

Nikolay T. Garabedian, Ph.D.

Personal Details:

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Professional Experiences:

Karlsruhe Institute of Technology (KIT) **Karlsruhe, Germany** **June 2019 - Present**
Group Leader: Christian Greiner, Ph.D. IAM-CMS Materials Tribology Group

Alexander von Humboldt Research Fellow January 2021 - December 2022

- Machine learning analysis techniques for experimental tribology and material science
- Metals tribology and microstructural evolution of critical industrially-relevant components

Postdoctoral Research Assistant June 2019 - December 2020

- Full digitalization, data management of scientific lab activities for the age of data science
- *In-situ* XRD measurements of copper under tribological loads and machine learning analysis thereof

Master's Thesis Adviser January 2020 - Present

- Julius Heinrich, M.Sc.: *A tribometer for studying in-situ wear and microstructural evolution of copper*
- Max Gorenflo, B.Sc.: *Paired load and velocity influence on friction and wear of metal surfaces*

University of Delaware **Newark, Delaware, USA** **August 2014 - June 2019**

Graduate Research Assistant *Doctoral Advisor: David L. Burris, Ph.D.*

Doctoral research: A direct experimental link between atomic-scale and macroscale friction

- End-to-end design, evaluation and application of laboratory measurement equipment
- Traceable lateral force calibration techniques for AFM and tribometry across all scales
- AFM at the macroscale: methods to fabricate and calibrate probes for millinewton force measurements
- Quantifying, locating, and following asperity scale wear within macroscale contact areas

Collaborative projects:

- Predicting bearing loads in wind turbine drivetrains (*Argonne National Laboratories*)
- In-situ observations of DLC transfer film formation (*Carpick group at University of Pennsylvania*)
- Mechanical characterization of hydrogel scaffolds for tissue engineering (*Jia group at Uni. Delaware*)
- QCM-integrated microtribometry for characterization of MoS₂ (*Borowski group at St. Olaf College*)
- Mechanical characterization of hydrogel spheres for drug delivery (*Kloxin group at Uni. Delaware*)
- Durability of PEDOT coatings for biodevices (*Martin group at Uni. Delaware*)
- Tribology of polymer blend coatings (*Epps group at Uni. Delaware*)

Graduate Teaching Assistant: Materials Engineering (a 3rd-year Class) August - December 2014

IBM India Research Laboratory **New Delhi, India** **June - August 2013**

Research Assistant - Intern

- Trained algorithms to extract features from A-V data in real time
- Project: Artificial intelligence for mobile sensing in *Smarter Cities*

Union College **Schenectady, NY, USA** **June 2012 - March 2013**

Research Assistant

- Effect of posterior curvature on the bending strength of maxillary canines in cercopithecoid monkeys
- Effect of head-carrying on cranial deformation and morphology

Education:

University of Delaware Ph.D. in Mechanical Engineering <i>Topic: A direct experimental link between atomic-scale and macroscale friction</i> <i>Advisor: David L. Burris, Ph.D.</i>	2014 - 2019 Newark, DE, USA
Union College B.S. in Mechanical Engineering (Hon.) <i>Economics Minor</i> <i>Union Scholars Program, Cum Laude</i> <i>Pi Tau Sigma Mechanical Engineering Honorary Society</i>	2010 - 2014 Schenectady, NY, USA
Plovdiv Language High School <i>English and German Language Program</i> <i>Languages: Bulgarian (native), English (full professional proficiency), German and Russian (intermediate proficiency)</i>	2005 - 2010 Plovdiv, Bulgaria

Refereed Publications:

Published

1. **Traceable Lateral Force Calibration (TLFC) for Atomic Force Microscopy**, Arnab Bhattacharjee (co-lead author), Nikolay T. Garabedian (co-lead author), Christopher L. Evans, David L. Burris, *Tribology Letters*, **2020**, 68:111, DOI: [10.1007/s11249-020-01349-y](https://doi.org/10.1007/s11249-020-01349-y)
2. **Integrated QCM-microtribometry: friction of single-crystal MoS₂ and gold from μm/s to m/s**, Brian P Borovsky (co-lead author), Nikolay T Garabedian (co-lead author), Gabriel R McAndrews, Raymond J Wieser, David L Burris, *ACS Applied Materials & Interfaces*, **2019**, 11 (43), 40961-40969 DOI: [10.1021/acsami.9b15764](https://doi.org/10.1021/acsami.9b15764)
3. **Durability of Poly(3,4-ethylene dioxythiophene) (PEDOT) films on metallic substrates for bioelectronics and the dominant role of relative shear strength**, Jing Qu, Nikolay T Garabedian, David L Burris, David C Martin, *Journal of Mechanical Behavior of Biomedical Materials*, **2019**, 100, pp 103376, DOI: [10.1016/j.jmbbm.2019.103376](https://doi.org/10.1016/j.jmbbm.2019.103376)
4. **Quantifying, locating, and following asperity scale wear within macroscale contact areas**, Nikolay T Garabedian, Arnab Bhattacharjee, Martin N. Webster, Gary L. Hunter, Peter W. Jacobs, Andrew R. Konicek, David L. Burris, *Tribology Letters*, **2019**, 67:89, DOI: [10.1007/s11249-019-1203-6](https://doi.org/10.1007/s11249-019-1203-6)
5. **Spatial patterning of molecular cues and vascular cells in fully integrated hydrogel channels via interfacial bioorthogonal crosslinking**, Kevin. T. Dicker, Axel. C. Moore, Nikolay T. Garabedian, Han Zhang, Samuel L. Scinto, Robert E. Akins, David L. Burris, Joseph M. Fox, and Xinqiao Jia, *ACS Appl. Mater. Interface*, **2019**, 11 (18), 16402-16411, DOI: [10.1021/acsami.9b04383](https://doi.org/10.1021/acsami.9b04383)
6. **Mechanical and compositional characterization of thick tribofilms formed from silicon- and oxygen-containing hydrogenated amorphous carbon**, J.B. McClimon, A.C. Lang, Z. Milne, N.T. Garabedian, A.C. Moore, J. Hilbert, F. Mangolini, J.R. Lukes, D.L. Burris, M.L. Taheri, J. Fontaine, R.W. Carpick, *Tribology Letters*, **2019**, 67(2), DOI: [10.1007/s11249-019-1155-x](https://doi.org/10.1007/s11249-019-1155-x)
7. **AFM at the macroscale: methods to fabricate and calibrate probes for millinewton force measurements**, Nikolay T Garabedian, Harman S Khare, Robert W Carpick, David L Burris, *Tribology Letters*, **2019** 67: 21, DOI: [10.1007/s11249-019-1134-2](https://doi.org/10.1007/s11249-019-1134-2)
8. **The cause of premature wind turbine bearing failures: overloading or underloading?**, Nikolay T Garabedian, Benjamin J Gould, Gary L Doll, David L Burris, *Tribology Transactions*, 61:5, 850-860, **2018**, DOI: [10.1080/10402004.2018.1433345](https://doi.org/10.1080/10402004.2018.1433345)

- **2020 Wilbur Deutsch Memorial Award**, STLE Awards Committee, May 2020
 - **Editor's Choice paper in Tribology & Lubrication Technology**, July 2018, pp 60-74
9. **Exploiting feedstock diversity to tune the chemical and tribological properties of lignin-inspired polymer coatings**, Jillian A Emerson, [Nikolay T Garabedian](#), Axel C Moore, David L Burris, Eric M Furst, Thomas H Epps III, *ACS Sustainable Chem. Eng.*, **2018**, 6 (5), pp 6856–6866, DOI: [10.1021/acssuschemeng.8b00667](https://doi.org/10.1021/acssuschemeng.8b00667)
 10. **Unexpected tribological synergy in polymer blend coatings: leveraging phase separation to isolate domain size effects and reduce friction**, Jillian A Emerson, [Nikolay T Garabedian](#), Axel C Moore, David L Burris, Eric M Furst, Thomas H Epps III, *ACS Appl. Mater. Interfaces*, **2017**, 9 (39), pp 34480–34488, DOI: [10.1021/acsami.7b10170](https://doi.org/10.1021/acsami.7b10170)

Other Archival Publications:

1. **Data science techniques applied to *in-situ* XRD measurements of copper under tribological load**, [Nikolay Garabedian](#), Patric Gruber, Christian Greiner, *World Tribology Congress 2021* (in review)
2. **Measuring friction at a single interface with two independent microtribometers: A model study with alumina spheres on gold or single-crystal MoS₂**, Brian P Borovsky, [Nikolay T Garabedian](#), Gabriel R McAndrews, Raymond J Wieser, David L Burris, *Tribology Frontiers Conference 2019*
3. **Bridging the Tribometry Gap**, [Nikolay Garabedian](#) and David Burris, *Tribology & Lubrication Technology*, March 2019
4. **The Cause of Premature Wind Turbine Bearing Failures: Overloading or Underloading?**, [Nikolay T Garabedian](#), Benjamin J Gould, Gary L Doll, David L Burris, *Tribology & Lubrication Technology*, pp 60-74, July 2018
5. **Effect of posterior curvature on the bending strength of maxillary canines in cercopithecoid monkeys**, Andrew J Rapoff, [Nikolay T Garabedian](#), Scott Mcgraw, David J Daegling, *American Journal of Physical Anthropology*, 2013, 150 p. 229

