Samuel E. Root, Ph.D.
Date: 5/27/26, **Cell:** 1-516-225-3044; **E-mail:** ser132@case.edu; **Web:** root-lab.net; LinkedIn; Google Scholar

RESEARCH INTERESTS

The Root Lab investigates multiscale phenomena at complex interfaces in functional macromolecular composites through synthesis, processing, characterization, and device prototyping for applications in electronics, robotics, energy, and health.

PROFESSIONAL EXPERIENCE

Present **Assistant Professor,** Macromolecular Science & Engineering, Case Western Reserve University
Principal Investigator of the Root Laboratory for Functional Macromolecular Composites
Teaching: Graduate: Electronic Properties of Polymers, Undergraduate: Polymer Analytical Laboratory

07-12/2024 **Scientific Consultant,** Thintronics Inc. Leading advanced materials characterization efforts:
Laser profilometry, electron microscopy, X-ray tomography, IR imaging, atomic force microscopy

2021-2024 **Postdoctoral Scholar,** Department of Chemical Engineering, Stanford University
Faculty Advisor: Zhenan Bao, Professor of Chemical Engineering, Chemistry, & Materials Science
Project: Investigation of electrical and mechanical self-healing in multilayered composites of immiscible dynamic polymers using modular synthesis, experimental characterization, and coarse-grained simulations.

2018–2021 **Postdoctoral Fellow,** Department of Chemistry & Chemical Biology, Harvard University
Faculty Advisor: George M. Whitesides, Woodford L. and Ann A. Flowers University Professor
Projects: Design of soft, adaptive systems for robotics and biomedical applications by leveraging the mechanical behavior of polymers. Physical-organic investigations of charge transport through self-assembled monolayers by combining modular synthesis and characterization with molecular simulations.

EDUCATION

2014–2018 **Ph.D. in Chemical Engineering**, University of California, San Diego, CA
Thesis: Mechanical Properties of Semiconducting Polymers
Faculty Advisor: Darren J. Lipomi, Professor of Nanoengineering
Faculty Collaborations: Gaurav Arya, Shirley Meng

2011– 2014 **B.S. in Chemical Engineering**, University of Rochester, NY
Minor in applied mathematics, *Highest Distinction in Chemical Engineering*
Faculty Adviser: Alexander Shestopolav, Professor of Chemical Engineering
External Advisor: Kenneth Marshall (Laboratory for Laser Energetics, Organic Optical Materials Group)

FELLOWSHIPS & AWARDS

Fellowships

Glennan Fellowship for teaching and scholarship, CWRU 2025-2026
Achievement Reward for College Scientists (ARCS) Fellowship, 2017-18
UC Presidents Dissertation Year Fellowship, 2017-18
UC San Diego Powell Fellowship, 2014-15

Awards

Corning Glass Age Runner-up Award ($30 000 research gift, based on written proposal), 2017-18
ACS Chemistry of Materials Lectureship & Paper of the Year Award, 2018
Participant in "Future Faculty Workshop: Diverse Leaders for the Future", summer 2023, Texas A&M
Participant in "Rising Stars in Soft and Biological Matter", Fall 2023, University of Chicago MRSEC
Young Alumni Award, University of Rochester, Department of Chemical Engineering, 2025
ACS Petroleum Research Fund, Doctoral New Investigator Award, 2026
Beckman Young Investigator Award, 2026-30

SELECTED MEDIA COVERAGE

- NSF Discoveries: Layers of self-healing electronic skin realign autonomously when cut
- Chemical & Engineering News: Glowing dyes could store digital data at low cost
- Current Science Daily: Harvard team designs soft robotic mechanism modeled from biology

PUBLICATIONS

Leading Author Journal Articles († indicates equal contribution) (Listed in Reverse Chronological Order)

1 **Root, S.E.**; Choi, H.; Wu, C.; Sun, E.; Ngaruka, G.; Park, H.; Ramos-Figueroa, A. L.; Berman, A.; Pugh, C.; Bao, Z.; A Damage-Perceptive, Multilayer Self-Healing Electronic Skin, *Device by Cell Press*, **2025**

2 Zhao, C.; † Park, J.; † **Root, S. E.;** † Bao, Z.*; Skin-inspired soft bioelectronic materials, devices, and systems. *Nature Reviews Bioengineering,* **2024**

3 Cooper, C.†; **Root, S. E.†;** Michalek, L.; Wu, S.; Lai, J-C.; Khatib, M.; Oyakhire, S.; Zhao, R.; Qin, J.; Bao, Z.*; Autonomous alignment and self-healing in multilayer soft electronics using dynamic polymers with immiscible backbones. *Science*, **2023**

