Sukyoung Won, PhD
California Institute of Technology, Pasadena, CA, USA
swon@caltech.edu | [Google Scholar] | [LinkedIn]

Research Interests

Programmable soft matter	Stimuli-responsive polymer composites	Structure-property-actuation relationships
Microrobotics	Shape-reconfigurable soft robots	Magnetic robotic swarms

Professional Experience

09/2023–Present **California Institute of Technology** Pasadena, CA, USA
Postdoctoral Scholar in Department of Medical Engineering (Advisor: Prof. Wei Gao)
- Develop ultrasound-guided micromachines for real-time in-vivo navigation and localized therapeutic intervention
- Design acoustic impedance-tuned microstructures to enhance sonographic contrast and magnetic steerability
- Couple on-demand nanoparticle release and chemotaxis-driven redistribution to enhance intratumoral drug coverage

03/2023–08/2023 **Hanyang University** Seoul, Republic of Korea
Postdoctoral Research Associate in Department of Organic and Nano Engineering (Advisor: Prof. Jeong Jae Wie)
- Designed magnetically anisotropic polymer composites enabling programmable assembly of microrobot swarms
- Developed scalable microfabrication strategies for spatial magnetization patterning to regulate inter-robot interactions
- Quantified structure-property-performance relationships in microrobot materials governing swarm-level controllability

Education

09/2019–02/2023 **Inha University** Incheon, Republic of Korea
Ph.D. in Environmental and Polymer Engineering (GPA: 4.38/4.5)
- Dissertation: Designs and Actuations of Polymer Nanocomposites for Agile Collective Maneuvers of Miniaturized Magnetic Robots (Advisor: Prof. Hee Joong Kim, Co-Advisor: Prof. Jeong Jae Wie)

03/2017–08/2019 **Inha University** Incheon, Republic of Korea
M.S. in Polymer Science and Engineering (GPA: 4.39/4.5)
- Dissertation: Construction and Hierarchical Actuation of Magnetic Soft Robots Using Thermoplastic Polyurethane-Iron Oxide Nanocomposites (Advisor: Prof. Jeong Jae Wie)

03/2011–02/2016 **Inha University** Incheon, Republic of Korea
B.S. in Polymer Science and Engineering (GPA: 4.14/4.5, Magna cum laude)
- Awarded Gyeonggi-do Scholarship; top 300 undergraduate students selected in the province annually (2012, 2013)

Awards and Fellowships

2023 Nurturing Next-Generation Researcher, National Research Foundation (NRF) Korea
- One-year fellowship awarded to 100 researchers nationwide

2023 Dean's Choice of the Best Research, Inha University

2023 Best Engineer Award, Inha University

2022 Outstanding Presentation Award, Oral Session, The Korean Institute of Chemical Engineers (KIChE)

2020 Tokyo Chemical Industry (TCI) Outstanding Research Award, The Polymer Society of Korea (PSK)
- Awarded to one researcher at each biannual meeting

2020 Outstanding Research Award (Excellence of Journal Publication), Inha University

2019 Outstanding Presentation Award, Oral Session, PSK

2018 Outstanding Presentation Award, Poster Session, PSK

2018 Outstanding Presentation Award, Poster Session, The Korean Fiber Society (KFS)

Professional Activities

Reviewer for *Nature Communications* (4 reviews, 2024–2025) and *npj Robotics* (2026)

Selected (Co-) First Author Publications

†First Author, *Corresponding Author

1. J.H. Hwang†, **S. Won**†, J.M. Lee, W. Cho, S. Park, H. Kim, C.-G Chae, W. Lee, D.-G Kim*, J.J. Wie*, and Y. S. Kim*, "Closed-Loop and Sustainable 4D Printing of Multi-Stimuli-Responsive Sulfur-Rich Polymer Composites for Autonomous Task Execution", ***Advanced Materials***, 37, 44, e07057 (2025)
2. **S. Won**, M. Kim, J. Lee, Y.J. Ko, K. Yang, H.E. Lee, Y.J. Kim, J.H. Jung, J.K. Kim*, K. Hyun*, J.J. Wie*, "Pivotal Role of Nanoparticle Distribution on Agile Steering of Magnetic Microrobots", ***Chemistry of Materials***, 37, 4350–4362 (2025)
3. K. Yang†, **S. Won**†, J.E. Park, J. Jeon, J.J. Wie*, "Magnetic Swarm Intelligence: Versatile Task Execution by Mass Production of Programmable Microrobot Assemblies", ***Device***, 3, 100626 (2025)
   - *Selected as Editor's Picks for 2025 (total 5 papers in the year)*
4. **S. Won**†, H.E. Lee†, Y.S. Cho, J.E. Park, S.J. Yang, J.J. Wie*, "Multimodal Collective Swimming of Magnetically Articulated Modular Nanocomposite Robots", ***Nature Communications***, 13, 6750 (2022)
   - *Featured in Nature Communication's Collection on Soft Robotics*
5. **S. Won**, S. Kim, J.E. Park, J. Jeon, J.J. Wie*, "On-Demand Orbital Maneuver of Multiple Soft Robots via Hierarchical Magnetomotility", ***Nature Communications***, 10, 4751 (2019)

