Bureau of Standards Electronics Engineer (1979-1986)

NBS graduate research fellowship (1981-84)

Research Interests:

Electron devices and circuits, nanoelectronics, nanofabrication, nanotechnology
Energy harvesting and storage, microwave and mm-wave technology
Tunneling-based devices and circuits: transistors, memory, rectifiers

Contents:

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1. Awards:

- Notre Dame Faculty Recognition Award (2015), Notre Dame Stadium, 14 November 2015.
- ISCS Quantum Devices Award (2011) for “seminal contributions and leadership in semiconductor devices and circuits based on quantum mechanical tunneling such as tunnel field-effect transistors and resonant tunneling transistors.”
- IEEE Fellow (2003) “for contributions to high speed and nanoelectronic device and circuit technology.”
- Outstanding Teacher Award 2001.
- DARPA Sustained Superior Performance award (1997)
- DARPA Outstanding Performance by a Project Manager award (1998)
- *IEEE Computer Society Outstanding Paper Award* (coauthored, 1994)
- *TI Achievement Award* for “Demonstration of the world’s first room temperature resonant tunneling integrated circuit” (1992)
- Teacher of the Year Award University of Texas at Dallas, IEEE student chapter (1989-1990)
- *TI Achievement Award* for “Demonstration of the world’s first pseudomorphic bipolar quantum resonant tunneling transistor” (1988).

2. Teaching - University of Notre Dame:

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| EE67052 | Tunnel Field-Effect Transistors (2013, 2015) |
| EE30347 | Fundamentals of Semiconductors (2012, 2014, 2016) |
| EE40448 | Electrical Energy Extraction (2008, 2011) |
| EE60542 | Analog Integrated Circuit Design (2008, 2010-2017) |
| EE20242 | Electronics I (2006-7), |
| EE67026 | Energy-Constrained Devices and Circuits (2006), |
| EE67024 | Communications Circuit Design (2005) |
| EE486 | Digital and Analog Integrated Circuits (2005), |
| EE30348 | Electromagnetic Fields and Waves (2000, 2002, 2009, 2010, 2017) |
| EE598F | Analog CMOS Design (2001, 2003, 2004) |
| EE598 | RF Integrated Circuit Design (2002) |
| EE556 | Fundamentals of Semiconductor Physics (2001, 2003, 2004) |
| EE30342 | Electronics II (2000-2, 2009) |
| EE598F | Advanced IC Laboratory Techniques (2000) |
| EE598F | Advanced Studies in Semiconductor Devices (1999) |

3. Professional Memberships and Committees:

- Editorial Advisory Board (EAB) Applied Physics Letters (2016-2019)
- Steep Transistors Workshop (2015, 2016, 2017)
- IEEE Int. Electron Dev. Meeting Technical Program Com., Nano Device Subcommittee (2013, 2014)
- Editorial Advisory Board, Solid State Electronics (2012 - present)
- Editor, Special issue of IEEE J. Electron Devices devoted to Tunnel Transistors (2015)
- Editor, IEEE Trans. Electron Dev. (2010-2013)
- Member APS
- VLSI Symp. Technical Program Committee (2009-2012)
- IEEE NANO 2010 Technical Program Committee
- IEEE Electron Device Society Nanotechnology Committee Chair (2001-2004)
- Device Res. Conf. (DRC) Technical Program Committee (1993-1995, 2001-2003), Local Arrangements Chair (2001), Technical Program Chair (2004), General Chair (2005), Executive Board (2005 -2015)
- Silicon Nanoelectronics Workshop Technical Program Chair (1996), General Chair (1998), Program committee (1999-2001, 2010)
- Int. Electron Dev. Mtg. technical program committee (1999, 2000, 2013-2014)
- Reviewer for Electronics Lett., IEEE Electron Dev. Lett., IEEE Trans. Electron Dev., Appl. Phys. Lett., J. Appl. Phys., Electronics Letters, Nano Letters, J. Vacuum Society B, ...
- IEEE Proceedings guest editor - Quantum Devices and Their Applications (1999).
- Patent Committee: Texas Instruments (1991-1997)
- Patent Committee Raytheon Systems Company (1997-1999)
- SRC Si Tunnel Diode and CMOS/HBT Integration Workshop organizer (1999)

