

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 –)
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)
Associate Director, Notre Dame Center for Nano Science and Technology (NDnano)
www.nd.edu/~ndnano (2000 –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) |
| 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)
- 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 (2/2016)

Journal Publications	109
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Ph.D. Dissertations Advised	12
M.S. Theses Advised	5
U.S. Patents	23
Pending and Provisional Patents	2
Foreign Patents	10

4. Journal Publications

- J118. 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," submitted to Nature Communications, 11 August 2017.
- J117. C. Alessandri, E. Kinder, and A. Seabaugh, "Field-dependent model for polarization reversal of multidomain ferroelectrics," *Appl. Phys. Lett.* 2017.
- J116. S. Fathipour, P. Paletti, S. Fullerton-Shirey, and Alan Seabaugh, "Electric-double-layer *p-i-n* junction in WSe₂," *Appl. Phys. Lett.* (2017).
- J115. C. Alessandri, S. Fathipour, H.-M. Li, I. Kwak, A. C. Kummel, M. Remškar, and A. Seabaugh, "Reconfigurable electric double layer doping in an MoS₂ nanoribbon transistor," *IEEE Trans. Electron Dev.* 2017.
- J114. W.-H. Wang, C. Gong, W. Wang, F. Kong, H. Kim, S. K. Fullerton-Shirey, A. Seabaugh, K. Cho," Energetics of metal ions adsorption on and diffusion through the crown ethers: first principles study on 2D electrolyte," accepted *Solid State Ionics*, November 2016.
- 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," accepted *J. Phys. Chem.* 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 titanyl 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 μA/μm 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. Welsch, "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).
- J45. T. P. E. Broekaert, B. Brar, J. P. A. van der Wagt, A. C. Seabaugh, T. S. Moise, F. J. Morris, E. A. Beam III, and G. A. Frazier, "A monolithic 4-bit 2-Gsps resonant tunneling analog-to-digital converter," *IEEE J. Solid State Circ.* 33, 1342-1349 (1998).
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5. Book Chapters

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6. Short Courses

5. A. C. Seabaugh, "Steep subthreshold swing transistors," *2017 VLSI-TSA*, Hsinchu, Taiwan.
4. A. Seabaugh, "Tunnel transistors based on two-dimensional crystals – the quest for low voltage technology." *2015 Muju Int. Winter School*, Muju, Korea.
3. A. C. Seabaugh and B. Dunn, "Nanotechnology: Its future and its implications," *Notre Dame Mendoza School of Business, Army Senior Executive Education Program*, July (2012).
2. A. Seabaugh, "Tunnel field-effect transistor - Engineering a better switch," short course, *Int. Electron Dev. Meeting*, December 4, 2011, Washington, DC.
1. A. C. Seabaugh and P. Mazumder, "Nanoelectronic devices, circuits, and systems," *Gov. Microcircuits Appl. Conf. Short Course*, Arlington, VA (1998).

7. Invited Papers and Presentations

- I124. A. Seabaugh, "Why ferroelectrics and 2D semiconductors are on the electron device horizon," *Boise State University*, 5 April 2017.
- I123. A. Seabaugh and S. Fullerton-Shirey, "Polymer/semiconductor electric double layers for memory and selectors," *Micron Technology*, Boise, Idaho, 30 September 2016.
- I122. A. Seabaugh, C. Alessandri, M. Asghari, H. Li, L. Liu, H. Lu, S. Fathipour, P. Paletti, P. Pandey, and T. Ytterdal, "Steep slope transistors: tunnel FETs and beyond," *2016 European Solid State Device Res. Conf. (ESSDERC)*, Lausanne, Switzerland, 12-15 Sept. 2016.
- 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.
- I120. A. Seabaugh, H. Lu, and S. Fathipour, "Tunnel transistors on transition metal dichalcogenide channels," IMEC, Leuven, Belgium, May 13, 2016.
- I119. A. Seabaugh, H. Lu, and S. Fathipour, "Low-voltage steep subthreshold swing transistors," *Int. Nanotech. Conf. Comm. and Coop. (INC12)* Leuven, Belgium, May 12, 2016.
- I118. A. Seabaugh, S. Fathipour, W. Li, H. Lu, J. H. Park, A. Kummel, D. Jena, S. Fullerton-Shirey, and P. Fay, "Steep subthreshold swing tunnel FETs: GaN/InN/GaN and transition metal dichalcogenide channels," *2015 Int. Electron Dev. Meeting*, Washington DC, 12 December.
- I118. A. Seabaugh, "Ion-doped transition metal dichalcogenide transistors," Jožef Stefan Institute, 13 May 2015, Ljubljana, Slovenia
- I117. A. Seabaugh, H. Lu, J. Appenzeller, S. Datta, D. Jena, V. Narayanan, and B. Wallace, "Center for low energy systems technology (LEAST)," *Government Microcircuit Applications & Critical Technology Conf. (GOMAC)*, March 23-26, 2015, St. Louis, MO.
- I116. A. Seabaugh, "Tunnel field-effect transistors for low voltage electronics," *Altera Corporation*, 18 Dec. 2014, San Jose, CA.
- I115. A. Seabaugh and H. Lu, "Tunnel field-effect transistors – update," *Int. Conf. Solid-State and Integrated Circuit Technology (ICSICT)*, 29 October 2014, Guilin, China.
- 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.
- I113. A. Seabaugh, "Tunnel field-effect transistors: status and challenges," *TSMC*, Taipei, Taiwan, 5 May 2014.
- I112. A. Seabaugh, H. Lu, N. Ma, S. Fathipour, E. Kinder, S. Sabnis, H. Xu, M. Asghari Heidarlou, W. S. Hwang, S. Fullerton-Shirey, and D. Jena, "Materials challenges for steep transistors," *Collaborative Conf. on Materials Res. (CCMR)*, June 23-27, 2014, Incheon/Seoul, South Korea.
- I111. A. Seabaugh and Hao Lu, "Is there life beyond CMOS?" *Int. Electron Dev. Meeting Rump Session*, Washington, DC, 10 December 2013.

