Petro Maksymovych

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Objective: advance knowledge, characterization and applications of nanoscale phase transitions through microscopy and computational thinking

Education/Training

Taras Shevchenko University (Ukranie)
2001 B.S. Chemistry. Advisor: Vitaliy Yatsimirsky
University of Pittsburgh
2007 Ph.D. Chemistry. Advisor: John T. Yates, Jr.

Research Experience

2023-present **Distinguished Research Scientist**, Oak Ridge National Laboratory

Leading research on non-linear dynamics of quantum and classical nanomaterials for energy and computing paradigms

2019-2023 **Senior Research Scientist**, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory

Led research on quantitative probes of superconductivity on atomic scale, "hidden" states in quantum materials and co-design for neuromorphic computing

2014 – 2019 **Research Scientist**, Center for Nanophase Materials Sciences, ORNL

Led research on switchable and adaptive van der Waals materials for integration of phase transitions into 2D electronics paradigm

2009–2013 **Research & Development Associate**, Center for Nanophase Materials Sciences, ORNL

Led effort on emergent correlations in molecular materials, including unconventional superconductors on molecular lattice

2007–2009 **Eugene P Wigner Fellow**, Center for Nanophase Materials Sciences, ORNL

Discovered electron tunneling and electronically conducting topological defects in ferroelectric materials, with potential for energy-efficient neuromorphic computing

Career Highlights

- International expert in scanning probe microscopy and molecular manipulation
- Quantification of nanoscale measurements, using modeling, machine learning and data analytics
- Principal investigator and task lead on large-scale collaborative projects
- Theme Leader for "Multiscale Dynamics" at Center for Nanophase Materials Sciences
- President of Tennessee chapter for American Vacuum Society
- 2019 ISI Highly Cited Researcher
- 2015 Peter Mark Award from the American Vacuum Society
- Eugene P. Wigner Fellow ORNL (2007-2009)
- 120+ peer-reviewed publications (h-index 45)
- 30+ invited talks
- 6 patents
- 4 book chapters
- Notable scientific results:
  - Andreev Tunneling Microscopy
  - Nanoscale phase transitions
  - Self-organization and topological defects
  - vdW and 2D ferroelectrics
  - programmable reactions
  - ferroelectric neuromorphics

Technical Expertise

Microscopy and Spectroscopy of materials with atomic scale spatial resolution: Inventor of (1) Tunneling Andreev Microscopy and Spectroscopy for direct measurement of unconventional superconductors on the atomic scale; (2) Contact Kelvin Probe Force microscopy for quantitative measurement of advanced dielectrics; and (3) Non-Contact Tunneling Thermocouple Spectroscopy for local profiling of temperature and thermopower. Proficiency in most flavors of scanning probe microscopy characterization methods with emphasis on ultrahigh-vacuum environment: Scanning Tunneling Microscopy and its derivatives (Scanning Tunneling Spectroscopy, Quasiparticle Interference, Josephson Tunneling Microscopy, Thermovoltage Tunneling Microscopy); Atomic Force Microcopy: Electrostatic/Kelvin Probe Force Microscopy, Piezoresponse Force Microscopy, Magnetic Force Microscopy, non-contact Atomic Force Microscopy with atomic resolution, Conductive Atomic Force Microscopy, Scanning Microwave Impedance Microscopy.

Ultrahigh-vacuum methodologies: surface analysis (LEED, TPD), vacuum deposition and surface preparation, thin film growth, molecular self-assembly, cryogenic equipment, SEM/cathodoluminescence, CAD design of UHV equipment.

Signal analytics: multivariate statistics and machine learning, image analysis (feature finding, graph representation, integral transforms, compressed sensing, data fusion), hyperspectral data (dimensionality reduction, clustering, component analysis, mixture models), time-series analytics (outlier detection, stochastic processes, quantile regression, Gaussian processes), metric learning, neural networks (autoencoders, Siamese networks, CNN, LSTM), probabilistic programming.

Computational methodologies: Python, Wolfram Language (Mathematica), Labview, Matlab, COMSOL, Kwant (tight-binding quantum modeling), cloud infrastructure

Code development: creator of Data-xray – a pythonic cure for the hyperspectral morass, focused on rapid aggregation and reporting of heterogeneous microscopy and spectroscopy datasets https://github.com/amplifilo/data-xray.