Publications Summary (1/2018)

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Ph.D. Dissertations Advised	12
M.S. Theses Advised	5
U.S. Patents	23
Pending and Provisional Patents	2
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4. Journal Publications

- J118. S. Fathipour, P. Paletti, S. Fullerton-Shirey, and Alan Seabaugh, “Electric-double-layer *p-i-n* junctions in WSe₂,” *Nat. Mat.* submitted 2018.
- J117. H. Lu, P. Paletti, W. Li, P. Fay, T. Ytterdal, and A. Seabaugh, “Tunnel FET analog benchmarking and circuit design,” submitted to *IEEE J. Explor. Solid-State Comput. Devices Circuit* (2017).
- J116. W. S. Hwang, P. Zhao, S. G. Kim, R. Yan, G. Klimeck, S. K. Fullerton-Shirey, H. Xing, A. Seabaugh, and D. Jena, “Room temperature graphene-nanoribbon tunneling field-effect transistors,” accepted *npj 2D Materials and Applications*, Jan. 2018.
- J115. C. Alessandri, S. Fathipour, H. Li, I. Kwak, A. Kummel, M. Remškar, and A. C. Seabaugh, “Reconfigurable electric double layer doping in an MoS₂ nanoribbon transistor,” *IEEE Trans. Electron Dev.*, vol. 64, no. 12, pp. 5217–5222, Dec. 2017
- J114. W.-H. Wang, C. Gong, W. Wang, F. Kong, H. Kim, S. K. Fullerton-Shirey, A. Seabaugh, and K. Cho, “Energetics of metal ion adsorption on and diffusion through crown ethers: first principles study on two-dimensional electrolyte,” *Solid State Ionics*, vol. 301, no. C, pp. 176–181, Mar. 2017.
- J113. H.-M. Li, K. Xu, B. Bourdon, H. Lu, Y.-C. Lin, J. A. Robinson, A. C. Seabaugh, and S. K. Fullerton-Shirey, “Electric double layer dynamics in polyethylene oxide LiClO₄ on graphene transistors”, *J. Phys.*

