Curriculum Vitae February 2024
Alan C. Seabaugh, Professor of Electrical Engineering https://seabaugh.nd.edu/
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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

2018−2024	Director, Notre Dame Nanoscience & Technology (NDnano) **https://nano.nd.edu/**
2020−2024	Director, Interdisciplinary Materials Science & Engineering doctoral program **https://nano.nd.edu/materials-science/**
2015−2024	Frank M. Freimann Professor of Electrical Engineering
2013−2017	Frank M. Freimann Director, SRC/DARPA STARnet Center for Low Energy Systems Technology (LEAST) http://least.nd.edu/
2010−2013	Frank M. Freimann Director of the Midwest Institute for Nanoelectronics Discovery (MIND) **http://mind.nd.edu/**
2000−2013	ND*nano* Associate Director
1999−2015	Professor of Electrical Engineering, University of Notre Dame

Raytheon, Dallas

1997−1999	Senior Member Technical Staff, Fellow (1999)

Texas Instruments

1997	Distinguished Member Technical Staff
1991−1997	Senior Member Technical Staff
1986−1991	Member Technical Staff

University of Texas at Dallas Visiting Lecturer

1987	EE3301 Electrical Network Analysis
1988, 1996	EE6320 Semiconductor Device Theory
1989	EE3310 Electronic Devices
1997	EE6321 Advanced Semiconductor Device Theory

National Bureau of Standards

1979−1986	Electronics Engineer
1981−1984	NBS graduate research fellowship

Research Interests:

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

Contents:

1. Awards
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1. Awards:

- Notre Dame Research REF-ie Award (2019) for impact on university research community, 18 July 2019.
- 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:

EE40063	IC Fabrication (2023-2024) – EE42063 Lab
EE60063	IC Fabrication (2023-2024) – EE62063 Lab
EE60546	IC Fabrication (2021-2022) – EE61546 Lab
EE40446	Integrated Circuit (IC) Fabrication (2020-2022) – EE41446 Lab
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, 2010-2019)
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:

- Guest Editor, IEEE Journal on Exploratory Solid-State Computational Devices and Circuits, Special Topics Issue, Steep Slope Transistors for Energy-Efficient Computing & More (2023)
- IEEE SOI-3D-Subthreshold Microelec. Technol. Unified Conf. (S3S) Program Commitee (2018-2019)
- U.S. - European Union Workshop on 2D (Two Dimensional) Layered Materials and Devices, Technical Program Chair, 2017, General Chair 2018.
- Berkeley Energy Efficient Electronics Symposium (E3S) Program Committee (2016-2017)
- Editorial Advisory Board (EAB) Applied Physics Letters (2016-2023)
- 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, Science, …
- 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)

Journal Publications …….... 135
Book Chapters ……...……..6
Short Courses …….. 5
Invited Papers and Presentations …….135
Conference Publications……..….227
Ph.D. Dissertations Advised ……... 18
M.S. Theses Advised …….. 5
U.S. Patents ……..... 25
Pending and Provisional Patents ……. 0
Foreign Patents ……10
Software ……...1

4. Journal Publications

J136. A. Seabaugh, "Perspectives on low-voltage tunnel transistors for beyond CMOS logic," IEEE Electron Devices Society Newsletter, Vol. 30, April 2023. https://www.ieee.org/ns/periodicals/EDS/EDS-APRIL-2023-HTML/index.html.

J135. Alan Seabaugh"M. Remškar, A. K. Hüttel, T, V. Shubina, A. Seabaugh, S. Fathipour, R. Lawrowski, and R. Schreiner, "Confinement related phenomena in MoS_2 tubular structures grown from vapour

phase," *Israel J Chem*, vol. 62, no. 3–4, pp. 1-10, 2022, doi: 10.1002/ijch.202100100.

J134 L. E. Calvet, J. Chen, T. Lee, and A. Seabaugh, "Mark A. Reed (1955–2021)," *Nat Nanotechnol*, vol. 17, no. 4, pp. 336–336, 2022, doi: 10.1038/s41565-022-01093-5.