Publications

1. **S. Won**, K. Yang, J.J. Wie*, "Processing–Structure–Property–Performance Relationships of Polymer Composites for Untethered Magnetic Robotics", ***Progress in Polymer Science***, 168, 102005 (2025)
2. J. Jeon†, H. Moon†, J. Park, **S. Won**, J.E. Park, Z. Ku, J.O. Kim*, J.J. Wie*, "Collective and Rapid High Amplitude Magnetic Oscillation of Anisotropic Micropillar Arrays", ***ACS Nano***, 19, 9946–9957 (2025)
3. H. Je, **S. Won**, J.J Wie*, S. Kim*, "Spatially Selective Ultraprecision Polishing and Cleaning by Collective Behavior of Micro Spinbots", ***Small Structures***, 5, 2400245 (2024)
   - *Selected as Editor's Choice and as Best of the Small Journals 2024*
4. J.E. Park, H. Je, C.R. Kim, S. Park, Y. Yu, W. Cho, **S. Won**, D.J. Kang, T.H. Han, R. Kwak, S.G. Lee*, S. Kim*, J.J. Wie*, "Programming Anisotropic Functionality of 3D Microdenticles by Staggered-Overlapped and Multilayered Microarchitectures", ***Advanced Materials***, 35, 2309518 (2023)
5. N. Han†, W. Cho†, J. H. Hwang, **S. Won**, D.-G. Kim*, J.J. Wie*, "Enhancement of Thermomechanical Properties of Sulfur-Rich Polymers by Post-Thermal Treatment", ***Polymer Chemistry***, 14, 943–951 (2023)
6. J.E. Park, J. Jeon, S.J. Park, **S. Won**, Z. Ku* J.J. Wie*, "On-Demand Dynamic Chirality Selection in Flower Corolla-Like Micropillar Arrays", ***ACS Nano***, 16, 18101–18109 (2022)
7. J.Y. Han†, H.H. Singh†, **S. Won**†, D.S. Kong, Y.C. Hu, Y.J. Ko, K.-T. Lee, J.J. Wie*, J.H. Jung*, "Highly Durable Direct-Current Power Generation in Polarity-Controlled and Soft-Triggered Rotational Triboelectric Nanogenerator", ***Applied Energy***, 314, 119006 (2022)
8. **S. Won**†, H. Je†, S. Kim*, J.J. Wie*, "Agile Underwater Swimming of Magnetic Polymeric Microrobots in Viscous Solutions", ***Advanced Intelligent Systems***, 4, 2100269 (2022)
9. J. Choi†, **S. Won**†, H.J. Yoon†, J.H. Lee, H.W. Jang, J. Jeon, A.Y. Kim, S.H. Park, J.H. Youk*, M. Lee*, J.J. Wie*, "Toxic Gas-Free Synthesis of Extremely Negative Triboelectric Sulfur Copolymer Blends Via Phase Separation of Fluorine-Rich Polymers", ***Nano Energy***, 92, 106761 (2022)
10. J.E. Park, **S. Won**, W. Cho, J.G. Kim, S. Jhang, J.G. Lee, J.J. Wie*, "Fabrication and Applications of Stimuli-Responsive Micro/Nanopillar Arrays", ***Journal of Polymer Science***, 59, 1491–1517 (2021)
11. S. Ha, H.J. Yoon, J.I. June, H. Kim, **S. Won**, J.H. Kwak, H.D. Lim, H.-J. Jin, J.J. Wie*, and Y.S. Yun*, "3D-Structured Organic-Inorganic Hybrid Solid-Electrolyte-Interface Layers for Lithium Metal Anode", ***Energy Storage Materials***, 37, 567–575 (2021)
12. J. Jeon, A.T.L. Tan, J. Lee, J.E. Park, **S. Won**, S. Kim, M. Bedewy, J. Go, J.K. Kim, A. J. Hart*, J.J. Wie*, "High-Speed Production of Crystalline Semiconducting Polymer Line Arrays by Meniscus Oscillation Self-Assembly", ***ACS Nano***, 14, 17254–17261 (2020)