Research Achievement Awards

2023 Outstanding Technical Accomplishment for Development of Decay Rate Spectroscopy, CNMS, ORNL
2020 Best Paper for discovery of tunable quadruple polarization well in $CuInP_2S_6$, ORNL
2019 ISI Highly Cited Researcher
2015 Peter Mark Award from the American Vacuum Society
2011 ORNL Director's Award for Outstanding Accomplishment in Science and Technology
2011 ORNL Early Career Award for Individual Scientific Accomplishment
2010 Martin and Beathe Block Prize from the Aspen Center for Physics
2007 Eugene P. Wigner Fellowship, Oak Ridge National Laboratory, Oak Ridge, TN
2007 Wayne B. Nottingham Prize from the Physical Electronics Conference
2006 Morton Traum Award from the American Vacuum Society

Leadership Experience

Task Leader for "Abisko: Deep Codesign of an Energy-Optimized, High Performance Neuromorphic Accelerator", 2021-present: leading research effort in bridging nano- and device scales in neuromorphic computing materials, through the use of switching microscopy and data analytics. Collaboration involves ORNL, Georgia Tech, Arizona State Univ., Harvard University, Sandia National Laboratory, University of Michigan and Fermilab.

Principal Investigator for "Probing Coupled and Competing Polar Orders from Nano to Mesoscales" Field-Work Proposal from Basic Energy Sciences, US DOE, 2020-2022: leading research effort in nanoscale phase transitions, with focus on advanced dielectric materials, functional topological defects (such as ferroelectric conductive domain walls), development of atomic-scale probe microscopy for measurement and manipulation of ferroelectric materials, and direct dynamic probes of order parameters characterizing classical and quantum materials.

Theme Leader for "Multiscale Dynamics", 2018-present: Center for Nanophase Materials Sciences, ORNL

Organizing and coordinating one of three primary research directions at CNMS (network of 10+ scientists), dedicated to understanding of metastable materials and non-equilibrium thermodynamics on the nanoscale. Report to Leadership team, Scientific Advisory Committee and DOE Review Panel.

President of the Tennessee Valley Chapter of the American Vacuum Society, 2016-present:

Organizing, sponsoring and coordinating members of American Vacuum Society in Tennessee, Georgia, Alabama, Kentucky and South Carolina – including local conferences, interaction with local scientific societies, society days, outreach to schools and connections with local industries.

Principal Investigator of Laboratory Directed Research Program "Layered Ferroics by Design", 2014-2017: pioneered new approaches to tune complex layered materials, enabling desired properties of ionic conductivity, spontaneous and magnetic polarization, and electron correlations in layered and 2D electronic materials with van der Waals lattice. The work culminated in new topics for MSED funded FWP at ORNL, theory and experimental programs at CNMS, and produced three successful postdoctoral fellows.

Funded initiatives and research proposals

Lead Investigator:

2021-present: *Abisko: Deep Codesign of an Energy-Optimized, High Performance Neuromorphic Accelerator*, DOE/BES/ASCR

2020-2022: *Probing Coupled and Competing Polar Orders from Nano to Mesoscales*, FWP DOE/BES/MSED (Scanning Probe and Electron Microscopy)

2015-2017: *Layered Ferroics by Design*, ORNL/LDRD

2011-2013: *Thermopower at the Atomic Scale*, ORNL/SEED

2009: *Molecular Imaging of Photoactive Interfaces using Tuning Fork Atomic Force Microscopy* – DOE instrument grant

Co-Investigator:

2009-2020: *Probing Ferroic Transitions from the Atomistic to Mesoscopic Scales*, FWP DOE/BES/MSED (Scanning Probe and Electron Microscopy)

2019-present: *Nanoscale quantum and classical sensing for superconducting and topological quantum information,* FWP DOE/BES/MSED (Scanning Probe and Electron Microscopy)

2019-2021 *Accelerating Discovery, Synthesis, and Control of Topological Quantum Materials*, ORNL/LDRD

2017-2019 *Atomic Force Microscopy Beyond the Standard Quantum Limit*, ORNL/SEED

2008-2010 *Single Molecular Imaging and Spectroscopy of Adsorbed Molecules,* ORNL/LDRD

Conference organization/networking

2024 Electronics Materials and Applications - "Fundamental mechanisms in materials for next generation computing devices"

2022 CNMS User meeting: Nano4Neuro – bringing nanoscale vision into neuromorphic computing

2021 APS Focus session: Topology in soft and condensed matter

2021 Fundamental Physics of Ferroelectrics and Related Materials (Ferro2021)

2020 Fundamental Physics of Ferroelectrics and Related Materials (Ferro2020)

2018 Annual conference of Tennessee Valley Chapter of the American Vacuum Society

2016 Workshop on "Collective phenomena in 2D and layered materials", co-organized with American Vacuum Society, Oak Ridge National Laboratory

