# Timothy D. Brown, Ph.D.

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## General Interests

Defining meaningful test procedures for analog electronics and circuits, and quantifying uncertainty
Simplification and exploitation of complex math & models to develop targeted performance metrics
Developing compact, reduced order models to better understand novel semiconductor device physics
Reducing complex systems and behavior to small simple components and coupling laws

## Employment

**Tenure Track Assistant Professor** 2025-
Department of Electrical & Computer Engineering, *Oklahoma State University, Stillwater OK*

**Postdoctoral Researcher** (Supervisor: Suhas Kumar) 2022-25
Materials Physics Department, *Sandia National Labs, Livermore CA*

**Postdoctoral Researcher** (Supervisor: R. Stanley Williams) 2019-22
Department of Electrical Engineering, *Texas A&M University, College Station TX*

**Graduate Research Assistant** (Supervisor: Patrick J. Shamberger) 2014-19
Department of Materials Science & Engineering, *Texas A&M University, College Station TX*

**Visiting Graduate Researcher** (Supervisor: Amber Reed) 2015/2
RXAN Department, *Air Force Research Lab, Dayton OH*

## Education

**Ph.D. in Materials Science and Engineering** 2019
Texas A & M University: College Station, TX *4.0 GPA*
*Dissertation:* Engineering hysteresis and non-diffusive phase transitions in magnetocaloric $(Mn,Fe)_2(P,Si)$ alloys for magnetic refrigeration applications
Committee Chair: Dr. Patrick J. Shamberger, Associate Professor
Certificate in D3EM NSF-IGERT data-driven design of energy materials 2017

**B.S. in Engineering Physics, Electronics** 2014
The University of Tulsa: Tulsa, OK *3.98 GPA, Magna cum laude*

## Honors and Awards

**Emerging Investigator Award, Mater. Res. Express (MRX 3 2016)** 2017
**Fellow of NSF- GRFP program, National Science Foundation** 2016
Excellence in Outreach Award, MSEN Department, Texas A&M 2018
University merit fellowship, Texas A&M University 2014

## Mentorship and Leadership

Built up three new-PI labs from scratch. Capable of planning and beginning new projects. 2016-2022
Mentored / helped train 3 PhD students in new RS Williams and S Kumar labs 2020-2022
Mentored 7+ undergraduate researchers; 3 co-authored on published work 2015-present
President, then senior adviser for Material Advantage professional development org. 2016-2019
Outreach and communications officer for Women in Materials Science education org. 2015-2018

## Course Instruction

ECEN 3314, Electronic Devices and Applications (+ Lab) 2025/3

## Recent Projects

*Predictive inverse design of electro-thermal voltage controlled oscillators* 2023-present

- Used stability theory to quickly construct compact models for and rank >30 candidate materials
- "Forgotten heroes," like Ge, CuO, InSe, C predicted capable of ~GHz oscillations at ~μW power

*Design and prototyping low capacitance current-voltage (IV) tracer* 2023-present

- Helped develop IV tracer from breadboard LM334 circuit to turnkey unit with Labview software
- Assisted with part selection, macro circuit design, lab testing, and data collection

*Active signal transmission in LaCoO3 electro-thermal memristors* 2023-2025

- Used stability theory for predicting novel phase shifting and active signal transmission at NDR
- Experimentally verified gain>1 active transmission & energy conversion with *operando* IR camera

*Compact modeling and in-situ thermal characterization of $VO_2$ lateral devices* 2019-2023

- Automated device measurement via parameter analyzer + (C++) + Labview
- Developed quantitative compact device model that accurately reproduces dynamical behavior

*Reformulation and unification of local activity and bifurcation theory* 2020-2022

- Developed simplified analysis for local activity & bifurcations for general electro-thermal memristors
- New analysis quantifies when and how NDR and self-oscillations arise; also external circuit effects

## Research Proposals

Exploratory Express Lab Directed R&D, Sandia National Lab CA 2025
*Engineering power gain in electrothermal active transmission lines*

Molecular Foundry, Lawrence Berkeley Lab 2023
*In-situ Raman investigation of electro-thermal localizations in locally active LaCoO3 based high entropy oxides* (Funded, declined)

Advanced Light Source, Lawrence Berkeley Lab 2023
*Entropy tunable spin density transition in neuromorphic LaCoO3 based high entropy oxides*