13. J.G. Lee, **S. Won**, J.E. Park, J.J. Wie*, "Multifunctional Three-Dimensional Curvilinear Self-Folding of Glassy Polymers", ***Journal of Micro and Nano-Manufacturing***, 8, 031004 (2020)
14. J.E. Park, J. Jeon, S.J. Park, **S. Won**, Z. Ku, J.J. Wie*, "Enhancement of Magneto-Mechanical Actuation of Micropillar Arrays by Anisotropic Stress Distribution", ***Small***, 16, 2003179 (2020)
15. J.H. Lee, J.-C. Choi, **S. Won**, J.-W. Lee, J.G. Lee, H.-R. Kim*, J.J. Wie*, "Light-Driven Complex 3D Shape Morphing of Glassy Polymers by Resolving Spatio-Temporal Stress Confliction", ***Scientific Reports***, 10, 10840 (2020)
16. J. You†, **S. Won**†, H.-J, Jin, Y.S. Yun*, J.J. Wie*. "Nano-Patching Defects of Reduced Graphene Oxide by Cellulose Nanocrystals in Scalable Polymer Nanocomposite", ***Carbon***, 165, 18-25 (2020)
17. J. Jeon, J.E. Park, S.J. Park, **S. Won**, H. Zhao, S. Kim, B.S. Shim, A. Urbas, A.J. Hart*, Z. Ku*, J.J. Wie*. "Shape-Programmed Fabrication and Actuation of Magnetically Active Micropost Arrays", ***ACS Applied Materials & Interfaces***, 12, 17113–17120 (2020)
18. J.E. Park, J.G. Kim, **S. Won**, J. Jeon, J.J. Wie*, "Contactless Manipulation of Soft Robots", ***Materials***, 12, 3065 (2019)
19. J.E. Park, J. Jeon, J.H. Cho, **S. Won**, H. Jin, K.H. Lee, J.J. Wie*, "Magnetomotility of Untethered Helical Soft Robots", ***RSC Advances***, 9, 11272–11280 (2019)

Research Projects

1. Smart Nanoswarm Platform for Targeted Cancer Therapy
   - Sungkyunkwan University | 05/2025–04/2026 | Institutional Postdoctoral Fellowship ($40K)
   - Developed enzyme-functionalized nanoparticle swarms for chemotaxis-driven tumor targeting
2. Segmentable Magnetic Robots via Chemical Responsivity
   - NRF Korea | 09/2023–08/2024 | National Postdoctoral Fellowship ($32K)
   - Designed magnetically and chemically responsive microstructures for controlled nanoparticle release
3. Swarm Intelligence of Multi-Stimuli Responsive Modular Robots
   - NRF Korea | 03/2022–02/2027 | 5-Year National Grant ($700K) | Co-Wrote Proposal and Led Research
   - Programmed anisotropic magnetization in polymer-hard magnet composites to enable adaptive microrobot swarms
4. Collective Behavior of Miniaturized Magnetic Soft Robots
   - NRF Korea | 03/2019–02/2022 | 3-Year National Grant ($200K) | Co-wrote Proposal and Led Research
   - Tuned nanoparticle dispersion in polymer nanocomposites to regulate collective magnetic interactions of soft robots
5. Reversibly Reconfigurable 3D Micro- and Nano-Photonic Devices
   - Asian Office of Aerospace Research and Development (AOARD USA) | 09/2018–09/2021
   - Developed magnetically programmable micropillar arrays of silicone and thermoplastic elastomer composites
6. Reverse Engineering of Thermoplastic Polyurethane-Silica Composites for Orthodontic Power Chains
   - Small and Medium Business Administration (SMBA Korea) | 06/2018–02/2019 | Co-wrote Proposal and Led Research
   - Optimized extrusion-based processing of TPU-silica composites for orthodontic industrial reverse engineering