2012 Materials Research Society Congress ("Oxide Nanoelectronics and Multifunctional Dielectrics")

2011 International Materials Research Congress, Cancun, Mexico ("Fundamentals and Applications of Complex Oxides for Information and Energy")

2011 MRS proceedings editor for "Oxide nanoelectronics" symposium

Member of American Physical Society, American Vacuum Society, Materials Research Society, American Ceramic Society

Service and Committee Membership

2019-2021 CNMS User Executive Committee

2015, 2019 - NSF review panels

2010-2012 SEED proposal committee at ORNL

Regular judge of student competitions (AVS Morton Traum Award, MRS Graduate Student Awards)

Select Peer-Reviewed Publications (total >130, h-index 49, >9000 citations):

1. W. Ko, S. Y. Song, J. Yan, J. L. Lado, P. Maksymovych,
Atomic-Scale Andreev Probe of Unconventional Superconductivity
Nano Letters, 23 (2023), 8310-8318, 10.1021/acs.nanolett.3c02658

2. S. N. Neumayer, N. Bauer, S. Basun, B. S. Conner, M. A. Susner, M. O. Lavrentovich, P. Maksymovych, *Dynamic stabilization of metastable states in triple-well ferroelectric $Sn_2P_2S_6$*, Advanced Materials 35 (2023), 2211194. http://doi.org/10.1002/adma.202211194

3. P. Maksymovych, J. Yan, B. Sales, J. Wang,
Atomic-scale analysis of disorder by similarity learning from tunneling spectroscopy,
Physical Review Research, 4 (2022) 033058, 10.1103/PhysRevResearch.4.033058.

4. W. Ko, E. F. Dumitrescu, P. Maksymovych,
Statistical detection of Josephson, Andreev and single quasiparticle currents in scanning tunneling microscopy, Physical Review Research 3, 033248 (2020), 10.1103/PhysRevResearch.3.033248.

5. B. Lawrie, R. Pooser, P. Maksymovych,
Squeezing noise in microscopy with quantum light:
Trends in Chemistry (2020) 10.1016/j.trechm.2020.06.003

6. S. M. Neumayer, S. Jesse, G. Velarde, A. L. Kholkin, I. Kravchenko, L. W. Martin, N. Balke, P. Maksymovych,
To switch or not switch – a machine learning approach for ferroelectricity,
Nanoscale Advances, 2 2063 (2020). 10.1039/C9NA00731H

7. F. Bao, R. Archibald, P. Maksymovych,
Levy backward SDE filter for jump diffusion processes and its applications in material sciences,
Communications in Computational Physics, 27 589 (2020). 10.4208/cicp.OA-2018-0238

8. J.A. Brehm, S. M. Neumayer, L. Tao, A. O'Hara, M. Chyasnavichus, M. A. Susner, M. A. McGuire, S. V. Kalinin, S. Jesse, P. Ganesh, S. T. Pantelides, P. Maksymovych, N. Balke,
Tunable quadruple-well ferroelectric van der Waals crystals,
Nature Materials, 19 43 (2020). 10.1038/s41563-019-0532-z

9. M. A. Susner, M. Chyasnavichyus, M. A. McGuire, P. Ganesh, and P. Maksymovych,

Transition metal thio- and selenophosphates as multi-Functional van der Waals layered materials,
Advanced Materials, 29 1602852 (2017). 10.1002/adma.201602852

10. J. Wang, D. C. Sorescu, S. Jeon, A. Belianinov, S. V. Kalinin, A. P. Baddorf, and P. Maksymovych,
Atomic intercalation to measure adhesion of graphene on graphite,
Nature Communications, 7 13263 (2016). 10.1038/ncomms13263

11. S. Jeon, P. W. Doak, B. G. Sumpter, P. Ganesh, P. Maksymovych,
Thermodynamic control of two-dimensional molecular ionic nanostructures on metal surfaces,
ACS Nano, 10 7821 (2016). 10.1021/acsnano.6b03492

12. Tselev, P. Yu, Y. Cao, L. R. Dedon, L. W. Martin, S. V. Kalinin, P. Maksymovych,
Microwave ac conductivity of domain walls in ferroelectric thin films,
Nature Communications, 7 11630 (2016). 10.1038/ncomms11630

13. M. A. Susner, A. Belianinov, A. Borisevich, Q. He, M. Chyasnavichyus, H. Demir, D. S. Sholl, P. Ganesh, D. L. Abernathy, M. A. McGuire, P. Maksymovych,
High-T_c Layered ferrielectric crystals by coherent spinodal decomposition,
ACS Nano, 9 12365 (2015). 10.1021/acsnano.5b05682