4 Li, Y.†; **Root, S. E.†;** Belding, L.; Park, J.; Yoon, H. J.; Huang, C.; Baghbanzadeh, M.; Whitesides, G. M.*, Charge Transport Measured Using the EGaIn Junction Through Self-Assembled Monolayers Immersed in Organic Solvents. *Journal of Physical Chemistry B,* **2023**

5 **Root, S. E.** †; Sanchez, V.†; Tracz, J.A.†; Preston, Whitesides, G. M.*, An Expanding Foam-Fabric Orthopedic Cast. *Advanced Materials Technologies,* **2022**

6 **Root, S. E**.; Preston, D. J.; Nemitz, M. P.; Belding, L.; Alcoran, R.; Fiefke, G.; Whitesides, G. M.*, Bio-inspired design of soft mechanisms using a toroidal hydrostat. *Cell Press Reports Physical Science,* **2021**, 2, 100572 **Citations: 6**

7 **Root, S. E.** †; Gao, R.†; Ge, S.; Whitesides, G. M.; Estimating the Density of Thin Polymeric Films using Magnetic Levitation. *ACS Nano*, **2021**

8 Li, Y.†; **Root, S. E**†; Baghbanzadeh, M.; Campbell V. E.; Rothemund, P. Cafferty, B. J.; Whitesides, G. M.*, Characterizing Chelation at Surfaces by Charge Tunneling. *Journal of the American Chemical Society* **2021**

9 Belding, L. †; **Root, S. E.** †; Li, Y.; Park, J.; Rojas, E.; Pieters, P.; Whitesides, G. M.*, Conformation, and Charge Tunneling Through Molecules in Self-Assembled Monolayers. *Journal of the American Chemical Society* **2021**

10 Runser, R.†; **Root, S. E.**†, Ober, D. E.; Choudhary, K.; Chen, A. X.; Dhong, C.; Urbina, A. D.; Lipomi, D.J.*, Interfacial Drawing: Roll-to-Roll Coating of Semiconducting Polymer and Barrier Films on Plastic Foils and Textiles *Chemistry of Materials* **2019**

11 **Root, S. E.**; Carpenter, C.W.; Kayser, L. V.; Rodriquez, D.; Davies, D. M.; Wang, S.; Tan, S. T. M.; Meng, Y. S.; Lipomi, D. J.*, Ionotactile Stimulation: Ionic Gels for Haptic Human-Machine Interfaces *ACS Omega* **2018**, 662-668

12 Alkhadra, M. A.†; **Root, S. E.†;** Hilby, K. M.; Rodriquez, D.; Sugiyama, F.; Lipomi, D. J.*, Quantifying the Fracture Behavior of Brittle and Ductile Thin Films of Semiconducting Polymers, *Chemistry of Materials* **2017**

13 **Root, S. E.**†; Alkhadra, M. A.†; Rodriquez, D.; Printz, A. D.; Lipomi, D. J.*, Measuring the Glass Transition Temperature of Conjugated Polymer Films with Ultraviolet-Visible Spectroscopy. *Chemistry of Materials* **2017** (Lectureship & Best Paper Award)

14 **Root, S. E.**; Savagatrup, S.; Printz, A. D.; Rodriquez, D.; Lipomi, D. J.*, Mechanical Properties of Organic Semiconductors for Stretchable, Highly Flexible, and Mechanically Robust Electronics. *Chemical Reviews* **2017** (selected as ACS Editors' Choice)

15 **Root, S. E.;** Jackson, N. E.; Savagatrup, S.; Arya, G.; Lipomi, D. J.*, Modelling the Morphology and Mechanical Behaviour of Low-Bandgap Conjugated Polymers and Bulk Heterojunction Films. *Energy & Environmental Science* **2017** (featured as a hot article)

16 **Root, S. E.;** Savagatrup, S.; Pais, C. J.; Arya, G.; Lipomi, D. J.*, Predicting the Mechanical Properties of Organic Semiconductors Using Coarse-Grained Molecular Dynamics Simulations. *Macromolecules* **2016**

Contributing Author Journal Articles (Listed in Reverse Chronological Order)

17 Berman, A.; Shi, B.; Kim, E.; **Root, S. E.**; Xu, C.; Beker, L.; Bao, Z. * A Compact, Elastomeric Multimodal Sensor for Tactile Softness Discrimination, *Advanced Materials Technologies*, **2025**