J133. K. A. Gonzalez-Serrano and A. C. Seabaugh, "Electrical properties of 6 nm to 19 nm thick polyethylene oxide capacitors for ion/electron functional devices. *J Electron Mater* 1–8 (2021) DOI: http://link.springer.com/article/10.1007/s11664-020-08716-4.

J132. P. Pandey, W.-S. Hwang, K. R. Udayakumar, T. S. Moise, and A. C. Seabaugh, "Programming-pulse dependence of ferroelectric partial polarization: insights from a comparative study of PZT and HZO capacitors," *IEEE Trans. on Electron Dev.*vol. 67, no. 10, pp. 4482–4487, Nov. 2020. DOI: 10.1109/TED.2020.3015794.

J131. S. Fathipour, P. Paletti, S. Fullerton-Shirey, and Alan Seabaugh, "Electric-double-layer *p-i-n* junctions in WSe_2," *Scientific Rep.* **10**, 12890–7, July 2020. DOI: https://doi.org/10.1038/s41598-020-69523-9.

J130. P. Paletti, R. Yue, C. Hinkle, and A. Seabaugh, "High mobility WSe_2 thin film transistors grown at low temperature by molecular beam epitaxy on atomic-layer-deposited oxides," submitted *npj2D* 4 March 2020.

J129. A. Chaney, H. Turski, K. Nomoto, Z. Hu, J. Encomendero, S. Rouvimov, T. Orlova, P. Fay, A. Seabaugh, H. G. Xing, and D. Jena, "Gallium nitride tunneling field-effect transistors exploiting polarization fields," *Appl. Phys. Lett.* **116**, 073502 (2020), DOI: 10.1063/1.5132329.

J128. Y. Zhang, S. Rouvimov, X. Yuan, K. Gonzalez Serrano, A. Seabaugh, and S. Howard, "Resolution enhancement of transmission electron microscopy by super-resolution radial fluctuations," *Appl. Phys. Lett.* vol. 116, no. 4, 044105, Jan 2020, DOI: 10.1063/1.5128353.

J127. M. Asghari Heidarlou, P. Paletti, B. Jariwala, J. A. Robinson, S. K. Fullerton-Shirey, and A. C. Seabaugh, "Batch-fabricated WSe_2-on-sapphire field-effect transistors grown by chemical vapor deposition," *IEEE T Electron Dev*, vol. 67, no. 4, pp. 1839–1844, Apr. 2020. DOI: https://doi.org/10.1109/TED.2020.2974450

J126. P. Paletti, S. Fathipour, M. Remškar, and A. Seabaugh, 'Quantitative, experimentally-validated, model of MoS_2 nanoribbon Schottky FETs from subthreshold to saturation" vol. 125, no. 6, *J. Appl. Phys.*, Feb 2020, DOI: 10.1063/1.5127769.

J125. P. Paletti, K. Gonzalez-Serrano, and A. Seabaugh, "Time-dependent subthreshold swing arising from the dynamic response of complex oxide gates," submitted to *Trans. Electron Dev.,* 30 Jul 2019.

J124. W. S. Hwang, P. Zhao, S. G. Kim, R. Yan, G. Klimeck, A. Seabaugh, S. K. Fullerton-Shirey, H. G. Xing, and D. Jena, "Room-temperature graphene-nanoribbon tunneling field-effect transistors," *npj 2D Materials and Applications*, vol. 3, no. 1, p. 666, Nov. 2019, DOI: 10.1038/s41699-019-0127-1

J123. P. Paletti, R. Yue, C. Hinkle, S. K. Fullerton-Shirey, and A. Seabaugh, "Two-dimensional electric-double-layer Esaki diode," *npj 2D Materials and Applications*, vol. 3, no. 1, 1-6, Apr. 2019, DOI: 10.1038/s41699-019-0101-y.

J122. C. Alessandri, P. Pandey, A. Abusleme, and A. Seabaugh, "Monte Carlo simulation of switching dynamics in polycrystalline ferroelectric capacitors," *IEEE Trans. Electron Dev.*, vol. 66, no. 8, pp. 3527–3534, Jul. 2019, DOI: 10.1109/TED.2019.2922268.