Graduate Research Fellowship Program, National Science Foundation 2016-19
*Towards Control of Microscopic Hysteresis Mechanisms in Discontinuous Phase Transitions*
(Funded)

## Refereed Publications (see https://tinyurl.com/gscholar-TimDBrown)

27. **T. D. Brown**, A. Zhang, E. D. Grant, E. J. Fuller, A. A. Talin, P. J. Shamberger, R. S. Williams, S. Kumar. Mapping tonic and phasic neuronal spiking in $LaCoO_3$. In prep. Adv Elec. Mater. *Probe station and oscilloscope characterization of memristive capacitance controlled oscillations.*
26. M. Islam, **T. D. Brown**, C. Perez, R. Bhattacharya, V. Gambin, R. S. Williams, S. Kumar, E. Pop. Resistive Switching via Electrical Spin-State Control in LaCoO3. In prep. Cell Press. *Performed operando thermoreflectance measurements under electrical excitation and analyses.*
25. S. Oh, A. Gross, A. Christensen, **T. D. Brown**, S. Radhakrishnan, P. Finnegan, J. Sugar, S. Bishop, S. Gilbert, K. S. Woo, P. Balbuena, R. S. Williams, E. J. Fuller, S. Kumar, A. A. Talin. Electro-chemically Stabilized Phase Coexistence for Reconfigurable Processing of Information. Under Review, Science. *Performed spectroscopic measurements and quantitative phase analyses.*
24. R. Gurrola, F. Jardali, J. Cain, **T. Brown**, J. Ponis, S. Oh, R. Schoell, D. Yadav, J. Dong, C. Smyth, M. Pharr, S. Kumar, K. Xie., S. Banerjee, K. Hattar, A. Talin, T. Lu, P. Shamberger . The effect of 10 keV and 2 MeV He+ irradiation in modulating charge transport in metal-insulator transition VO2

films. Under review. Appl. Phys. Lett. *Performed compositional analyses via Raman mapping.*

23. B. Zutter, S. Oh, **T. D. Brown**, J. Anderson, S. P. Beltran, S. R. Bishop, P. Finnegan, A. Ievlev, Y. Li, J. Sugar, H. E. Lai, B. A. A. Blanco, A. Lopez-Meza, S. Kumar, E. J. Fuller, R. S. Williams, P. B. Balbuena, A. A. Talin. Mechanisms enabling reconfigurability and long-term retention in vanadium oxide electrochemical memory. Phys. Rev. Mater. **9** (2025). doi: 10.1103/k616-d2q5 *Constructed compact device model for oscillations; automated parameter analyzer measurements w/ C++.*

22. A. Bradicich, Y. Yu, **T. D. Brown**, F. Jardali, S. Kumar, R. S. Williams, P. J. Shamberger. Electrically Driven Metal-Insulator Transitions Emerging from Localizing Current Density and Temperature. Adv. Elec. Mater. **11** (2025). doi: 10.1002/aelm.202400975. *Consulted on how to most accurately represent NDR steady state experiments in FEM sims; provided exp data.*

21. F. Jardali, J. L. Chong, Y. Yu, S. Kumar, R. S. Williams, P. J. Shamberger, **T. D. Brown**. Materials Selection Principles for Designing Electro-Thermal Neurons. Adv. Elec. Mater. (2025) doi: 10.1002/aelm.202400938 *Led interdisciplinary team for defining requirements for memristive capacitance driven oscillators, conditions for ~10 GHz oscillations at ~100 μW in <micron devices.*

20. M. Islam, S. M. Bohaichuk, **T. D. Brown**, S. Oh, C. Perez, C. Zhang, T. J. Park, M. Park, A. A. Talin, S. Ramanathan, S. Kumar, E. Pop. An electro-optical Mott neuron based on niobium dioxide. Nature Electronics, (2025) doi: 10.1038/s41928-025-01406-1 *Performed operando Raman and photoluminescence measurements, preliminary analyses*.

19. S. H. Zadeh, **T. D. Brown**, X. Qian, I. Karaman, R. Arroyave. A composition-based predictive model for the transformation strain of NiTi shape memory alloys. Acta Materialia, **289** (2025), doi: 10.1016/j.actamat.2025.120861.