- Chem. C.*, 121, 16996–17004 (2017).
- J112. K. Xu, H. Lu, E. W. Kinder, A. Seabaugh, and S. K. Fullerton-Shirey, “Monolayer solid-state electrolyte for electric double layer gating of graphene field-effect transistors,” *ACS Nano*, vol. 11, no. 6, pp. 5453–5464, Jun. 2017.
- J111. S. Fathipour, P. Pandey, S. Fullerton, and A. Seabaugh, “WSe₂ electric-double-layer field-effect transistors using polyethylene-oxide cesium perchlorate,” *J. Appl. Phys.* 120, 234902 (2016).
- J110. J. H. Park, S. Fathipour, I. Kwak, K. Sardashti, C. Ahles, S. Vishwanath, H. G. Xing, S. Fullerton-Shirey, A. Seabaugh, A. Kummel, “Atomic layer deposition of Al₂O₃ on WSe₂ functionalized by titanil phthalocyanine,” *ACS Nano*, vol. 10, no. 7, pp. 6888–6896, Jul. 2016.
- J109. H. Lu, W. Li, Y. Lu, P. Fay, T. Ytterdal, and A. Seabaugh, “Universal charge-conserving TFET SPICE model incorporating gate current and noise,” *IEEE J. Explor. Solid-State Comput. Devices Circuit*, pp. 20–27, Nov. 2016.
- J108. M. R. Müller, R. Salazar, S. Fathipour, H. Xu, K. Kallis, U. Künzelmann, A. Seabaugh, J. Appenzeller, and J. Knoch, “Gate-controlled WSe₂ transistors using a buried triple-gate structure,” *Nanoscale Res. Lett.*, pp. 1–6, Nov. 2016.
- J107. W.-H. Wang, C. Gong, W. Wang, S. K. Fullerton-Shirey, A. Seabaugh, and K. Cho, “First-principles study of crown ether and crown ether-Li complex interactions with graphene,” *J. Phys. Chem. C*, vol. 119, no. 34, pp. 20016–20022, Aug. 2015.
- J106. H. Lu, I. Kwak, J. H. Park, K. O’Neill, T. Furuyama, N. Kobayashi, A. Seabaugh, A. Kummel, and S. K. Fullerton-Shirey, “Solution-cast monolayers of cobalt crown ether phthalocyanine on highly ordered pyrolytic graphite,” *J. Phys. Chem. C*, vol. 119, no. 38, pp. 21992–22000, Sep. 2015.
- J105. S. Fathipour, M. Remškar, A. Varlec, A. Ajoy, R. Yan, S. Vishwanath, S. Rouvimov, W. S. Hwang, H. G. Xing, D. Jena, and A. Seabaugh, “Synthesized multiwall MoS₂ nanotube and nanoribbon field-effect transistors,” *Appl. Phys. Lett.* 106, 022114 (2015).
- J104. H.-M. Li, D. Lee, D. Qu, X. Liu, J. Ryu, A. Seabaugh, and W. J. Yoo, “Ultimate thin vertical p-n junction composed of 2D layered molybdenum disulphide,” *Nat. Comm.* 6, pp. 1-9, Mar. 2015.
- J103. W. Li, S. Sharmin, H. Ilatikhameneh, R. Rahman, Y. Lu, J. Wang, X. Yan, A. Seabaugh, G. Klimeck, D. Jena, and P. Fay, “Polarization-engineered III-nitride heterojunction tunnel field-effect transistors,” *IEEE J. Explor. Solid-State Comput. Devices Circuits*, vol. 1, pp. 28–34, Jul. 2015.
- J102. H. Xu, S. Fathipour, E. Kinder, A. Seabaugh and S. Fullerton-Shirey, “Reconfigurable ion gating in 2H-MoTe₂ field-effect transistors using PEO:CsClO₄ solid polymer electrolyte,” *ACS Nano*, vol. 9, 4900-4910 May 2015.
- J101. Z. Jiang, Y. Lu, Y. Tan, Y. He, M. Povolotskyi, T. Kubis, A. Seabaugh, P. Fay, and G. Klimeck, “Quantum transport in AlGaSb/InAs TFETs with gate field in-line with tunneling direction,” *IEEE Trans. Electron Dev.*, vol. 62, 2445-2449 (2015).
- J100. H. Lu, D. Esseni, and A. Seabaugh, “Universal analytic model for tunnel FET circuit simulation,” *Solid State Electronics* 108, pp. 110-117 (2015).
- J99. W. S. Hwang, P. Zhao, K. Tahy, L. Nyakiti, V. Wheeler, R. Myers-Ward, C. Eddy, K. Gaskill, J. Robinson, W. Haensch, H. Xing, A. Seabaugh, and D. Jena, “Graphene nanoribbon field-effect transistors on wafer-scale epitaxial graphene on SiC substrates,” *APL Materials*, 3, 011101-9 (2015).
- J98. S. Fathipour, N. Ma, W. S. Hwang, V. Protasenko, S. Vishwanath, H. G. Xing, H. Xu, D. Jena, J. Appenzeller, and A. Seabaugh, “Exfoliated multilayer MoTe₂ field-effect transistors,” *Appl. Phys. Lett.* 105, 19210 (2014).
- J97. G. Fiori, F. Bonaccorso, G. Iannaccone, T. Palacios, D. Neumaier, A. Seabaugh, S. K. Banerjee, and L. Colombo, “Electronics based on two-dimensional materials,” *Nature Nanotech.* 9, 768-799 (2014).
- J96. H. Lu and A. Seabaugh, “Tunnel field-effect transistors: state-of-the-art,” *IEEE J. Electron Devices Soc.*, vol. 2, no. 4, pp. 44–49 (2014).
- J95. W. S. Hwang, K. Tahy, P. Zhao, L. O. Nyakiti, V. D. Wheeler, R. L. Myers-Ward, C. R. Eddy Jr., D. K. Gaskill, H. Xing, A. Seabaugh, and D. Jena, “Electronic transport properties of top-gated epitaxial-graphene nanoribbon field-effect transistors on SiC wafers,” *J. Vac. Sci. Technol. B*, 32, pp. 012202 (2014).
- J94. W. S. Hwang, A. Verma, H. Peelaers, V. Protasenko, S. Rouvimov, H. Grace Xing, A. Seabaugh, W. Haensch, C. Van de Walle, Z. Galazka, M. Albrecht, R. Fornari, and D. Jena, “High-voltage field effect