J121. C. Alessandri, P. Pandey, A. Abusleme, and A. Seabaugh, "Switching dynamics of ferroelectric Zr-doped HfO_2," *IEEE Elec. Dev. Lett.*, vol. 39, no. 11, pp. 1780-1783, Nov. 2018. DOI: https://doi.org/10.1109/LED.2018.2872124

J120. D. R. Kazanov, A. V. Poshakinskiy, V. Y. Davydov, A. N. Smirnov, I. A. Eliseyev, D. A. Kirilenko, M. Remškar, S. Fathipour, A. Mintairov, A. Seabaugh, B. Gil, and T. V. Shubina, "Multiwall MoS_2 tubes as optical resonators," *Appl. Phys. Lett.*, vol. 113, no. 10, pp. 101106–6, Sep. 2018. DOI: https://doi.org/10.1063/1.5047792

J119. K. Xu, M. M. Islam, D. Guzman, A. C. Seabaugh, A. Strachan, and S. K. Fullerton-Shirey, "Pulse dynamics of electric double layer formation on all-solid-state graphene field-effect transistors," *ACS Appl. Mat. & Interfaces*, vol. 10, no. 49, pp. 43166–43176, Nov. 2018. DOI: https://pubs.acs.org/doi/10.1021/acsami.8b13649

J118. T. A. Ameen, H. Ilatikhameneh, P. Fay, A. Seabaugh, R. Rahman, and G. Klimeck, "Alloy engineered nitride tunneling field-effect transistor: a solution for the challenge of heterojunction TFETs," *IEEE Trans. Electron Dev.*, vol. 66, no. 1, pp. 736–742, Dec. 2018.

DOI: https://doi.org/10.1109/TED.2018.2877753

J117. H. Lu, P. Paletti, W. Li, P. Fay, T. Ytterdal, and A. Seabaugh, "Tunnel FET analog benchmarking and circuit design," *IEEE J. Explor. Solid-State Comput. Devices Circuits*, vol. 4, pp. 19–25 (2018). DOI: https://doi.org/10.1109/JXCDC.2018.2817541

J116. C. Alessandri, S. Fathipour, H. Li, I. Kwak, A. Kummel, M. Remškar, and A. C. Seabaugh, "Reconfigurable electric double layer doping in an MoS_2 nanoribbon transistor," *IEEE Trans. Electron Dev.*, vol. 64, no. 12, pp. 5217–5222, Dec. 2017. DOI: https://doi.org/10.1109/TED.2017.2767501

J115. 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. DOI: https://doi.org/10.1016/j.ssi.2017.01.029

J114. S. Fullerton, K. Xu, H. Lu, W. Wang, H. Kim, I. Kwak, K. Cho, A. Kummel and A. Seabaugh, "Electrostatic double layer flash memory based on two-dimensional crystals," *Amer. Inst. Chem. Engr. (AIChE)* November 13-18, 2016, San Francisco. DOI: https://doi.org/10.1149/MA2017-01/12/825

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 $LiClO_4$ on graphene transistors," *J. Phys. Chem. C.*, 121, 16996–17004 (2017). DOI: https://doi.org/10.1021/acs.jpcc.7b04788

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. DOI: https://doi.org/10.1021/acsnano.6b08505

J111. S. Fathipour, P. Pandey, S. Fullerton-Shirey, and A. Seabaugh, "Electric-double-layer doping of WSe_2 field-effect transistors using polyethylene-oxide cesium perchlorate," *J Appl Phys*, vol. 120, no. 23, p. 234902, Dec. 2016. DOI: https://doi.org/10.1063/1.4971958

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 Al_2O_3 on WSe_2 functionalized by titanyl phthalocyanine," *ACS Nano*, vol. 10, no. 7, pp. 6888–6896, Jul. 2016. DOI: https://doi.org/10.1021/acsnano.6b02648

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 Circuits*, vol. 2, pp. 20–27, 2016. DOI: https://doi.org/10.1109/JXCDC.2016.2582204