18 Khatib, M.†; Zhao, E. R†.; Wei, S.†; Abramson, A.; Bishop, E. B.; Chen, C.-H.; Thomas, A.-L.; Xu, C.; Park, J.; Lee, Y.; Hamnett, R.; Yu, W.; **Root, S. E**.; Yuan, L.; Chakhtoura, D.; Kim, K. K.; Zhong, D.; Nishio, Y.; Zhao, C.; Wu, C.; Jiang, Y.; Zhang, A.; Li, J.; Wang, W.; Salimi-Jazi, F.; Rafeeqi, T. A.; Hemed, N. M.; Tok, J.B.H.; Chen, X.; Kaltschmidt, J. A.; Dunn, J.; Bao, Z. High-Density Soft Bioelectronic Fibers for Multimodal Sensing and Stimulation, *Nature,* **2025**

19 Berman, A.†; Hsiao, K.†; **Root, S. E.;** Choi, H.; Ilyn, D.; Xu, C.; Stein, E.; Cutkosky, M.; DeSimone, J. M.*; Bao, Z.* Additively manufactured micro-lattice dielectrics for multiaxial capacitive sensors, *Science Advances*, **2024**

20 Kim, E.; Lai, J.-C.; Michalek, L.; Wang, W.; Xu, C.; Lyu, H.; Yu, W.; Park, H.; Tomo, Y.; **Root, S. E.;** Lee, B.; Park, J.; Wei, S.; Zhao, C.; Bao, Z.*A Transparent, Patternable, and Stretchable Conducting Polymer Solid Electrode for Dielectric Elastomer Actuators, *Advanced Functional Materials,* **2024**

21 Kim, K. K.†; Kim, M.†; Pyun, K.; Kim, J.; Min, J.; Koh, S.; **Root, S. E.;** Kim, J.; Nguyen, B. N. T.; Nishio, Y.; Han, S.; Choi, J.; Kim, C.Y.; Tok, J. B.-H.; Jo, S.; Ko, S. H.*; Bao, Z.*, A Substrate-Less Nanomesh Receptor with Meta-Learning for Rapid Hand Task Recognition, *Nature Electronics*, **2023**

22 Peña-Alcántara, A.l Nikzad, S.; Prine, N.; Wang, Y.; Michalek, L.; Gong, H.; Ponte, E.; Schneider, S.; Wu, Y.; **Root, S.E.**; Tok, J.B.-H.; Gu, X.*; Bao, Z.*; Effect of Molecular Weight on the Morphology of a Polymer Semiconductor Blended with a Thermoplastic Elastomer, *Advanced Electronic Matrials,* **2023**

23 Gao, R.†; Kodaimati, M. O.†; Handy, K.; **Root, S. E.;** Whitesides, G. M.*, Generating Oscillatory Behavior by Applying a Magnetic Field During the Electrocatalytic Oxidation of Glycerol *Journal of Physical Chemistry C,* **2022**

24 Decker, C. J.†; Jiang, H. J.†; Nemitz, M. P.; **Root, S. E.**; Rajappan, A.; Alvarez, J . T.; Tracz, J., Wille, L.; Preston, D.J.; Whitesides, G. M.*; Programmable Soft Valves for Digital and Analog Control, *Proceedings of the National Academy of Sciences*, **2022**

25 Tracz, J. A.; Wille, L.; Pathiraja, D.; Kendre, S. V.; Pfisterer, R.; Turett, E.; Abrahamsson, C. K.; **Root, S. E.;** Lee, W. K.; Preston, D. J.; Jiang, H. J.; Whitesides, G. M.*; Nemitz, M. P.*; Tube-Balloon Logic for the Exploration of Fluidic Control Elements *IEEE Robotics and Automation Letters*,

26 Park, J.; Kodaimati, M. A.; Belding, L.; **Root, S. E.**; Schatz, G.; Whitesides, G. M.*, Controlled Hysteresis of Conductance in Molecular Tunneling Junctions, *ACS Nano*, **2022**

27 Kodaimati, M. A.†; Gao, R.†; **Root, S. E.**; Whitesides, G. M.*, Magnetic Fields Enhance Mass Transport During Electrocatalytic Reduction of CO_2, *Chem Catalysis,* **2022**

28 Nagarkar, A.; **Root, S. E.;** Fink, M. J.; Ten, A. S.; Cafferty, B. J.; Richardson, D. S.; Mrksich, M.; Whitesides, G. M.*, Storing and Reading Information in Mixtures of Fluorescent Molecules. *ACS Central Science* **2021**