- transistors with wide-bandgap β -Ga₂O₃ nanomembranes,” *Appl. Phys. Lett.*, vol. 104, no. 20, 203111, May (2014).
- J93. Q. Zhang, Y. Lu, C. A. Richter, D. Jena, and A. Seabaugh, “Optimum band gap and supply voltage in tunnel FETs,” *IEEE Trans. Electron Dev.*, 61, 2719-2724 (2014).
- J92. A. Seabaugh, “The tunneling transistor,” *IEEE Spectrum*, vol. 50, pp. 35–62 (2013).
- J91. W. S. Hwang, M. Remškar, R. Yan, T. Kosel, J. K. Park, B. J. Cho, W. Haensch, H. G. Xing, A. Seabaugh, and D. Jena, “Comparative study of chemically synthesized and exfoliated multilayer MoS₂ field effect transistors,” *Appl. Phys. Lett.*, 102, 043116 (2013).
- J90. Q. Zhang, R. Li, R. Yan, T. Kosel, H. G. Xing, A. Seabaugh, K. Xu, O. A. Kirillov, D. J. Gundlach, C. A. Richter, and N. V. Nguyen, “A unique photoemission method to measure semiconductor heterojunction band offsets,” *Appl. Phys. Lett.*, 102, 012101, (2013).
- J89. K. Xu, C. Zeng, Q. Zhang, R. Yan, P. Ye, K. Wang, A. Seabaugh, H. Xing, J. Suehle, C. Richter, D. Gundlach, and N. Nguyen, “Direct measurement of Dirac point energy at the graphene/oxide interface,” *Nano Lett.* 13, 131-136 (2013).
- J88. R. Yan, Q. Zhang, O. Kirillov, W. Li, J. Basham, A. Boosalis, X. Liang, D. Jena, C. Richter, A. Seabaugh, D. Gundlach, H. Xing, and N. Nguyen, “Graphene as transparent electrode for direct observation of hole photoemission from silicon to oxide,” *Appl. Phys. Lett.* 102, 123106 (2013).
- J87. K. Karda, S. Sutar, J. Nahas, J. Brockman, and A. Seabaugh, “Bistable-body tunnel SRAM,” *IEEE Trans. Nanotechnology* 11, 1067-1071 (2012).
- J86. N. S. Do, D. Schaeztl, B. Dey, A. Seabaugh, and S. Fullerton-Shirey, “Influence of Fe₂O₃ nanofiller shape on the conductivity and thermal properties of solid polymer electrolytes: Nanorods versus nanospheres,” *J. Phys. Chem. C*, 116, 21216 (2012).
- J85. Q. Liu, L. Dong, Y. Liu, R. Gordon, P. Ye, P. Fay, and A. Seabaugh, “Frequency response of LaAlO₃/SrTiO₃ all-oxide field-effect transistors,” *Solid-State Electronics*, 76, 1-4 (2012).
- J84. R. Yan, Q. Zhang, W. Li, I. Calizo, T. Shen, C. Richter, A. Hight-Walker, X. Liang, A. Seabaugh, D. Jena, H. Xing, D. Gundlach, and N. V. Nguyen, “Determination of graphene work function and graphene-insulator-semiconductor band alignment by internal photoemission spectroscopy,” *Appl. Phys. Lett.*, 101, 022105, 2012.
- J83. W. S. Hwang, M. Remškar, R. Yan, V. Protasenko, K. Tahy, S. D. Chae, P. Zhao, A. Konar, H. Xing, A. Seabaugh, and D. Jena, “Transistors with chemically synthesized layered semiconductor WS₂ exhibiting 10⁵ room temperature modulation and ambipolar behavior,” *Appl. Phys. Lett.*, 101, 013107 (2012).
- J82. W. S. Hwang, K. Tahy, X. Li, H. Xing, A. Seabaugh, C. Y. Sung, and D. Jena, “Transport properties of graphene nanoribbon transistors on chemical-vapor-deposition grown wafer-scale graphene,” *Appl. Phys. Lett.*, 100, 203107 (2012).
- J81. G. Zhou, Y. Lu, R. Li, Q. Zhang, Q. Liu, T. Vasen, H. Zhu, J.-M. Kuo, T. Kosel, M. Wistey, P. Fay, A. Seabaugh, and H. Xing, “InGaAs/InP tunnel FETs with a subthreshold swing of 93 mV/dec and I_{ON}/I_{OFF} ratio near 10⁶,” *IEEE Electron Dev. Lett.*, 33, 6, pp. 782-84 (2012).
- J80. W. S. Hwang, K. Tahy, R. L. Myers-Ward, P. M. Campbell, C. R. Eddy Jr., D. K. Gaskill, H. Xing, A. C. Seabaugh, and D. Jena, “Fabrication of top-gated epitaxial graphene nanoribbon FETs using hydrogen-silsesquioxane,” *J. Vac. Sci. Technol. B*, 30, 03D104, (2012).
- J79. Y. Lu, G. Zhou, R. Li, Q. Liu, Q. Zhang, T. Vasen, S. D. Chae, T. Kosel, M. Wistey, H. Xing, A. Seabaugh, and P. Fay, “Performance of AlGaSb/InAs TFETs with gate electric field and tunneling direction aligned,” *IEEE Electron Device Lett.*, 33, pp. 655-657 (2012).
- J78. R. Li, Y. Lu, G. Zhou, Q. Liu, S. D. Chae, T. Vasen, W. S. Hwang, Q. Zhang, P. Fay, T. Kosel, M. Wistey, H. Xing, and A. Seabaugh, “AlGaSb/InAs tunnel field-effect transistor with on-current of 78 μ A/ μ m at 0.5 V,” *IEEE Electron Device Lett.*, 33, pp. 363-365 (2012).
- J77. Q. Zhang, G. Zhou, H. Xing, A. Seabaugh, K. Xu, S. Hong, O. Kirillov, C. Richter, and N. Nguyen, “Tunnel field-effect transistor heterojunction band alignment by internal photoemission spectroscopy,” *Appl. Phys. Lett.*, 100, 102104 (2012).
- J76. R. Li, Y. Lu, S. D. Chae, G. Zhou, Q. Liu, C. Chen, M. S. Rahman, T. Vasen, Q. Zhang, P. Fay, T. Kosel, M. Wistey, H. Xing, S. Koswatta, and A. Seabaugh, “InAs/AlGaSb heterojunction tunnel field-effect transistor with tunnelling in-line with the gate field,” *Physica Status Solidi C*, 9, no. 2, pp. 389-392 (2011).