Patents:

1. **Frictionless Wedge and Reference Spring** for Lateral Force AFM Calibration, David L Burris and Nikolay T Garabedian, US 62/674,042, 21 May 2018, *Provisional*

ARCHIVAL ABSTRACTS:

Oral Presentations:

1. **Data science techniques applied to *in-situ* XRD measurements of copper under tribological load**, Nikolay T Garabedian, Patric Gruber, Christian Greiner, *MSE 2020*, Darmstadt (online), September 2020
2. **Sliding over 10,000 Times Faster: QCM-Integrated Microtribometry to Probe Friction Fundamentals via Gold and Single-Crystal MoS₂**, Nikolay T Garabedian, R.J. Wieser, G.R. McAndrews, Brian P. Borovsky, David L Burris, *2019 STLE Annual Meeting*, Nashville TN, May 2019
3. **Linking macro-scale and atomic-scale friction**, Nikolay T Garabedian and David L Burris, *2019 STLE Annual Meeting*, Nashville TN, May 2019
4. **Sliding over 10,000 Times Faster: QCM-Integrated Microtribometry to Probe Friction Fundamentals via Gold and Single-Crystal MoS₂**, Nikolay T Garabedian, Brian P. Borovsky, David L Burris, *2019 MRS Spring Meeting*, Phoenix AZ, April 2019

5. **How to Mitigate Friction and Wear?**, Nikolay T Garabedian and David L Burris, *University of Delaware Graduate Student Forum*, Newark DE, April 2019
6. **Sliding over 10,000 Times Faster: QCM-Integrated Microtribometry to Probe Friction Fundamentals via Gold and Single-Crystal MoS₂**, Nikolay T Garabedian, R.J. Wieser, G.R. McAndrews, Brian P. Borovsky, David L Burris, *2019 MRS Spring Meeting*, Phoenix AZ, April 2019
7. **A direct experimental link between atomic-scale and macroscale friction**, Nikolay T Garabedian, David L Burris, *Tribology Frontiers Conference*, October 2018
8. **A direct experimental link between atomic-scale and macroscale friction**, Nikolay T Garabedian, Harman S Khare, Robert W Carpick, David L Burris, *Tribology Gordon Research Seminar*, Lewiston ME, June 2018
9. **Linking macro-scale and atomic-scale friction**, Nikolay T Garabedian and David L Burris, *2018 STLE Annual Meeting*, Minneapolis MN, May 2018
10. **Challenges in developing more efficient and reliable tribological systems**, Nikolay T Garabedian and David L Burris, *University of Delaware Graduate Student Forum*, Newark DE, April 2018
11. **A direct experimental link between atomic-scale and macro-scale**, Nikolay T Garabedian and David L Burris, *University of Delaware Graduate Student Forum*, Newark DE, April 2017
12. **Relating wear uncertainties to material characteristics through interrupted topography measurements**, Nikolay T Garabedian and David L Burris, *2016 STLE Annual Meeting*, Las Vegas NV, May 2016
13. **Analysis of planetary bearing under-loading in wind turbines**, Nikolay T Garabedian, Benjamin J Gould, David L Burris, *University of Delaware Graduate Student Forum*, Newark DE, April 2016
14. **Quantifying wear volume uncertainty based on interrupted topography measurements**, Nikolay T Garabedian, Harman S Khare, David L Burris, *Tribology Frontiers Conference*, Denver CO, October 2015
15. **Analysis of planetary bearing under-loading in wind turbines**, Nikolay T Garabedian, Benjamin J Gould, David L Burris, *Tribology Frontiers Conference*, Denver CO, October 2015
16. **Quantifying wear volume uncertainty based on interrupted topography measurements**, Nikolay T Garabedian, Harman S Khare, David L Burris, *University of Delaware Graduate Student Forum*, Newark DE, April 2015
17. **Quantifying and tracking the life of an asperity subject to tribological contact**, Arnab Bhattacharjee, Nikolay T Garabedian, David L Burris, *2019 STLE Annual Meeting*, Nashville TN, May 2019
18. **Quantifying and tracking asperity scale wear during microscale wear measurements**, Arnab Bhattacharjee, Nikolay T Garabedian, David L Burris, *Tribology Frontiers Conference*, October 2018
19. **Methods to study the life of an asperity subject to tribological contact**, Arnab Bhattacharjee, Nikolay T Garabedian, David L Burris, *2019 STLE Annual Meeting*, Nashville TN, May 2019
20. **Methods to study the life of an asperity subject to tribological contact**, Arnab Bhattacharjee, Nikolay T Garabedian, David L Burris, *2018 STLE Annual Meeting*, Minneapolis MN, May 2018
21. **Evaluating transfer film wear rates of polymeric solid lubricants**, Kazi I Alam, Diana R Haidar, Juaxin Ye, Nikolay T Garabedian, David L Burris, *2017 STLE Annual Meeting*, Atlanta, GA, May 2017