29 Park, J.; Belding, L.; Li, Y.; Mousavi, M.; **Root, S. E.;** Yoon, H. J.; Whitesides, G. M.*, Rectification in Molecular Tunneling Junctions based on Alkanethiolates with Bipyridine-Metal Complexes, *Journal of The American Chemical Society*, **2021**

30 Carpenter, C.W.; Malinao, M.G.; Rafeedi, T.A.; Rodriquez, D.; Tan, S.T.M.; Root, N.B.; Skelil, K.; Ramirez, J.; Polat, B.; **Root, S.E.**; Ramachandran, V.S.; Lipomi, D.J.*, Electropneumotactile Stimulation: Multimodal Haptic Actuators Enabled by a Stretchable Conductive Polymer on Inflatable Pockets *Advanced Materials Technologies*, **2020**

31 Sugiyama, F.; Kleinschmidt, A. T.; Kayser, L.V.; Rodriquez, D.; Fin, M. F.; Alkhadra, M. A.; Wan, J. M. H.; Chiang, A. S. C..; Ramirez, J.; **Root, S. E.**; Lipomi, D. J.*, Effects of Flexibility and Branching of Side Chains on the Mechanical Properties of Low-Bandgap Copolymers *Polymer Chemistry*, **2018**

32 Sugiyama, F.; Kleinschmidt, Kayser, L.V.; Alkhadra, M. A.; Wan, J. M. H.; Chiang, A. S. C.; Rodriquez, D.; **Root, S. E.**; Lipomi, D. J.*, Stretchable and Degradable Semiconducting Block Copolymers *Macromolecules*, **2018**

33 Rodriquez, D.; Kohl, G.; Morel, P.; Burrows, K.; Favaro, G.; **Root, S. E.**; Ramirez, J.; Alkhadra, M.A.; Carpenter, C. W.; Fei, Z.; Boufflet, P.; Heeney, M.; Lipomi, D. J.*, Measurement of Cohesion and Adhesion of Semiconducting Polymers by Scratch Testing: Effect of Side-Chain Length and Degree of Polymerization *Macroletters,* **2018**

34 Kleinschmidt, A. T.; **Root, S. E.**; Lipomi, D. J.*, Poly (3-hexylthiophene) (P3HT): Fruit Fly or Outlier in Organic Solar Cell Research? *Journal of Materials Chemistry A* **2017**

35 Marin, B. C.; **Root, S. E.**; Urbina, A. D.; Alklile, E.; Miller, R.; Zaretski, A. V.; Lipomi, D. J.*, Graphene-Metal Composites with Near-Zero Temperature Coefficient of Resistance *ACS Omega* **2017**, 2, 626-630.

36 Marin, B. C.; Ramirez, J.; **Root, S. E.**, Aklile, E.; Lipomi, D. J.*, Metallic Nanoislands on Graphene: A Metamaterial for Chemical, Mechanical, Optical, and Biological Applications. *Nanoscale Horizons* **2017**, *2,* 311-318.

37 O'Connor, T. F.; Fach, M. E.; Miller, R.; **Root, S. E.**; Mercier, P. P.; Lipomi, D. J.*, The Language of Glove: Wireless gesture decoder with low-power and stretchable hybrid electronics. *PloS one* **2017**, 12, 1-12.

38 Rodriquez, D.†; Kim, J.H.†; **Root, S. E.**; Fei, Z.; Boufflet, P.; Heeney, M.; Kim, T. S.*; Lipomi, D. J.*, Comparison of Methods for Determining the Mechanical Properties of Semiconducting Polymer Films for Stretchable Electronics *Applied Materials & Interfaces* **2017**, 9, 8855-8862.

39 Zaretski, A. V.; **Root, S. E.**; Savchenko, A.; Molokanova, E.; Printz, A. D.; Jibril, L.; Arya, G.; Mercola, M.; Lipomi, D. J.*, Metallic Nanoislands on Graphene as Highly Sensitive Transducers of Mechanical, Biological, and Optical Signals. *Nano Letters* **2016**,16, 1375-1380

40 Savagatrup, S.; Printz, A. D.; O'Connor, T. F.; Zaretski, A. V.; Rodriquez, D.; Sawyer, E. J.; Rajan, K. M.; Acosta, R. I.; **Root, S. E.**; Lipomi, D. J.*, Mechanical Degradation and Stability of Organic Solar Cells: Molecular and Microstructural Determinants. *Energy & Environmental Science* **2015**, *8*, 55–80.