- J75. G. Zhou, Y. Lu, R. Li, Q. Zhang, W. S. Hwang, Q. Liu, T. Vasen, C. Chen, H. Zhu, J.-M. Kuo, S. Koswatta, T. Kosel, M. Wistey, P. Fay, A. Seabaugh, and H. Xing, "Vertical InGaAs/InP tunnel FETs with tunneling normal to the gate," *IEEE Electron Dev. Lett.*, 32, pp. 1516-1518 (2011).
- J74. M. Remškar, Ales Mrzel, M. Virsek, M. Godec, A. Singh, and A. Seabaugh, "The MoS₂ nanotubes with defect-controlled electric properties," *Nanoscale Res. Lett.* 1-7 (2011).
- J73. A. Seabaugh and Q. Zhang, "Low voltage tunnel transistors for beyond-CMOS logic," *Proc. IEEE* 98, 2095-2110 (2010).
- J72. K. Bernstein, R. Cavin, W. Porod, A. Seabaugh, and J. Welser, "Device and architecture outlook for beyond CMOS switches," *Proc. IEEE* 98, 2169-2184 (2010).
- J71. S. Sutar, Q. Zhang, and A. Seabaugh, "InAlAs/InGaAs interband tunnel diodes for SRAM," *IEEE Trans. Electron Dev.* 57, 2587-2593 (2010).
- J70. D. Wheeler, L.-E. Wernersson, L. Fröberg, C. Thelander, A. Mikkelsen, K.-J. Weststrate, A. Sonnet, E. M. Vogel, A. Seabaugh, "Deposition of HfO₂ on InAs by atomic-layer deposition," *Microelec. Eng.* 86, 1561-1563 (2009).
- J69. Q. Zhang, S. Sutar, T. Kosel, and A. Seabaugh, "Fully-depleted Ge interband tunnel transistor: modeling and junction formation," *Solid State Electronics* 53, 30-35 (2009).
- J68. Q. Zhang, T. Fang, H. Xing, A. Seabaugh, and D. Jena, "Graphene nanoribbon tunnel transistors," *IEEE Electron Dev. Lett.* 29, 1344-1346 (2008).
- J67. S. Jha, X. Song, S. E. Babcock, T. F. Kuech, D. Wheeler, B. Wu, P. Fay, and A. Seabaugh, "Growth of InAs on Si substrates at low temperatures using metalorganic vapor phase epitaxy," *J. Cryst. Gr.* 310, 4772-4775 (2008).
- J66. I. Yoon, C. Yi, T. Kim, A. S. Brown, A. Seabaugh, "Effect of surface pretreatment and substrate orientation on the characteristics of InAs quantum dots on Si and SiO₂ substrates," *J. Vac. Sci. & Technol. B (Microelectronics and Nanometer Structures)* 25, p. 945-947 (2007).
- J65. M. Remškar, J. Kovac, M. Virsek, M. Mrak, A. Jesih, and A. Seabaugh, "W₅O₁₄ nanowires," *Advanced Functional Materials*, 17, 1974-1978 (2007).
- J64. Z. Racz and A. C. Seabaugh, "Characterization and control of unconfined lateral diffusion under stencil masks," *J. Vac. Sci. Technol. B*, 25, 857-861 (2007).
- J63. J. Zhao, A. C. Seabaugh, and T. H. Kosel, "Rapid melt growth of germanium tunnel junctions," *J. Electrochem. Soc.* 154, H536-539 (2007).
- J62. Q. Zhang, W. Zhao, and A. Seabaugh, "Low subthreshold swing transistors," *IEEE Electron Dev. Lett.* 27, 297-300 (2006).
- J61. W. Zhao, A. Seabaugh, B. Winstead, D. Jovanovich, and V. Adams, "Influence of uniaxial tensile strain on the performance of partially depleted SOI CMOS ring oscillators," *IEEE Electron Dev. Lett.* 27, 52-54 (2006).
- J60. S. L. Skala, W. Wu, J. R. Tucker, J. W. Lyding, A. Seabaugh, E. A. Beam, and D. Jovanovic, "Interface characterization in an InP/InGaAs resonant tunneling diode by scanning tunneling microscopy," *J. Vac. Sci. Technol. B*, 13, 660-663 (1994).
- J59. W. Zhao, A. Seabaugh, V. Adams, D. Jovanovic, and B. Winstead, "Opposing dependence of the electron and hole gate currents in SOI MOSFETs under uniaxial strain," *IEEE Electron Device Lett.* 26, 410-412 (2005).
- J58. Q. Liu and A. Seabaugh, "Design approach using tunnel diodes for lowering power in differential amplifiers," *IEEE Trans. Circ. Sys. – II: Express Briefs*, 52, 572-575 (2005).
- J57. L.-E. Wernersson, S. Kabeer, V. Zela, E. Lind, J. Zhang, W. Seifert, T. Kosel, and A. Seabaugh, "A combined chemical vapor deposition and rapid thermal diffusion process for SiGe Esaki diodes by ultra shallow junction formation," *IEEE Trans. Nanotechnology* 4, 594-598 (2005).
- J56. W. Zhao, J. He, R. Belford, L-E Wernersson, and A. Seabaugh, "Partially-depleted SOI MOSFETs under uniaxial tensile strain," *IEEE Trans. Electron Dev.* 51, 317-323 (2004).
- J55. L.-E. Wernersson, S. Kabeer, V. Zela, E. Lind, J. Zhang, W. Seifert, T. Kosel, and A. Seabaugh, "SiGe Esaki tunnel diodes fabricated by UHV-CVD growth and proximity rapid thermal diffusion," *Electronics Lett.* 40, 83-85 (2004).
- J54. Q. Liu, A. Seabaugh, P. Chahal, and F. Morris, "Unified AC model for the resonant tunneling diode," *IEEE*