1110. A. Seabaugh, S. Fathipour, H. Xu, N. Ma, E. Kinder, S. Sabnis, S. Fullerton, H. Xing, and D. Jena, "Tunnel FETs based on 2D crystals," *SEMATECH Beyond CMOS Workshop*, Washington, DC, 8 December 2013.
1109. A. Seabaugh, "The tunnel transistor," *IEEE Spectrum*, September 2013.
1108. A. Seabaugh, "Benchmarking low-voltage steep devices, circuits, and systems," *SRC Nanoelectronics Res. Initiative Benchmarking Workshop*, Rockville, MD, 23 October 2013.
1107. A. Seabaugh, "The best tunnel diode and tunnel transistor circuits," *TxACE Analog Symp.*, University of Texas at Dallas, Richardson, TX, 21 October 2013.
1106. A. Seabaugh, "Low-voltage, steep-subthreshold, beyond-CMOS technology," *IEEE SOI-3D-Subthreshold Microelectronics Technology Unified Conf.*, Monterey, CA, 8 October 2013.
1105. A. Seabaugh, "Steep Subthreshold Swing Transistors, Yonsei University, 6 September 2013.
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1103. A. Seabaugh, "III-V tunnel field-effect transistors and beyond," *Samsung Electronics*, Seoul, Korea, 5 September 2013
1102. A. Seabaugh, "Recent progress in III-V tunnel FETs," *Topical Workshop on Heterostructure Microelectronics (TWHM)*, Hakodate, Japan, 2 September 2013.
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197. A. Seabaugh, "Steep subthreshold swing transistors for low voltage computing," *2013 SEMINATEC*, May 3, University of Campinas, Campinas, Brazil.
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194. A. Seabaugh, "Tunnel field-effect transistor perspective," *Int. Symp. on Comp. Semicon. (ISCS)*, 18 August 2012, Santa Barbara, CA.
193. A. Seabaugh, "Low-voltage tunnel transistors: Benchmarking and circuits," *Int. Conf. on IC Design and Technology (ICICDT)*, 30 May 2012, Austin, TX.
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185. A. Seabaugh, "Recent progress in the development of III-V and graphene tunnel field-effect transistors," *7th Int. Nanotechnology Conf. on Communication and Cooperation*, May 16, 2011, Albany, NY.
184. A. Seabaugh, "III-V tunnel transistors," *Workshop on Comp. Semiconductor Materials and Devices*

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182. A. Seabaugh, "Emerging energy-efficient device technologies vs. ultimate CMOS," *University Government Industry Micro-Nano Symp.*, UGIM 2010, June 29, West Lafayette, IN.
181. A. Seabaugh, "Tunnel field-effect transistors – status and prospects," *2010 Dev. Res. Conf.*, June 22, Notre Dame.
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 153. A. Seabaugh, "Difference-defined nanofabrication" *DARPA Workshop on Massively Reconfigurable Microfabrication Tools*, Napa, California, October 29, 2003.
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