J108. M. R. Müller, R. Salazar, S. Fathipour, H. Xu, K. Kallis, U. Künzelmann, A. Seabaugh, J. Appenzeller, and J. Knoch, "Gate-controlled WSe_2 transistors using a buried triple-gate structure," *Nanoscale Res. Lett.*, pp. 1–6, Nov. 2016. DOI: https://doi.org/10.1186/s11671-016-1728-7

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. DOI: https://doi.org/10.1021/acs.jpcc.5b07049

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. DOI: https://doi.org/10.1021/acs.jpcc.5b05233

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 MoS_2 nanotube and nanoribbon field-effect transistors," *Appl. Phys. Lett.* 106, 022114 (2015). DOI: https://doi.org/10.1063/1.4906066

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. DOI: https://doi.org/10.1038/ncomms7564

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. DOI: https://doi.org/10.1109/JXCDC.2015.2426433

J102. H. Xu, S. Fathipour, E. Kinder, A. Seabaugh and S. Fullerton-Shirey, "Reconfigurable ion gating in 2H-$MoTe_2$ field-effect transistors using PEO:$CsClO_4$ solid polymer electrolyte," *ACS Nano*, vol. 9, 4900-

4910 May 2015. DOI: https://doi.org/10.1021/nn506521p

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). DOI: https://doi.org/10.1109/TED.2015.2443564

J100. H. Lu, D. Esseni, and A. Seabaugh, "Universal analytic model for tunnel FET circuit simulation," *Solid State Electronics* 108, pp. 110-117 (2015). DOI: https://doi.org/10.1016/j.sse.2014.12.002

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). DOI: https://doi.org/10.1063/1.4905155

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 $MoTe_2$ field-effect transistors," *Appl. Phys. Lett.* 105, 19210 (2014). DOI: https://doi.org/10.1063/1.4901527

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). DOI: https://doi.org/10.1038/nnano.2014.207

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). DOI: https://doi.org/10.1109/JEDS.2014.2326622

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). DOI: https://doi.org/10.1116/1.4861379

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-Ga_2O_3 nanomembranes," *Appl. Phys. Lett.*, vol. 104, no. 20, 203111, May (2014). DOI: https://doi.org/10.1063/1.4879800

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). DOI: https://doi.org/10.1109/TED.2014.2330805

J92. A. Seabaugh, "The tunneling transistor," *IEEE Spectrum*, vol. 50, pp. 35–62 (2013). https://spectrum.ieee.org/semiconductors/devices/the-tunneling-transistor

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 MoS_2 field effect transistors," *Appl. Phys. Lett.*, 102, 043116 (2013). DOI: https://doi.org/10.1063/1.4789975

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). DOI: https://doi.org/10.1063/1.4772979

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). DOI: https://doi.org/10.1021/nl303669w

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). DOI: https://doi.org/10.1063/1.4796169

J87. K. Karda, S. Sutar, J. Nahas, J. Brockman, and A. Seabaugh, "Bistable-body tunnel SRAM," *IEEE Trans. Nanotechnology* 11, 1067-1071 (2012). DOI: https://doi.org/10.1109/TNANO.2010.2053555

J86. N. S. Do, D. Schaetzl, B. Dey, A. Seabaugh, and S. Fullerton-Shirey, "Influence of Fe_2O_3 nanofiller shape on the conductivity and thermal properties of solid polymer electrolytes: Nanorods versus nanospheres," *J. Phys. Chem. C*, 116, 21216 (2012). DOI: https://doi.org/10.1021/jp3059454

J85. Q. Liu, L. Dong, Y. Liu, R. Gordon, P. Ye, P. Fay, and A. Seabaugh, "Frequency response of $LaAlO_3/SrTiO_3$ all-oxide field-effect transistors," *Solid-State Electronics*, 76, 1-4 (2012).

DOI: https://doi.org/10.1016/j.sse.2012.05.044

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. DOI: https://doi.org/10.1063/1.4734955

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 WS_2 exhibiting 10^5 room temperature modulation and ambipolar behavior," *Appl. Phys. Lett.*, 101, 013107 (2012). DOI: https://doi.org/10.1063/1.4732522

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). DOI: https://doi.org/10.1063/1.4716983

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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

I137. A. Seabaugh, "High-speed and low-power transistors," SEMICON Korea 2024, Seoul, Korea, 31 January 2024.