- Trans. Electron Dev.* 51, 653-657 (2004).
- J53. Z. Racz, J. He, S. Srinivasan, W. Zhao, A. Seabaugh, K. Han, P. Ruchhoeft, and J. Wolfe, "Nanofabrication using nanotranslated stencil masks and lift off," *J. Vac. Sci. Technol.* B 22, 74-76 (2004).
- J52. J. Wang, D. Wheeler, Y. Yan, J. Zhao, S. Howard, and A. Seabaugh, "Silicon tunnel diodes formed by proximity rapid thermal diffusion," *IEEE Electron Device Lett.* 24, 93-95 (2003).
- J51. E. M. Jackson, B. D. Weaver, S. Shojah-Ardalan, R. Wilkins, A. C. Seabaugh, and B. Brar, "Irradiation effects in InGaAs/InAlAs high electron mobility transistors," *Appl. Phys. Lett.* 79, pp. 2279-2281 (2001).
- J50. B. D. Weaver, E. M. Jackson, G. P. Summers, and A. C. Seabaugh, "Disorder-effects in reduced dimension: indium-phosphide resonant tunneling diodes," *J. Appl. Phys.* 88, 6951-6953 (2000).
- J49. B. D. Weaver, E. M. Jackson, A. C. Seabaugh, and P. van der Wagt, "MeV ion-induced suppression of resonance current in InP-based resonant tunneling diodes," *Appl. Phys. Lett.* 76 2562-2564 (2000).
- J48. M. W. Dashiell, R. T. Troeger, S. L. Rommel, T. N. Adam, P. R. Berger, J. Kolodzey, A. C. Seabaugh, and R. Lake, "Current voltage characteristics of high current density silicon Esaki diodes grown by molecular beam epitaxy and the influence of thermal annealing," *IEEE Trans. Electron Dev.*, 47, 1707-1714 (2000).
- J47. P. E. Thompson, K. D. Hobart, M. E. Twigg, S. L. Rommel, N. Jin, P. R. Berger, R. Lake, A. C. Seabaugh, P. H. Chi and D. S. Simons, "Epitaxial Si-Based Tunnel Diodes," *Thin Solid Films*, 380, 145-150, (2000).
- J46. A. Seabaugh, B. Brar, T. Broekaert, F. Morris, and G. Frazier, "Resonant tunneling mixed signal circuit technology," *Solid-State Electronics* 43 1355-1365 (1999).
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6. Short Courses