14. P. Maksymovych, S. J. Kelly, J. I. Cerda,
Surface-state enhancement of tunneling thermopower on the Ag(111) Surface,
ACS Nano, 8 12110 (2014). 10.1021/nn506123g

15. P. Maksymovych, S. Jesse, P. Yu, R. Ramesh, A. P. Baddorf, S. V. Kalinin,
Polarization control of electron tunneling into ferroelectric surfaces,
Science, 324 1421 (2009), 10.1126/science.1171200

16. P. Maksymovych, D. C. Sorescu, K. D. Jordan, J. T. Yates, Jr.,
Collective reactivity of molecular chains self-assembled on a surface,
Science, 322 1664 (2008)
10.1126/science.1165291

Invited book chapters

1. ***Nanoscale ferroelectric switching - a method to inject and study non-equilibrium domain walls***: A. Ievlev, A. Tselev, R. Vasudevan, S. Kalinin, A. Morozovska, P.

Maksymovych, "Domain Walls: From Fundamental Properties to Nanotechnology Concepts" by Oxford Scientific, ISBN: 9780198862499.

2. ***Landau-Ginzburg-Devonshire theory for the domain wall conduction and observation of the microwave conduction of domain walls***: Tselev, A. Ievlev, R. Vasudevan, S. Kalinin, P. Maksymovych, A. N. Morozovska, "Domain Walls: From Fundamental Properties to Nanotechnology Concepts" by Oxford Scientific, ISBN: 9780198862499.
3. ***Scanning Probe Microscopy – Forces and Currents in the Nanoscale World***: B. J. Rodriguez, R. Proksch, P. Maksymovych, S. V. Kalinin, "Handbook of Nanoscopy", DOI: 10.1002/9783527641864.ch16
4. ***Excitation and Mechanisms of Single Molecule Reactions in Scanning Tunneling Microscopy***, P. Maksymovych in "Scanning Probe Microscopy of Functional Materials", Springer 2011, Part1, 3-37, DOI: 10.1007/978-1-4419-7167-8_1

Select invited talks: (>30)

Tunneling Andreev Reflection for quantitative microscopy of superconductors with atomic resolution, Electronic Materials and Applications (EMA) 2023, January, Orlando, Florida, 2023

The Multiwells: Switching Portraits of the Thiophosphate Family, International Symposium on Ferroic Domains & Micro- to Nanoscopic Structures, Kofu, Japan, August 2022.

Navigating atomic scale disorder with correlative tunneling microscopy and machine learning, American Physical Society March Meeting 2021

Ferroics Meet Ionics in the land of van der Waals, VIRTUAL 21st IEEE International Conference on Nanotechnology, Montreal CA, 2021

Using forces and data to understand disorder in unconventional superconductors, Electronic Materials and Applications 2020, Orlando, Florida.

Ferroelectric domain walls: from conductors to insulators and back again, Deutsche Physikalische Gesellschaft spring meeting 2017, Dresden, Germany

To switch or not to switch: another probe microscopy perspective, Ferro2016, 27th Annual Workshop on Fundamental Physics of Ferroelectircs, Washington, D.C. 2016

Taking control of the nanoscale with scanning programming microscopy, Peter Mark Memorial Award Lecture, 62nd Symposium of the American Vacuum Society, *San Jose, CA,* October, 2015.

Epitaxial growth of ionic molecules: our quest for electron spectroscopy of superatoms, Gordon Research Conference on Conductivity & Magnetism in Molecular Materials, Lewiston, ME, August 2014.

A Transport perspective on local manipulation of ferroelectric and complex oxide surfaces, American Physical Society March Meeting, 2013, Baltimore, MD

Patents

1. *Truncated Non-linear Interferometer-based Sensor System*, R. C. Pooser, B. J. Lawrie, P. Maksymovych, US Patent 20210405503A1
2. *Microwave AC conductivity of domain walls*, P. Maksymovych, A. Tselev, S. V. Kalining, US Patent 10160645B2
3. *Self-assembly patterning of organic molecules on a surface*, P. Maksymovych, M. A. Fuentes-Cabrera, B. G. Sumpter, M. Pan, Q. Li, US Patent: 9,610,608 (2017).
4. *Electronic Thermometry in Tunable Tunnel Junction*, P. Maksymovych, US Patent: 9,285,279, (2016)
5. *Single Contact Tunneling Thermometry*, P. Maksymovych, US Patent: 9,267,851, (2016)
6. *Real space mapping of oxygen vacancy diffusion and electrochemical transformations by hysteretic current reversal curve measurements*, S. V. Kalinin, N. Balke, Albina Y. Borisevich, Stephen Jesse, P. Maksymovych, Y. Kim, E. Strelcov, US Patent: 8,752,211 (2014)