Textbook Chapter

1 Alkhadra, M. A.; Kleinschmidt, A. T.; **Root, S. E.;** Rodriquez, D.; Printz, A. D.; Savagatrup, S.; Lipomi, D. J. Mechanical Properties of Semiconducting Polymers, *Conjugated Polymers: Properties, Processing, and Applications* 2019 CRC Press

Patents

1 **Root, S.E.;** Fazzini, J.A.; Sanchez, V.; Preston, D.J.; Whitesides, G.M., "Expanding Foam-Fabric Orthopedic Limb Stabilization Device," U.S. Patent US12311062B2, published: May 27th, 2025

2 Sakamoto, J.; Ten, A.; Kodaimati, M. S.; Jiang, H. J.; Nagarkar, A.; **Root, S. E**.; Whitesides, G. M., "Polyphosphate Materials" U.S. Provisional Patent Application No. 63/248691; WH Ref. No.: 42697.579US1

3 Cooper, C. B.; **Root, S. E.;** Bao, Z.; "Multi-layer self-healing apparatuses and methods" U.S. Provisional Patent Application No. 63/440,656, January 23, 2023

PRESENTATIONS

Invited Presentations

1. UC Santa Barbara, Department of Material Science, March 22, 2018.
2. American Chemical Society Summer Meeting, Boston Ma., August 19, 2018
3. University of Rochester, Department of Chemical Engineering, October 7th, 2020 (virtual)
4. Technion-Israel Institute of Technology, Department of Chemical Engineering, October 20th, 2020 (virtual)
5. University of Kentucky, Department of Chemical & Materials Engineering, January 11th, 2023
6. Stevens Institute of Technology, Department of Chemical Engineering and Materials Science, February 10th, 2023
7. Tufts University, Department of Chemical & Biological Engineering, March 6th, 2023
8. UC San Diego, Department of NanoEngineering, August 8th, 2023
9. Stanford Polymer Collective (student selected), Stanford University, October 6th, 2023
10. Rising Stars in Soft and Biological Matter Symposium (University of Chicago MRSEC), October 12th, 2023
11. eWear Seminar, Stanford University, October 23rd, 2023
12. Florida State University, Department Chemical and Biomedical Engineering, January 3rd, 2024
13. Georgia Institute of Technology, Department of Chemical and Biomolecular Engineering, January 8th, 2024
14. University of Wisconsin, Madison, Department of Mechanical Engineering, January 22nd, 2024
15. Auburn University, Department of Chemical Engineering, February 5th, 2024
16. University of New Mexico, Department of Chemical & Biological Engineering, February 12th, 2024
17. Clemson University, Department of Chemical Engineering and Biomolecular Engineering, February 15th, 2024
18. Case Western Reserve University, Department of Macromolecular Science and Engineering, February 27th, 2024
19. University of Massachusetts, Amherst, Department of Chemical Engineering, March 11th, 2024
20. University of Akron, Department of Polymer Science and Polymer Engineering, March 14th, 2024
21. Lawrence Livermore National Laboratory, Center of Applied Science and Polymer Research, November 13th, 2024
22. Case Western Reserve University, Department of Chemistry, February 27th, 2025
23. Case Western Reserve University, Department of Chemical Engineering, April 17th, 2025
24. The 14th International Conference on Advanced Materials and Devices, Busan, Korea, December 10th, 2025
25. Case Western Reserve University, Department of Biomedical Engineering, February 5th, 2026

Contributed Conference Presentations

1. United States National Congress on Computational Mechanics, San Diego, CA, July 26-30, 2015
2. International Conference on Advanced Polymeric Materials, Jeju, Korea, October 4-7, 2016
3. Fall Meeting of the Materials Research Society, Boston, Massachusetts, December 2-5, 2016
4. Pan-American Polymer Science Conference, Guaruja, Sao Paolo State, Brazil, March 22-25, 2017
5. Fall Meeting of the Materials Research Society, Boston, Massachusetts, December 2-5, 2017
6. American Institute of Chemical Engineering (AIChE), November 10th-15th, 2019
7. (Virtual) American Physical Society March Meeting 2020
8. (Virtual) American Institute of Chemical Engineering Annual Meeting, November 16-20th, 2020
9. Fall meeting of the Materials Research Society, Boston, Massachusetts, December 2023
10. American Institute of Chemical Engineering Annual Meeting, San Diego, California, October 2024
11. Global Polymer Summit, Cleveland, Ohio, August 2025
12. American Institute of Chemical Engineering Annual Meeting, Boston, Massachusetts, November 2025

PROFESSIONAL SERVICE

Peer reviewer for:

Science Advances, ACS Macromolecules, ACS Chemistry of Materials, ACS Materials Letters, Frontiers in Chemistry, Chemical Engineering Journal

Member of the American Institute of Chemical Engineers and the Materials Research Society

2025 Co-Chair for AICHE Polymer Thin Films, Confinement and Interfaces Symposium

TEACHING & MENTORSHIP

Course Instruction at Case Western Reserve University

EMAC 382/482 Polymer Composites for Electronics (Fall 2025)

- Developed a new elective senior undergraduate/graduate course covering the physical chemistry underlying the dielectric, conductive, and semiconductive properties of polymers and composites (Fall 2025)
- Secured $7,000 Glennan Fellowship to incorporate experiential education through hands-on laboratory projects.
    - Designed Arduino prototyping and materials characterization modules.
    - Brought in an industry speaker from Intel Inc. for a guest lecture.
- Enrollment: 4 students (Fall 2025)
- Evaluations: 3/4 responses.
    - Instructor Rating: 4.667/5
    - Course Rating: 4.33/5
    - Assignment score: 5/5
- Selected Comments:
    - "I really liked the homework problem set as they helped put the lectures into context. The scientific article presentations were helpful in seeing real-world applications of the lectures. The exam tested us in a very fair manner. I did like the lab and in class activities as well."
    - "Class time was used effectively, and I appreciate how open the professor was to questions and discussions"

EMAC 355 Polymer Analysis Laboratory (Spring 2025, Spring 2026)

- Introduced new 3D printing module leveraging Sears Thinkbox resources (Co-instructor Spring 2025)
- Enrollment: 7 students (Spring 2025)
- Evaluations: 7/7 responses.
    - Instructor Rating: 5/5
    - Course Rating: 4.14/5
    - Assignment score: 4.6/5
- Selected Comments:
    - "Prof. Root, who teaches the majority of lectures in the course, is very good at communicating the course content in an effective manner. He also is very clear in his expectations for assignments."
    - "Overall I think the course helped deepen my knowledge of a lot of concepts relevant to polymer science. It helped that some of the topics we discussed, like viscoelasticity, overlapped with those topics in other classes I was taking. It was nice to have the hands-on experience from this class, instead of concepts like TTS remaining conceptual (and a little abstract)"

Research Mentorship at Case Western Reserve University

Postdoctoral Scholars

- Dr. Jiahao Huang, Senior Postdoctoral Associate, March 2025—March 2026
  Project: Molecular design of tunable vitrimer interfaces for reconfigurable multilayer soft electronics
  Current: Professor of Soft Matter Engineering

Graduate Students

- Roberto Obregon, Graduate Research Assistant, May 2025—present
  Project: Characterization of neat vitrimer interfaces for reconfigurable multilayer soft electronics
- Riley Donahue, Graduate Research Assistant, September 2025—present
  Project: Characterization composite vitrimer interfaces for reconfigurable multilayer soft electronics

Undergraduate Students

- Trevor Swan, November 2024—August 2025
  Project: Characterization of a damage-sensing, self-healing multilayer soft electronic skin
  - Awarded SOURCE funding for summer 2025, presented poster on results
- Rina Nishimura, January 2025—June 2025
  Project: Synthesis and characterization of supramolecular self-healing polymer
- Isaac Reader-Taatjes, January 2025—June 2025
  Project: Synthesis and characterization of dissociative and associative dynamic polymer networks
- Kianna Verdugo, Summer 2025
  Project: Characterization of a damage-sensing, self-healing multilayer soft electronic skin
- Jake Tan, Fall 2025-present
  Project: Characterization of vitrimer composites and device prototyping.
- Alex Xue, Fall 2025-present
  Project: Characterization of a damage-sensing, self-healing multilayer soft electronic skin
  - Awarded SOURCE funding for summer 2026
- Hanan Abas, Fall 2025-present
  Project: Synthesis and characterization of branched poly(butadiene-co-urethane) thermoplastic elastomers.

Previous Experience as a Teaching Assistant

Responsibilities included developing new class materials and exam questions; leading class discussions; grading assignments and exams; and meeting with students individually.

Graduate Level

- Applied Boundary Value Problems and Fourier Series Analysis (Fall 2013)
  University of Rochester, ~100 students.
- Intermolecular & Surface Forces (Fall 2015 & 16)
  University of California, San Diego, ~50 students.

Undergraduate Level

- Polymeric Materials (Winter 2016 & 17)
  University of California, San Diego, ~100 students.
- Statistical Thermodynamics (Spring 2020)
  Harvard University, ~30 students.