I136. A. Seabaugh, "High-speed and low-power transistors," Korea Aerospace University, Goyang, Korea, 30 January 2024.

I135. A. Seabaugh, "Steep transistors for low voltage computing," Emerging Device Architectures for Tunnel FET/Diodes and their Applications "75th Anniversary of Transistor Invention" in Virtual Mode, IEEE EDS Delhi Chapter (India), 25 September 2022.

I134. A. Seabaugh, "Tunnel Transistors," UB-IEEE Nano-Symposium on the 75th anniversary of the transistor, Capen Hall, University at Buffalo, September 21 - 23, 2022.

I133. A. Seabaugh, P. Paletti, M. Asghari Heidarlou, K. Gonzalez Serrano, and P. Pandey, "2D Esaki junctions, Schottky-barrier and tunnel field-effect transistors, and the path to applications," Graphene & 2D Materials International Conference and Exhibition, New York, 20-21 February 2020.

I132. A. Seabaugh, P. Paletti, A. Palit, K. González–Serrano, and P. Pandey, "Dynamics of ferroelectric and ionic memories: physics and applications," *2019 Int. Conf. on ASIC* (ASICON), Chongqing, China, Oct. 29 - Nov. 1, 2019. DOI: https://doi.org/10.1109/ASICON47005.2019.8983607

I131. A. Seabaugh, C. Alessandri, P. Paletti, P. Pandey, K. Gonzalez, and M. Asghari Heidarlou, "Low-voltage steep-subthreshold-swing transistors," *Norwegian University of Science and Technology* (NTNU), Trondheim, Norway, 17-19 June 2019.

I130. A. Seabaugh, C. Alessandri, P. Paletti, P. Pandey, K. Gonzalez, and M. Asghari Heidarlou, "Ferroelectric and ionic gates: action and function," *Norwegian PhD Network on Nanotechnology for Microsystems*, Tromso, Norway, 17-19 June 2019.

I129. A. Seabaugh, C. Alessandri, P. Paletti, P. Pandey, K. Gonzalez, and M. Asghari Heidarlou, "Ferroelectric and ionic analog memory," 2019 Int. Nanodevices and Computing Conf. (INC), Grenoble, France, 3-5 April 2019.

I128. A. Seabaugh, C. Alessandri, M. Asghari Heidarlou, K. Gonzalez-Serrano, P. Paletti, P. Pandey, S. Fullerton-Shirey, A. Strachan, and A. Abusleme, "Switching dynamics of ferroelectrics and ionic gates for steep transistors and analog weight storage," Microelectronics Institute, Peking University, Beijing, 22 October 2018.

I127. A. Seabaugh, C. Alessandri, M. Asghari Heidarlou, K. Gonzalez-Serrano, P. Paletti, and P. Pandey, S. Fullerton, C. Hinkle, A. Kummel, J. Robinson, and A. Strachan, "Emerging phenomena at metal-X-

semiconductor interfaces for electronics," 2018 Structures and Materials Intelligence Seminar (SMIS), *MITRE,* Building 3, McLean, VA, 13-14 June 2018.

I126. A. Seabaugh, "Electronic applications of 2D materials," *2017 NSF Nanoscale Science and Engineering Grantees Conf.*, Arlington, Va., Dec. 12-13, 2017.

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.
DOI: https://doi.org/10.1109/ESSDERC.2016.7599658

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.
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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.
DOI: https://doi.org/10.1109/ICSICT.2014.7021205

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.
http://www.e2switch.org/members/repository/downloads/E2SWITCHworkshopESSDERC/Presentations/E2SWITCHworkshopESSDERC_Sep14_Seabaugh.pdf

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.

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I108. A. Seabaugh, "Benchmarking low-voltage steep devices, circuits, and systems," *SRC Nanoelectronics Res. Initiative Benchmarking Workshop*, Rockville, MD, 23 October 2013.