Refereeing activities

- Referee in Nature (Nanotechnology, Communications, Scientific Reports, Computational Materials, Quantum Materials), Science, Journal of the American Chemical Society, Physical Review Letters, Physical Review B, Advanced Functional Materials, Surface Science, ACS Nano, ACS Applied Materials and Interfaces, Nanotechnology, Physical Chemistry Chemical Physics, Physica Status Solidi, Journal of Physics D, Chemical Reviews, Langmuir
- Referee of research grant proposals from DOE Office of Science, DOE and NSF Early Career Programs, DOE SBIR initiatives, Israel-US joint grant intiatives

Postdoctoral Scholars Advised:

1. **Geoffrey Rojas**, Ph. D. U Nebraska → Research Scientist at University of Minnesota
2. **Simon Kelly**, Ph. D. Leiden University → Staff Scientist at Lord Corporation
3. **Seokmin Jeon**, Ph. D. CalTech → Research Analyst at Institute for Defense Analyses
4. **Marius Chyasnavichus**, Ph. D. Clemson University → Research Scientist at Dow Chemical
5. **Jun Wang**, Ph. D. University of New Hampshire → Research Scientist at Cargill
6. (co-Advisor) **Sabine Neumayer**, Ph. D. University College, Dublin
   - 2018 Vacuum Society Poster Award
   - 2018 Material Research Society Spring Meeting NM11 Best Presentation Award Gold
   - 2020 Outstanding Presentation Award, Fundamental Physics of Ferroelectrics and Related Materials Workshop
7. **Sang Yong Song** (present), Ph. D. Daegu Gyeongbuk Institute of Science and Technology, South Korea
8. **Olha Popova** (present), Ph. D. University of Basel, Switzerland.

Students co-Advised:

1. **Nora Bauer** (University of Tennessee, Knoxville)
2. **Nickolay Borodinov** (Clemson University) → data scientist at Siemens
3. **Stuart Burns** (UNSW, Australia) → postdoctoral researcher at U. of Calgary, Canada

Collaborators:

Jose Lado, Aalto Univ. (Finland),
Matthew Marinella, Arizona State Univ.,
Maxim Lavrentovich, University of Tennessee, Knoxville,
Dan C. Sorescu, National Energy Technology Laboratory;
Alec Talin, Sandia National Laboratory
Oleksandr Voznyy, University of Toronto, Cananda;
Michael Shatruk, Florida State University
Gang Wang, Institute of Physics, Beijing, China
Michael Sunser, US Air Force
Anna N. Morozovska, V. Lashkaryov, Institute for Semiconductor Physics, Ukraine;
Ramamoorthy Ramesh, Rice University
Ryan Baumbach, Florida State University
Lane W. Martin, University of California, Berkeley;
John A. Schlueter, Argonne National Laboratory;
Sokrates Pantelides, Vanderbilt University;
Feng Bao, Florida State University
Andrius Dziaugys, Vilnius University, Lithuania

List of all publications since 2001 (>130 , h-index 47)

1. W. Ko, S. Y. Song, J. Yan, J. L. Lado, P. Maksymovych, ***Atomic-Scale Andreev Probe of Unconventional Superconductivity***, Nano Letters, 23 (2023) 8310, 10.1021/acs.nanolett.3c02658
2. S. N. Neumayer, N. Bauer, S. Basun, B. S. Conner, M. A. Susner, M. O. Lavrentovich, P. Maksymovych, ***Dynamic stabilization of metastable states in triple-well ferroelectric $Sn_2P_2S_6$***, Advanced Materials, 35 (2023) 2211194.
3. S. Y. Song, C. Hua, L. Bell, W. Ko, H. Fangohr, J. Yan, G. B. Halász, E. F. Dumitrescu, B. J. Lawrie, P. Maksymovych, ***Nematically Templated Vortex Lattices in Superconducting FeSe***, *Nano Letters 23 (2023)* 2822.
4. J. S. Vetter, P. Date, F. Fahim, S. R. Kulkarni, P. Maksymovych, A. A. Talin, M. Gonzalez Tallada, P. Vanna-iampikul, A. R. Young, D. Brooks, Y. Cao, Wei Gu-Yeon, S. K. Lim, F. Liu, M. Marinella, B. Sumpter, N. R. Miniskar, Abisko: Deep codesign of an architecture for spiking neural networks using novel neuromorphic materials, The International Journal of High Performance Computing 37, (2023), 351-379.
5. N. Bauer, S. M. Neumayer, P. Maksymovych, M. O. Lavrentovich,***Structures and velocities of noisy ferroelectric domain walls***, Physical Review Materials 6 (2023) 124401.