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- I125. A. Seabaugh, "Why ferroelectrics and 2D semiconductors are on the electron device horizon," *Boise State University*, 5 April 2017.
- I124. A. Seabaugh and S. Fullerton-Shirey, "Polymer/semiconductor electric double layers for memory and selectors," *Micron Technology*, Boise, Idaho, 30 September 2016.
- I123. A. Seabaugh, C. Alessandri, M. A. Heidarlou, H.-M. Li, L. Liu, H. Lu, S. Fathipour, P. Paletti, P. Pandey, and T. Ytterdal, "Steep slope transistors: tunnel FETs and beyond," *2016 46th European Solid-State Device Research Conference (ESSDERC)* pp. 349–351.
- I122. A. Seabaugh, "Low voltage steep subthreshold swing transistors for beyond-CMOS analog and digital applications," *École Polytechnique Fédérale de Lausanne (EPFL)*, 20 July 2016.
- I121. A. Seabaugh, S. Fathipour, H.-M. Li, P. Paletti, E. Kinder, L. Liu, H. Lu, M. Asghari, K. González, P. Pandey, C. Alessandri, M. Remškar, and S. Fullerton-Shirey, "2D Tunnel FETs," 19 July 2016, IBM Zurich, Switzerland.
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- I114. A. Seabaugh, "Tunnel field-effect transistors – the promise and the reality," *Workshop In the Quest of Zero Power: Energy Efficient Computing Devices and Circuits, E2 Switch European Project*, 26 Sept. 2014 Venice, Italy.
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