Guest lecturer

Intermolecular & Surface Forces: Computer Simulations (Winter 2017) (video recording on YouTube)
Polymeric Materials: Computer Simulations (Spring 2016 & 17)
Statistical Thermodynamics (Spring 2020)

Mentees at Stanford University (9/2021–present)

- Alexandra L. Figueroa Ramos, graduate student in chemical engineering, (09/22–present)
  Project title: Selective self-healing between dynamic polymers with orthogonal dynamic bonds
- Arielle Berman, graduate student in chemical engineering (09/22–present)
  Project title: 3D printed capacitive sensors of pressure and shear stress.
- Gradie Ngaruka, undergraduate student in chemical engineering, ’24 (06/22 – present)
  Project title: A self-healing, damage-sensing electronic skin for surgical simulation
- Eric Sun, high school summer intern (06/23-08/23)
  Project title: A self-healing, damage-sensing electronic skin for surgical simulation
- Ian Coates, rotational graduate student in chemical engineering (01/22-05/22)
  Project title: Development of resistive pressure sensors based on self-healing composites

Mentees at Harvard University (4/2018 – 8/2021)

- Jovanna A. Tracz, Postbaccalaureate pre-med student (1/19–6/20)
  Project title: An expanding foam-fabric orthopedic cast
  - Awarded SWE WeLocal San Diego Best Poster Award 2020
  - Currently: medical student at Eastern Virginia Medical School

- Julie Ortiz, undergraduate student in mechanical engineering (9/18–6/19)
  Project title: An expanding foam-fabric orthopedic cast (Senior design project)
    - Currently: robotics and coding instructor at Happy Code Club
- Hunter Wallace, undergraduate student in mechanical engineering (9/19–6/20)
  Project title: Gripping, catching, and conveying with a soft toroidal hydrostat
    - Currently: Senior System Engineer at Symbotic
- Renz Marion Alcoran, aerospace engineering REU student (06/18-08/18)
  Project title: Gripping, catching, and conveying with a soft toroidal hydrostat
- Gideon Feifke, mechanical engineering REU student (06/18-08/18)
  Project title: Gripping, catching, and conveying with a soft toroidal hydrostat

Mentees at UC San Diego (9/2014 – 2/2018)

- Rory Runser, first year graduate student in chemical engineering (09/17-02/18)
  Project title: Interfacial drawing of polymer thin films
    - Currently: Materials Engineer at GAF
- Kristan Hilby, undergraduate nanoengineering student (06/17-02/18)
  Project title: Fracture behavior in thin films of semiconducting polymers
    - Currently: PhD candidate at Massachusetts Institute of Technology
- Mohammad Alkhadra, undergraduate chemical engineering student (06/16-02/18)
  Project title: Thermomechanical behavior of thin films of semiconducting polymers
    - *ACS Chemistry of Materials* Lectureship & Paper of the Year, 2018
    - Currently: Co-founder and CEO at Lithios.
- Armando Urbina, undergraduate chemical engineering student (06/16-06/17)
  Project title: Graphene-metal composites for resistive strain sensors
    - Currently: Graduate student at University of Southern California
- C.J. Pais, undergraduate student in computer science (06/15-06/16)
  Project title: Coarse-grained molecular dynamics simulations of semiconducting polymers
    - Currently: Software engineer at Qualcomm.

Previous Educational Outreach

Laboratory tours at UC San Diego for K-12 outreach, ~5 per year, 2014-18
Weekly science lessons with a single 3rd grade class at Dingeman Elementary School (Fall 2017)
Weekly science lessons with various 5th grade classes from Boston Public Schools (April 2019)
Engineering Immersion Program, monthly workshops with high school students, (Spring 2022)
Perry Outreach Program, introducing high school women to careers in orthopedic surgery & engineering (Spring 2022)

GRANTS at CWRU

As Principal Investigator: (Total Funding Secured: $ 760,000)

1. Petroleum Research Fund, American Chemical Society, 2025 Doctoral New Investigator Award, "Thermal Transport and Dielectric Stability in Macromolecular Composites of Liquid Metal Microdroplets. ($110,000, 9/01/26-8/31/28, PI: **Samuel E. Root**)
2. Arnold and Mabel Beckman Foundation, 2026 Beckman Young Investigator Award, "Imaging the Micromechanics of Self-Healing Polymers and Multilayers using Dynamic Speckle" ($600,000, 9/01/26-8/31/30, **PI: Samuel E. Root**)
3. Sherwin-Williams, 2026 University Challenge Grant Program, 'Drop-In Integration of Dynamic Covalent Bonds into Tri-Layer Infrastructure Coatings to Enable Damage Repair and Enhance Interlayer Adhesion" ($50,000, 6/01/26-12/31/26, **PI: Samuel E Root**)

As a Contributing Author (Total Funding Secured: ~$ 100,000 TBD)

4. Department of Defense – Office of Naval Research ($2,413,382, 12/1/25-11/30/27, PI: Kathryn Daltorio, Co-PI: Glenna Clifton). "Air to Water to Benthic Surfaces, Cross Domain Bio-inspired Robotics – Multifunctional Legs"—contributed section for one aim, listed as Co-Investigator (~$100,000).