18. A. Zhang, **T. D. Brown**, S. Oh, C. Spataru, E. Kinigstein J. Guo, J. D. Sugar, A. Mascaraque, E. G. Mitchel, A. Shad, J. Zhu, M. D. Witman, S. Kumar., A. A. Talin, E. J. Fuller, Tuning the Spin Transition and Carrier Type in Rare-Earth Cobaltates via Compositional Complexity. Adv. Mater. (2024) doi: 10.1002/adma.202406885. *Supportive spectroscopic materials characterization.*

17. **T. D. Brown**, A. Zhang, F. Nitta, E. D. Grant, J. Chong, J. Zhu, S. Radhakrishnan, M. Islam, E. J. Fuller, A. A. Talin, P. J. Shamberger, E. Pop, R. S. Williams, S. Kumar. Axon-like active transmission. **Nature. 633** (2024) doi: 10.1038/s41586-024-07921-z. *Used frequency and noise analyses and thermal imaging to demonstrate novel active transmission line effect.*

16. K. M.Kim, G. Kim, J. H. In, Y. Lee, H. Rhee, W. Park, H. Sung, J. Park, J. B. Jeon, **T. D. Brown**, A. A. Talin, S. Kumar, K. Kim. Mott Neurons with Dual Thermal Dynamics for Spatiotemporal Computing. Nature Mater. **23** (2024), doi: 10.1038/s41563-024-01913-0. *Supportive operando thermal imaging of coupled memristive capacitance controlled oscillator devices.*

15. S. H. Zadeh, C. Cakirhan, D. Khatamsaz, J. Broucek, **T. D. Brown**, X. Qian, I. Karaman, R. Arroyave. Data-driven study of composition-dependent phase compatibility in NiTi shape memory alloys. Materials and Design. **244** (2024), doi: 10.1016/j.matdes.2024.113096.

14. K. S. Woo, A. Zhang, A. Arabelo, **T. D. Brown**, M. Park, A. A. Talin, E. J. Fuller, R. S. Bisht, X. Qian, R. Arroyave, S. Ramanathan, L. Thomas, R. S. Williams, S. Kumar. True random number generation using the spin crossover in LaCoO3. Nature Comms. **15** (2024). doi: 10.1038/s41467-024-49149-5. *Preliminary characterization of capacitance-controlled oscillators for RNG.*

13. R. M. Gurrola, J. Cain, S. Oh, **T. D. Brown**, F. Jardali, R. Schoell, D. Yadav, J. Dong, C. Smyth, M. Pharr, S. Kumar, K. Xie, K. Hattar, A. Alec Talin, T. Liu, p. J. Shamberger. Selective modulation of electronic transport in VO2 induced by 10 keV He ion irradiation. J. Appl. Phys. **135** (2024). doi: 10.1063/5.0189562. *Developed technique for compositional analysis via Raman mapping.*

12. **T. D. Brown**, S. M. Bohaichuk, M. Islam, S. Kumar, E. Pop, R. S. Williams. Electro-thermal characterization of dynamical VO2 memristors via local activity modeling. Adv. Mater. **35** (2023). doi: 10.1002/adma.202205451. *Developed quantitative compact device model for memristive capacitance controlled oscillations.*

11. P. Schofield, A. Bradicich, R. M. Gurrola, Y. Zhang, **T. D. Brown**, M. Pharr, P. J. Shamberger, S. Banerjee. Harnessing the metal-insulator transition of VO2 in neuromorphic computing. Adv. Mater. **35** (2022). doi: 10.1002/adma.202205294. *Review paper discussing requirement definition for memristive capacitance controlled oscillations.*

10. A. Bradicich, **T. D. Brown**, S. Ganguli, R. S. Williams, P. J. Shamberger. Spontaneous symmetry-breaking of non-equilibrium steady-states caused by nonlinear electrical transport. Adv. Elec. Mater. **9** (2023). doi: 10.1002/aelm.202300265. *Helped develop analyses for defining requirements for simultaneous localization, memristive capacitance controlled oscillations.*

9. **T. D. Brown**, S. Kumar, R. S. Williams. Physics-based compact modeling of electro-thermal memristors: Negative differential resistance, local activity and non-local dynamical bifurcations. Appl. Phys. Rev. **9** (2022), doi: 10.1063/5.0070558 **[invited paper]**. *Foundational work translating challenging concepts into visuals and simplified equations defining requirements for capacitance controlled oscillations in electro thermal memristors.*