Invited Presentations

22. **A direct experimental link between atomic-scale and macroscale friction**, Nikolay T Garabedian, David L Burris, *Philadelphia STLE Section Meeting*, Oreland PA, September 2018

Poster Presentations:

23. **Sliding over 10,000 Times Faster: QCM Integrated Microtribometry to Probe Friction Fundamentals via Gold and Single-Crystal MoS₂**, Nikolay T Garabedian, R.J. Wieser, G.R. McAndrews, Brian P. Borovsky, David L Burris, *Tribology Frontiers Conference*, Chicago IL, October 2018
24. **A direct experimental link between atomic-scale and macroscale friction**, Nikolay T Garabedian, Harman S Khare, Robert W Carpick, David L Burris, *Tribology Gordon Research Conference*, Lewiston ME, June 2018
25. **A direct experimental link between atomic-scale and macroscale friction**, Nikolay T Garabedian, Harman S Khare, Robert W Carpick, David L Burris, *Tribology Gordon Research Seminar*, Lewiston ME, June 2018
26. **A direct experimental link between atomic-scale and macroscale friction**, Nikolay T Garabedian and David L Burris, *2018 STLE Annual Meeting*, Minneapolis MN, May 2018 – **Gold Poster Presentation Award Winner**
27. **A new experimental approach to study micro and nano-scale friction**, Nikolay T Garabedian and David L Burris, *2017 STLE Annual Meeting*, Atlanta GA, May 2017
28. **Low wind speed as a paradoxical driver of premature bearing failure in wind turbines**, Nikolay T Garabedian, Benjamin J Gould, David L Burris, *2017 STLE Annual Meeting*, Atlanta GA, May 2017
29. **Quantifying wear volume uncertainty based on interrupted topography measurements**, Nikolay T Garabedian, Harman S Khare, David L Burris, *Tribology Frontiers Conference*, Denver CO, October 2015
30. **Quantifying wear volume uncertainty based on interrupted topography measurements**, Nikolay T Garabedian, Harman S Khare, David L Burris, *2015 STLE Annual Meeting*, Dallas TX, May 2015
31. **Traceable Lateral Force Calibration (TLFC) for Atomic Force Microscopy**, Arnab Bhattacharjee, Nikolay T Garabedian, David L Burris, *Tribology Frontiers Conference*, Chicago IL, November 2020 (online)
32. **Measuring friction at a single interface with two independent microtribometers: A model study with alumina spheres on gold or single-crystal MoS₂**, Brian P Borovsky, Nikolay T Garabedian, Gabriel R McAndrews, Raymond J Wieser, David L Burris, *Tribology Frontiers Conference 2019*, Chicago IL, October 2019
33. **Methods to study the life of an asperity subject to tribological contact**, Arnab Bhattacharjee, Nikolay T Garabedian, David L Burris, *2019 STLE Annual Meeting*, Nashville TN, May 2019
34. **A Microscale Study of Friction on Single-Crystal Molybdenum Disulfide Using a Combined Indenter Probe and Quartz Crystal Microbalance**, Gabriel McAndrews, Raymond Wieser, Nikolay T Garabedian, David L Burris, Brian Borovsky, *Tribology Frontiers Conference*, Chicago IL, October 2018
35. **Investigating Microscale Friction at High Sliding Speeds Using a Combined Indenter Probe and Quartz Crystal Microbalance** Brian Borovsky, Gabriel McAndrews, Raymond Wieser, Nikolay T Garabedian, David L Burris, *Tribology Frontiers Conference*, Chicago IL, October 2018
36. **Quantifying and Tracking Asperity Scale Wear During Microscale Wear Measurements**, Arnab Bhattacharjee, Nikolay T Garabedian, David L Burris, *Tribology Frontiers Conference*, Chicago IL, October 2018