6. S. M. Neumayer, A. V. Ievlev, A. Tselev, S. A. Basun, B. S. Conner, M. A. Susner, P. Maksymovych, ***Polarization-controlled volatile ferroelectric and capacitive switching in $Sn_2P_2S_6$,*** *Neuromorphic Computing and Engineering, 3 (2023) 014005.*
7. W. Ko, J.L. Lado, P. Maksymovych, ***Non-contact Andreev reflection as a direct probe of superconductivity on the atomic scale***, Nano Letters, 22 (2022) 4042-4048.
8. K. P. Kelley, S. V. Kalinin, E. Eliseev, S. Raghuraman, S. Jesse, P. Maksymovych, A. N. Morozovska, ***Probing Temperature-Induced Phase Transitions at Individual Ferroelectric Domain Walls***, Advanced Electronic Materials, 9 (2023) 10.1002/aelm.202200552
9. O'Hara, L. Tao, S. M. Neumayer, P. Maksymovych, N. Balke, S. T. Pantelides, ***Effects of thin metal contacts on few-layer van der Waals ferrielectric $CuInP_2S_6$***, Journal of Applied Physics 132 (2022) 114102 – Editor's highlight.
10. P. Maksymovych, J. Yan, B. Sales, J. Wang, ***Atomic-scale analysis of disorder by similarity learning from tunneling spectroscopy***, Physical Review Research, 4 (2022) 033058.
11. S. R. Burns, A. Tselev, A. V. Ievlev, J. C. Agar, L. W. Martin, S. V. Kalinin, D. Sando, P. Maksymovych, ***Tunable Microwave Conductance of Nanodomains in Ferroelectric $PbZr_{0.2}Ti_{0.8}O_3$ Thin Film***, *Advanced Electronic Materials, 2022, 8, 2100952*
12. M. Checa, X. Jin, R. Millan-Solsona, S. M. Neumayer, M. A. Susner, M. A. McGuire, A. O'Hara, G. Gomila, P. Maksymovych, S. T. Pantelides, L. Collins, ***Revealing Fast Cu-Ion Transport and Enhanced Conductivity at the $CuInP_2S_6$-$In_{4/3}P_2S_6$ Heterointerface***, *ACS Nano (2022) DOI: 10.1021/acsnano.2c06992*
13. M. Checa, I. Ivanov, S. M. Neumayer, M. A. Susner, M. A. McGuire, P. Maksymovych, L. Collins, ***Correlative piezoresponse and micro-Raman imaging of $CuInP_2S_6$–$In_{4/3}P_2S_6$ flakes unravels phase-specific phononic fingerprint via unsupervised learning***, Appl. Phys. Lett. 121 (2022) 062901.
14. S. M. Neumayer, Z. Zhao, A. O'Hara, M. A. McGuire, M. A. Susner, S. T. Pantelides, P. Maksymovych, and N. Balke, ***Nanoscale Control of Polar Surface Phases in Layered van der Waals $CuInP_2S_6$***, *ACS Nano* (**2022**) *16,* 2452-2460
15. S. M. Neumayer, M. Si, J. Li, P.-Y. Liao, L. Tao, A. O'Hara, S. T. Pantelides, P. D. Ye, P. Maksymovych, N. Balke, ***Ionic Control over Ferroelectricity in 2D Layered van der Waals Capacitors***, *ACS Applied Materials & Interfaces* (**2022**) *14*, 3018.
16. K. P Kelley, A. N. Morozovska, E. A. Eliseev, V. Sharma, D. E. Yilmaz, A. CT van Duin, P. Ganesh, A. Borisevich, S. Jesse, P. Maksymovych, N. Balke, S. V. Kalinin, R. K. Vasudevan
17. ***Oxygen Vacancy Injection as a Pathway to Enhancing Electromechanical Response in Ferroelectrics***, *Advanced Materials (2022) 34, 2106426.*
18. *E. A. Eliseev, M. D. Glinchuk, L. P. Yurchenko, P. Maksymovych, A. N. Morozovska,* ***Phase Transitions in Ferroelectric Domain Walls***, *Condensed Matter Physics, 25 (2022) 43706.*
19. M. Checa, S. M. Neumayer, M. A. Susner, M. A. McGuire, P. Maksymovych, and L. Collins , ***Simultaneous mapping of nanoscale dielectric, electrochemical, and ferroelectric surface properties of van der Waals layered ferroelectric via advanced SPM***, *Appl. Phys. Lett. (2021) 119, 252905*