Patents

1. J.J. Wie, K. Yang, **S. Won**, "Manufacturing Method of Microrobot with Programmed Magnetic Anisotropy, Microrobot and Reconfigurable Robot Swarm System", Application No.10-2025-0132443, Republic of Korea; 19/420,602, USA; 2025-265424, Japan (2025)
2. S. Kim, H. Je, J.J. Wie, **S. Won**, "Device for Surface Engineering and Method Thereof", Application No. 10-2025-0125357, Republic of Korea (2025)
3. J.J. Wie, H.-J. Jin, Y.S. Yun, H.J. Yoon, S. Ha, **S. Won**, "Lithium Metal Anode Material with Organic-Inorganic Hybrid Solid-Electrolyte-Interface and the Method for Manufacturing the Same", Registration No. 10-2552766, Republic of Korea (2023)
4. H.-J. Jin, J.J. Wie, Y.S. Yun, J. You, **S. Won**, "Graphene-Nanocellulose Complex Materials and Gas and Water Vapor Barrier Comprising the Same", Registration No. 10-2510757, Republic of Korea (2023)
5. J.J. Wie, S.J. Yang, **S. Won**, H.E. Lee, Y.S. Cho, "Musculoskeletal System-Mimetic Magnetic Polymer Nanocomposites and Use Thereof", Registration No. 10-2497619, Republic of Korea (2023)

6. J.J. Wie, **S. Won**, Y. Kim, H. J. Yoon, “A Novel Thermoplastic Polyurethane-Silica Composite for Orthodontic Power Chain and a Method of Preparing the Same”, Registration No. 10-2349694, Republic of Korea (2022)
7. J.J. Wie, H. Kim, J. Lee, J. Choi, J. Lee, **S. Won**, “A Novel Three-Dimensional Curvilinear Structure and A Method of Preparing the Same”, Registration No. 10-2333494, Republic of Korea (2021)
8. J.J. Wie, **S. Won**, W. Lee, “Rotating and Revolving Magnetic Soft Robots Based on Polymer Composites and Method for Preparing the Same”, Registration No. 10-2005323, Republic of Korea (2019)

Invited Seminars

1. Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Department of Computer Science, Germany (02/2025)
   - [Webinar] “Polymer Composite Engineering for Microrobot Swarm Intelligence”
2. Hanyang University, Department of Organic and Nano Engineering, Republic of Korea (07/2024)

Selected Conference Presentations

1. “Effects of Particle Distribution on Maneuver of Nanocomposite-Based Helical Magnetic Microrobots”, The Materials Research Society (MRS), Poster Presentation (04/2023)
   - *Finalist in the Science as Art competition - “Into the Vortex”*
2. “Reconfigurable Collective Swimming of Biomimetic Nanocomposite Robots”, MRS, Oral Presentation (05/2022)
3. “Enhanced Triboelectric Nanogenerators via Phase Separation of Fluorine-Rich Polymers from Sulfur-Rich Polymers”, KIChE, Oral Presentation, *Awarded* (04/2022)
4. “Agile Hierarchical Swimming of Soft Microrobots in Viscous Glycerol Solution”, The American Chemical Society (ACS), Oral Presentation (08/2021)
5. “Orbital Maneuver and Collective Behaviors of Untethered Soft Robots”, PSK, Oral Presentation, *Awarded* (10/2019)
6. “Hierarchical Maneuverability and Simultaneous Regulation of Multi-Magnetic Soft Robot”, PSK, Poster Presentation, *Awarded* (10/2018)
7. “Homogenous Dispersion of Iron Oxide Nanoparticles in Thermoplastic Polyurethane via Rapid Precipitation Technique”, KFS, Poster Presentation, *Awarded* (04/2018)

Teaching & Mentorship

1. Graduate Student Tutor, Institute for Specialized Teaching and Research, Inha University (03/2022–08/2022)
   - Mentored two graduate students in scientific writing, manuscript development, and journal targeting strategy
2. Laboratory Assistant, Polymer Laboratory (PSE3211 and PSE4181), Inha University (2017, 2018)
   - Assisted in undergraduate laboratory instruction on polymer synthesis and characterization
3. Research and Education (R&E) Mentor, Wondang High School (09/2017–02/2018)
   - Mentored a high school research project on “3D Self-Folding of Polymeric 2D Films Using Origami and Kirigami”
   - Project received Excellence Award at National Science Contest (2018)