37. **Investigating Microscale Friction at High Sliding Speeds Using a Combined Indenter Probe and Quartz Crystal Microbalance** Brian Borovsky, Gabriel McAndrews, Raymond Wieser, Nikolay T Garabedian, David L Burris, *AVS 65th International Symposium & Exhibition*, Long Beach CA, October 2018
38. **Lubricity of SiO_x-containing hydrogenated amorphous carbon (a-C:H:Si:O) probed at several lengthscales**, J.B. McClimon, A.C. Lang, Z. Milne, N. T. Garabedian, A.C. Moore, F. Mangolini, J.R. Lukes, D.L. Burris, J. Fontaine, R.W. Carpick, *Tribology Gordon Research Conference*, Lewiston ME, June 2018
39. **Quantifying the relationship between durability and adhesion of PEDOT on metallic substrates**, Jing Qu, Nikolay T Garabedian, David L Burris, David C Martin, *BioInterface Workshop & Symposium*, San Diego CA, October 2017

Awards and Fellowships:

1. **Alexander von Humboldt Postdoctoral Fellowship, January 2021 – December 2022**, Research Fellowship, Alexander von Humboldt Foundation, *Topic: Metals Tribology Revisited*
2. **Goethe Institut German Language Fellowship, September 2020 – December 2020**, Alexander von Humboldt Foundation, declined due to COVID-19 related amendments
3. **Robert W. Gore Fellowship, September 2018 – May 2019**, Dissertation Research Fellowship, College of Engineering, University of Delaware
4. **Philadelphia STLE Scholarship, July 2018**, STLE Local Chapter Award, *A direct experimental link between atomic-scale and macroscale friction*
5. **Elmer E. Klaus Fellowship, May 2018**, STLE Presidential Award, *A direct experimental link between atomic-scale and macroscale friction*
6. **Gold Poster Presentation Award, STLE Annual Meeting, May 2018**, *A direct experimental link between atomic-scale and macroscale friction*
7. **Professional Development Award, March 2018**, University of Delaware, Office of Graduate and Professional Education, *A direct experimental link between atomic-scale and macroscale friction*
8. **Poster Presentation Award, STLE Annual Meeting, May 2015**, *Quantifying Wear Volume Uncertainty Based on Interrupted Topography Measurements*
9. **Union College Presidential Scholarship, August 2010 – June 2014**, Union College
10. **Donald C. Brate '45 Scholarship, August 2010 – June 2014**, Union College
11. **International Scholarship, August 2010 – June 2014**, Union College

Outreach, Mentoring and Academic Involvement:

- Graduate Research Supervisor Karlsruhe, Germany 2019 - Current
 - Master's thesis adviser of KIT student
 - Julius Heinrich, M.Sc.
 - Topic: *Development of a reciprocating tribometer for studying in-situ wear and microstructural evolution of copper under a variable load*
 - Max Gorenflo, B.Sc.:
 - Topic: *Paired load and velocity influence on friction and wear of metal surfaces*

- Undergraduate Research Supervisor Newark, DE, USA 2014 - 2019
 - Trained and worked with a University of Delaware Mechanical Engineering undergraduate student – Brian Bell. He worked on designing precision tribometers and conducted multiple projects in the field of precision mechanical design.
- Journal Reviewer for: Measurement 2020 – Current
 - Journal of Materials Engineering and Performance 2020 - Current
 - ASTM Journal of Testing and Evaluation 2019 - Current
 - Tribology Letters 2018 - Current
 - Tribology Transactions 2018 - Current
- STLE Nanotribology Committee Vice Paper Solicitation Chair, Volunteer 2017 - Current
- Academic Opportunity Program Engineering Tutor Schenectady, NY, USA 2011 - 2013
 - The Academic Opportunity Program at Union College is aimed at supporting students who otherwise would not attend college. I tutored and advised in all engineering-related subjects for two years. Becoming a tutor in the program is based on recommendations and academic achievements.
- Engineers Without Borders Event Coordinator Schenectady, NY, USA 2011 - 2013
 - Scheduled, promoted and coordinated volunteering trips aimed at servicing the local community.
- ASME at Union College Help Center Manager Schenectady, NY, USA 2012 - 2013
- SAE Aero at Union College Team Captain Schenectady, NY, USA 2013 - 2014