20. M. Yelisieiev, P. Maksymovych, A. N. Morozovska, ***Probing phonon softening in ferroelectrics by scanning probe microwave spectroscopy,*** *Phys. Rev. B (2021) 104, 174105*
21. E. Lerner, A. Flores-Garibay, B. J. Lawrie, P. Maksymovych, ***Compressed sensing for scanning tunnel microscopy imaging of defects and disorder,*** *Phys. Rev. Research (2021) 3, 043040.*
22. A.N. Morozovska, E. A. Eliseev, S. V. Kalinin, Y. M. Vysochanskii, P. Maksymovych, ***Stress-induced phase transitions in nanoscale $CuInP_2S_6$,*** *Phys. Rev. B (2021) 104, 054102.*
23. S. M. Neumayer, M. A. Susner, M. A. McGuire, S. T. Pantelides, S. Kalnaus, P. Maksymovych, N. Balke, ***Lowering of Tc in van der Waals Layered Materials Under In-plane Strain***, IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, 68 (2021) 253-258.
24. W. Ko, E. F. Dumitrescu, P. Maksymovych, ***Statistical detection of Josephson, Andreev and single quasiparticle currents in scanning tunneling microscopy****, Physical Review Research (2021), 3, 033248.*
25. A. N. Morozovska, E. N. Eliseev, K. Kelly, Y. M. Vysochanskii, S. V. Kalinin, P. Maksymovych, ***Phenomenological description of bright domain walls in ferroelectric-antiferroelectric layered chalcogenide****, Phys. Rev. B (2020), 102, 174108.*
26. S. M. Neumayer, J. A. Brehm, L. Tao, A. O'Hara, P. Ganesh, S. Jesse, M. A. Susner, M. A. McGuire, P. Maksymovych, S. T. Pantelides, N. Balke, ***The concept of negative capacitance in ionically conductive van der Waals ferroelectrics****, Advanced Energy Materials (2020), 10, 2001726.*
27. S. M. Neumayer, J. A. Brehm, L. Tao, A. O'Hara, P. Ganesh, S. Jesse, M. A. Susner, M. A. McGuire, S. T. Pantelides, P. Maksymovych, N. Balke, ***Local strain and polarization mapping in ferrielectric materials****, ACS Appl. Mater. Interfaces (2020), 12, 38546.*
28. B. Lawrie, R. Pooser, P. Maksymovych, ***Squeezing noise in microscopy with quantum light****, Trends in Chemistry (2020) DOI: 10.1016/j.trechm.2020.06.003.*
29. S. M. Neumayer, S. Jesse, G. Velarde, A. L. Kholkin, I. Kravchenko, L. W. Martin, N. Balke, P. Maksymovych, ***To switch or not switch – a machine learning approach for ferroelectricity****, Nanoscale Advances (2020), 2, 2063.*
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List of Invited talks:

1. **Multimodal microscopy for intrinsic dynamics of neuromorphic materials,** SPIE Optics + Photonics, San Diego, August 2023.
2. **Tunneling Andreev Reflection for quantitative microscopy of superconductors with atomic resolution**, Electronic Materials and Applications (EMA) 2023, January, Orlando, Florida, 2023
3. **Phase transitions through the looking glass: new methods to probe ferroelectricity and superconductivity,** Joint Vanderbilt/ORNL workshop, University of Vanderbilt, November 2022.
4. **The Multiwells: Switching Portraits of the Thiophosphate Family**, International Symposium on Ferroic Domains & Micro- to Nanoscopic Structures, Kofu, Japan, August 2022.