8. I. Messaris, **T. D. Brown**, A. S. Demirkol, A. Ascoli, M. M. Al Chawa, R. S. Williams, L. O. Chua, NbO2-Mott Memristor: A circuit-theoretic investigation. IEEE Trans. Circuits. **68** (2021), doi: 10.1109/TCSI.2021.3126657. *Supported theoretical analyses describing NDR and capacitance controlled oscillations in electrothermal memristor devices.*

7. D. G. Sellers, E. J. Braham, R. Villareal, B. Zhang, A. Parija, **T. D. Brown**, T. E. G. Alivio, H. Clarke, L. R. De Jesus, L. Zuin, D. Prendergast, X. Qian, R. Arroyave, P. J. Shamberger, S. Bannerjee. Atomic hourglass and thermometer based diffusion of a mobile dopant in $VO_2$. J. Am. Chem. Soc. **142**, 36 (2020), doi: 10.1021/jacs.0c07152. *Supported ab-initio calculations with group theory analyses of potential dopant interstices in VO2 crystal lattice.*

6. **T. D. Brown**, D. Galvan, J. van Buskirk, A. Mott, P. J. Shamberger, Effect of carbide formation on phase equilibria and compositional modulation properties in $(Mn,Fe)_2(P,Si)$ alloys. J. Alloy Comp. **830** (2020), doi: 10.1016/j.jallcom.2020.154532

5. **T. D. Brown**, J.-H. Chen, E. J. Braham, S. Stadler, P. J. Shamberger, Dynamic re-equilibration controlled multi-step transformations in $(Mn,Fe)_2(P,Si)$ alloys. J. Phys. D. Appl. Phys **53** (2021), doi: 10.1088/1361-6463/ab768a

4. **T. D. Brown**, T. Buffington, P. J. Shamberger. Effects of hysteresis & Brayton cycle constraints on magnetocaloric refrigerant performance. J. Appl. Phys. **123** (2018), doi: 10.1063/1.5022467.

3. H. Clarke, **T. Brown**, J. Hu, R. Ganguli, A. Reed, A. Voevodin, P. J. Shamberger. Microstructure dependent filament forming kinetics in $HfO_2$ programmable metallization cells. Nanotech. **42** (2016), doi: 10.1088/0957-4484/27/42/425709

2. **T. D. Brown**, I. Karaman, P. J. Shamberger. Impact of cycle-hysteresis interactions on the performance of giant magnetocaloric effect refrigerants. Mater. Res. Express **3** (2016), doi: 10.1088/2053-1591/3/7/074001

1. **T. D. Brown**, N. M. Bruno, J.-H. Chen, I. Karaman, J. H. Ross, Jr., P. J. Shamberger. A Preisach-based nonequilibrium methodology for simulating performance of hysteretic MR cycles. JOM **67** (2015), doi: 10.1007/s11837-015-1519-0

## Invited Seminars

3. **T.D. Brown*** on behalf of Reconfigurable Electronic Materials Inspired by Nonlinear Neuron Dynamics (reMIND) EFRC, Predictive inverse design of neuronal components. Lightning Talk. DOE-EFRC 1-year review. 1 February 2024.
2. **T.D. Brown*** on behalf of Reconfigurable Electronic Materials Inspired by Nonlinear Neuron Dynamics (reMIND) EFRC, Towards datasheets for neuromorphic components. Lightning Talk. DOE-EFRC 1-year review. 26 September 2023.
1. **T.D. Brown***, S. Kumar, S. Bohaichuk, R. S. Williams, Thermal mapping of localized conducting channels in lateral $VO_2$. Naval Research Lab, invited by Dr. Hans Cho. 15 October 2021.

## Selected Conference Presentations

10. **T. D. Brown***, A. Zhang, F. Nitta, E. D. Grant, E. Radhakrishnan, J. Zhu, M. Islam, E. Pop, E. J. Fuller, A. A. Talin, E. Pop, R. S. Williams, Active signal transmission at the edge of chaos. DoE-EFRC Purple Team Meeting **[oral]**, DOE-EFRC Fall 2023 Purple Team.