I107. A. Seabaugh, "The best tunnel diode and tunnel transistor circuits," *TxACE Analog Symp.*, University of Texas at Dallas, Richardson, TX, 21 October 2013.

I106. A. Seabaugh, "Low-voltage, steep-subthreshold, beyond-CMOS technology," *IEEE SOI-3D-Subthreshold Microelectronics Technology Unified Conf.*, Monterey, CA, 8 October 2013.

I105. A. Seabaugh, "Steep Subthreshold Swing Transistors," Yonsei University, 6 September 2013.

I104. A. Seabaugh, "Steep Subthreshold Swing Transistors," SKKU Graphene Center, 6 September 2013.

I103. A. Seabaugh, "III-V tunnel field-effect transistors and beyond," *Samsung Electronics*, Seoul, Korea, 5 September 2013

I102. A. Seabaugh, "Recent progress in III-V tunnel FETs," *Topical Workshop on Heterostructure Microelectronics (TWHM)*, Hakodate, Japan, 2 September 2013.

I101. A. Seabaugh, "DARPA/SRC Center for Low Energy Systems Technology," *University of California, Berkeley NSF Center for Energy Efficient Electronics Science Seminar*, 11 July 2013.

I100. A. Seabaugh, "The transistor has changed the world. What next?" *Dev. Res. Conf. rump session*, Notre Dame, 25 June 2013.

I99. A. Seabaugh, "Steep subthreshold swing transistors," *Int. Symp. on Extremely Low Voltage VLSI Devices and Circuits*, Kyoto, Japan, 15 June 2013

I98. A. Seabaugh, "Beyond CMOS transistors," *TechConnect World*, National Harbour, MD, 14 May 2013.

I97. A. Seabaugh, "Steep subthreshold swing transistors for low voltage computing," *2013 SEMINATEC*, May 3, University of Campinas, Campinas, Brazil.

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I95. A. Seabaugh, "Nanoelectronics Devices and Circuits," *Pontificia Universidad Católica de Chile (PUC)*, 11 October 2012, Santiago, Chile

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I84. A. Seabaugh, "III-V tunnel transistors," *Workshop on Comp. Semiconductor Materials and Devices (WOCSEMMAD)*, February 21-23, 2011, Savannah, GA.

I83. A. Seabaugh, "Tunnel FET gate-stack characterization," *Int. Symp. Adv. Gate Stack Technology*, Troy,

NY, October 1, 2010.

I82. A. Seabaugh, "Emerging energy-efficient device technologies vs. ultimate CMOS," *University Government Industry Micro-Nano Symp*., UGIM 2010, June 29, West Lafayette, IN.

I81. A. Seabaugh, "Tunnel field-effect transistors – status and prospects," *2010 Dev. Res. Conf.*, June 22, Notre Dame. DOI: https://doi.org/10.1109/DRC.2010.5551883

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I79. A. Seabaugh, "Tunnel transistors and SRAM," *Solid State Seminar, Department of Electronic and Computer Engineering, UC Berkeley*, April 23, 2010.

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I69. A. Seabaugh, "Energy-efficient transistors," *Rochester Institute of Technology, Microelectronic Engineering Seminar*, January 10, 2008.

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I58. A. Seabaugh, "Silicon tunnel diodes and integrated circuits," *SEMATECH*, Austin, TX, March 26, 2004.

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I54. A. Seabaugh, "Emerging Technologies for Ambient Intelligence" at the *Fifth Int. Workshop on Future Information Processing Technologie*s, Miyazaki, Japan, November 10, 2003.

I53. A. Seabaugh, "Difference-defined nanofabrication" *DARPA Workshop on Massively Reconfigurable Microfabrication Tools*, Napa, California, October 29, 2003.

I52. A. Seabaugh, *NSF IGERT (Integrative Graduate Education and Research Trainingship) Lecture, "Nanotechnology: Devices, Agents, and Swarms*," University of Michigan, Ann Arbor, Michigan, October 10, 2003.

I51. A. Seabaugh, "Nanoelectromechanical Switches and Circuits," *Sensors Directorate of the Wright Patterson Air Force Base*, February 6, 2003.

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