5. **Navigating disorder spaces of superconductors using atomic-scale imaging,** Electronics Materials and Applications 2021, American Ceramic Society.
6. **Navigating atomic scale disorder with correlative tunneling microscopy and machine learning**, APS March Meeting 2021.
7. **Ferroics Meet Ionics in the land of van der Waals**, VIRTUAL 21st IEEE International Conference on Nanotechnology, Montreal CA
8. **Using forces and data to understand disorder in unconventional superconductors**, Electronic Materials and Applications 2020, Orlando, Florida.
9. **Nanoscale Ferroelectricity Beyond Size Effects**, Taiwan Semiconductor Manufacturing Company, April 2018
10. **Stitching Complex Materials with Metal Thiophosphates**, Annual meeting of the Appalachian Regional Microscopy Society, Boone, NC, Oct. 2018
11. **Reanimating Atoms, Molecules and Topological Defects**, Washington University in St. Louis, September 2018.
12. **Charting the future for Tennessee Valley AVS Chapter**, AVS Board of Director's Meeting, Raleigh, NC, January 2018
13. **Sorting through the nanoscale with more dimensions, better observables and smarter sampling**, Center for Nanophase Materials Sciences Seminar, January 2018
14. **Ferroelectric domain walls: from conductors to insulators and back again**, Deutsche Physikalische Gesellschaft spring meeting 2017, Dresden, Germany
15. **Toward programmable matter at the nanoscale**, 63rd Symposium of the American Vacuum Society, Nashville, TN, October, 2016. Symposium in honor of Prof. John T. Yates, Jr.
16. **Nanoscale control of phase transitions as a pathway to precise material manipulation**, Electronic States and Phases Induced by Electric or Optical Impacts, IMPACT 2016, Cargese, France, August-September, 2016.
17. **Taking control of the nanoscale with scanning programming microscopy**, Peter Mark Memorial Award Lecture, 62nd Symposium of the American Vacuum Society, San Jose, CA, October, 2015.
18. **Electrostatic Control of Low Dimensional Molecular Ionic Assemblies**, 11th International Symposium on Crystalline Organic Metals, Superconductors and Magnets, Bad Goegging, Germany, September, 2015.
19. **Local Manipulation of Electronic Transport and Atomic Structure in Ferroelectric and Complex Oxides**, 42nd Conference on the Physics and Chemistry of Surfaces and Interfaces (PSCI-42), Snow Bird, Utah, January 2015.
20. **Taking control of the nanoscale with scanning programming microscopy**, Drexel University, February 2015.
21. **Epitaxial growth of ionic molecules: our quest for electron spectroscopy of superatoms**, Gordon Research Conference on Conductivity & Magnetism in Molecular Materials, Lewiston, ME, August 2014.
22. **Novel properties of topological defects in proper and improper ferroelectrics**, CIMTEC 2014, Montecatini-Terme, Italy, June, 2014.
23. **To Switch or not to Switch: A Probe Microscopy Perspective**, Materials Science & Technology Conference, MS&T 2013, Montreal, Canada, October 2013

24. **A Transport perspective on Local Manipulation of Ferroelectric and Complex Oxide Surfaces**, American Physical Society March Meeting, 2013, Baltimore, MD
25. **A Transport perspective on Local Manipulation of Ferroelectric and Complex Oxide Surfaces**, XXI International Materials Research Congress (IMRC) 2012, Cancun, Mexico, August 2012
26. **Nanoscale Transport through Ferroelectric and Metal Surfaces**, Nanoscience colloquium at Vanderbilt University, Nashville, TN, 2012
27. **Topological Size-effects in Polarization-controlled Transport through Ferroelectric Surfaces**, 2011 Spring Meeting of the Materials Research Society, San Francisco, CA
28. **Local Polarization-dependent Electron Transport Through Ferroelectric and Multiferroic Surfaces**, 2010 Spring Meeting of the Materials Research Society, San Francisco, CA
29. **Local Ferroelectric Switching and Size-effect of $BiFeO_3$ Films in Ultra-High Vacuum Down to 4 Unit Cells**, 2010 Spring Meeting of the Materials Research Society, San Francisco, CA
30. **Polarization-dependent Electron Tunneling into Ferroelectric Surfaces**, 2009 International Symposium on Integrated Ferroelectrics, Colorado Springs, CO
31. **Polarization-dependent Electron Transport Through Ferroelectric and Multiferroic Surfaces**, 2009 physical sciences colloquium at the North Carolina State University, Raleigh, NC
32. **Intrinsic Polarization Dynamics and Disorder Effects by Ultra-High Vacuum Piezoresponse Force Microscopy**, 2009 Spring Meeting of the Materials Research Society, San Francisco, CA
33. **Imaging Hot-electron Transport using Scanning Tunneling Microscopy**, physical sciences colloquium at the University of Tennessee, Knoxville, 2008.
34. **Imaging Hot-electron Transport using Chemical Reactions in Scanning Tunneling Microscopy**, American Physical Society March Meeting, New Orleans 2008.
35. **The Role of Au(111) Herringbone Reconstruction as a Stress-landscape and Source of Adatoms**, Center for Individual Nanoparticle Functionality, Technical University of Denmark, Lyngby, Denmark, 2006.
36. **Adatom-mediated Chemistry in Self-assembled Monolayers of Alkanethiols on Au(111)**, University of Toronto, Canada 2006.