GRANTS PRIOR to TENURE-TRACK POSITION

As Principal Investigator: (Total Funding Secured: $ 25,000)

5. National Science Foundation, ACCESS Discover supercomputer allocation (estimated value ~$10,000, 10/05/22 - 10/04/23, **PI: Samuel E. Root,** Co-PI: Zhenan Bao), "Coarse-grained molecular dynamics simulations of interfaces of dynamic polymers and composites"
6. National Science Foundation, XSEDE Research Allocation (estimated value ~$15,000, 1/1/19-1/1/20, **PI: Samuel E. Root**, Co-PI: George M. Whitesides), "Molecular Dynamics Simulations of Self-Assembled Monolayers for Molecular Electronics"
7. Thrasher Research Fund (Pediatric Healthcare), Early Career Award (**PI: Samuel E. Root,** rejected in final round, best 20 out of 140 proposals), "A Foam-Fabric Orthopedic Cast for Fractures of the Wrist in Pediatric Populations"
8. National Institute of Health, F32 Postdoctoral Fellowship (**Fellow: Samuel E. Root,** score 33, percentile 43%, not funded, 2022), "Reusable, Multisensory Surgical Simulation Models Based on Self-healing Composites of Dynamic Polymers with Conductive Nanomaterials"

As a Contributing Author:

9. National Science Foundation, Division of Materials Research (*unknown*, PI: Zhenan Bao). "Periodic Dynamic Polymers with Strain-Induced Supramolecular Structures for One-Way and Two-Way Shape-Memory Actuators"—contributed 4 out of 20 pages including one task, and the broader impacts section.
10. National Science Foundation, Division of Chemistry ($800,000, 9/1/22–8/31/26, PI: George M. Whitesides), "Quantum Charge Tunneling through Self-Assembled Monolayers"—led writing of entire proposal with feedback from adviser.
11. Air Force Office of Scientific Research ($450 000, 5/1/16–4/30/19, PI: Darren Lipomi, co-PIs: Gaurav Arya and Shyue Ping Ong), "High-performance semiconducting elastomers"—provided the core idea, a figure, and approximately 1.5 pages of text for one of three sub-projects.
12. National Science Foundation, XSEDE Research Allocation ($60,872.98, 10/1/15-10/1/16, PI: Darren Lipomi Co-PI: Gaurav Arya), "Computational Design of Nanostructured Materials"—provided the core idea, wrote the proposal.
13. National Science Foundation, XSEDE Research Allocation ($50,226.25, 10/1/16-10/1/17, PI: Darren Lipomi Co-PI: Gaurav Arya) "Computational Design of Nanostructured Materials"—provided the core idea, wrote the proposal.
14. Hellman Fellowship ($46,000, 6/1/15–5/31/16, PI: Darren Lipomi), "Modeling the mechanical properties of organic semiconductors for flexible, printed devices"—made significant intellectual contributions, provided text and one figure.

PROFESSIONAL REFERENCES

1. **Professor Darren J. Lipomi**
   Professional Relationship: PhD Adviser
   Department of NanoEngineering
   University of California, San Diego
   1 (617) 797-9155, email: dlipomi@eng.ucsd.edu

2. **Professor George M. Whitesides**
   Professional Relationship: Postdoctoral Adviser
   Department of Chemistry and Chemical Biology
   Harvard University
   Email: gmwoffice@gmwgroup.harvard.edu

3. **Professor Zhenan Bao**
   Professional Relationship: Postdoctoral Adviser
   Department of Chemical Engineering
   Stanford University
   1 (650) 723 2419, email: zbao@stanford.edu

4. **Professor Gaurav Arya**
   Professional Relationship: Computational Research Adviser/Collaborator
   Department of Mechanical Engineering and Materials Science, Biomedical Engineer, and Chemistry
   Duke University
   1 (919) 660 5435, email: Gaurav.arya@duke.edu