9. **T. D. Brown***, S. M. Bohaichuk, M. Islam, S. Kumar, E. Pop, R. S. Williams, Development of property-performance links for VO2 nonlinear dynamical memristors via local activity modeling **[oral]**, APS Spring 2023.

8. M. Islam*, S. Bohaichuk, **T. D. Brown,** C. Perez, C. Zhang, T. J. Park, A. A. Talin, S. Ramanathan, S. Kumar, Origins of visible light emission upon resistive switching in NbO2 **[oral]**, APS Spring 2023.
7. **T. D. Brown*,** S. Bohaichuk, S. Kumar, R. S. Williams, Characterization and exploitation of non-linear dynamics in vanadium dioxide thermal memristors **[oral]**, EMC Summer 2021.
6. **T. D. Brown*,** J. Billman, P. J. Shamberger, Phase microstructure evolution observed by magnetic force microscopy in $(Mn,Fe)_2(P,Si)$ alloys **[oral]**, TMS Spring 2019.
5. **T. D. Brown***, P. J. Shamberger, Orientation relationships and lattice matching effects on hysteresis in $(Mn,Fe)_2(P,Si)$ phase transformations **[oral]**, MRS Fall 2018.
4. **T. D. Brown**, P. J. Shamberger*, Assessing performance of caloric material refrigerants through hysteretic thermodynamic modeling **[oral]**, MRS Spring 2017.
3. **T. D. Brown***, T. Buffington, D. Galvan, P. J. Shamberger, Efficiency-based comparisons of conventional and magnetic refrigerant performance in refrigeration cycles **[oral]**, Texas A&M University Energy Research Society: Conference on Energy. September 2016.
2. **T. D. Brown***, N. M. Bruno, I. Karaman, P. J. Shamberger, Thermodynamic analysis of irreversible thermal energy conversion cycles in giant magnetocaloric effect materials **[oral]**, MRS Fall 2015.
1. **T. D. Brown***, Y. Zhang, P. J. Shamberger, Hysteresis engineering in caloric effect materials **[poster]**, AFRL 2030 symposium. June 2018.

## Service

ECEN Publicity Committee 2025/3

## Technical Skills

- Expertise (5 yrs) with advanced steady-state & dynamical electrical characterization using e.g., SMUs, oscilloscopes, micro-probing stations, in combination with *in operando* thermoreflectance
- Expertise (5 yrs) with compact model inverse problem, what type of nonlinear device and diff eqs yield observed electrical device behavior
- Proficient (2 yrs) with pump-probe measurements of dynamic Joule self-heating in semiconductor devices, especially reducing line capacitance / inductance for achieving 20 ns temporal resolution
- Expertise (5 yrs) in a variety of structural, compositional, and local materials characterization techniques and analysis: XRD(+Rietveldt), SEM, EDS/WDS, XPS, Raman, AFM/c-AFM/MFM
- Familiarity (2 yr) with basic device fabrication: photolithography & cleanroom synthesis
- Familiarity (1 yr) with machine learning in materials design problems: EGO, SVM, random forest
- Expertise (10+ yrs) in MatLAB. Developed custom numerical integrator for nonlinear dynamics in state-dependent / hysteretic phase transitions and sophisticated visualizations
- Proficient (3 yr) with Python. Modified existing Raman analysis code for in operando Raman mapping
- Proficient (2 yr) with NI Labview. Automated file saving for read-write cycling of synapses
- Familiarity (1 yr) with C+. Automated PMU pulse card of Keithley 4200 SCS SMU mainframe
- General experimental expertise: troubleshooting, soldering for circuit repair or custom equipment, using relays & buffer amps, pros / cons of various cablings and connectors

## Non-Technical Skills

- 10+ years of experience working on teams in and out of classroom, collaboration on research projects
- 8 years of experience leading teams, delegating tasks, managing others to achieve project goals
- Detail oriented. Good at following strings of assumptions and conclusions, or debugging software.
- Skilled at creating simple, attractive visuals for complex data or equations. Good at explaining complex, mathematically difficult ideas in intuitive, plain language
- Self motivated. Learned nonlinear dynamics, complex analysis, group theory through self-study.
- Expert in circuit stability and dynamical analyses using L. Chua's Local Activity theory