Stanford

Renee Zhao

Assistant Professor of Mechanical Engineering and, by courtesy, of Materials Science and Engineering

Bio

BIO

Ruike Renee Zhao is an Assistant Professor of Mechanical Engineering at Stanford University, where she directs the Soft Intelligent Materials Laboratory. Originally from the historic city of Xi'an, she earned her BS from Xi'an Jiaotong University in 2012. She then pursued Solid Mechanics at Brown University, obtaining her MS in 2014 and PhD in 2016. Following her doctoral studies, she completed postdoctoral training at MIT (2016–2018) before serving as an Assistant Professor at The Ohio State University (2018–2021).

Renee’s research focuses on developing stimuli-responsive soft composites for multifunctional robotic systems with integrated shape-changing, assembly, sensing, and navigation capabilities. By integrating mechanics, material science, and advanced material manufacturing, her work enables innovations in soft robotics, miniaturized biomedical devices, robotic surgery, origami systems, active metamaterials, and general deployable morphing structures.

Her contributions have been recognized with honors and awards, including the ARO Early Career Program (ECP) Award (2023), AFOSR Young Investigator Research Program (YIP) Award (2023), Eshelby Mechanics Award for Young Faculty (2022), ASME Henry Hess Early Career Publication Award (2022), ASME Pi Tau Sigma Gold Medal (2022), ASME Applied Mechanics Division Journal of Applied Mechanics Award (2021), NSF CAREER Award (2020), and ASME Applied Mechanics Division Haythornthwaite Research Initiation Award (2018). She is also recognized as a National Academy of Sciences Kavli Fellow and was named one of MIT Technology Review's 35 Innovators Under 35.

ACADEMIC APPOINTMENTS

- Assistant Professor, Mechanical Engineering
- Assistant Professor (By courtesy), Materials Science and Engineering
- Member, Bio-X
- Member, Cardiovascular Institute
- Member, Wu Tsai Human Performance Alliance
- Faculty Fellow, Sarafan ChEM-H
- Member, Wu Tsai Neurosciences Institute

ADMINISTRATIVE APPOINTMENTS

- Associate Editor, Journal of Applied Mechanics, (2024- present)

HONORS AND AWARDS

- Kavli Fellow, National Academy of Sciences (2024)
- Sia Nemat-Nasser Early Career Award, ASME (2024)
- Melville Medal, ASME (2024)
- The 35 Innovators Under 35, Global list, MIT Technology Review (2023)
- Grainger Foundation Frontiers of Engineering Symposium, National Academy of Engineering (2023)
- Early Career Program Award, Army Research Office (2023)
- Young Investigator Program Award, Air Force Office of Scientific Research (2023)
- Eshelby Mechanics Award for Young Faculty, ASME Applied Mechanics Division (2022)
- Pi Tau Sigma Gold Medal, ASME (2022)
- Henry Hess Early Career Publication Award, ASME (2022)
- Cozzarelli Prize Finalist, Proceedings of the National Academy of Sciences (2022)
- Journal of Applied Mechanics Award, ASME Applied Mechanics Division (2021)
- Terman Faculty Fellow, Stanford University (2021)
- Gabilan Faculty Fellow, Stanford University (2021-2024)
- Moore Inventor Fellows Finalist, Gordon and Betty Moore Foundation (2021)
- CAREER Award, National Science Foundation (2020)
- Haythornthwaite Foundation Award, ASME Applied Mechanics Division (2018)
- Plastech Graduate Fellowship, Brown University (2015-2016)

PROGRAM AFFILIATIONS

- Stanford SystemX Alliance

PROFESSIONAL EDUCATION

- Postdoctoral Associate, Massachusetts Institute of Technology , Mechanical Engineering (2018)
- PhD, Brown University , Mechanical Engineering, Solid Mechanics (2016)
- MS, Brown University , Mechanical Engineering (2014)
- BS, Xi'an Jiaotong University , Mechanical Engineering (2012)

LINKS

- ZhaoLab Website: https://zhaolab.stanford.edu/
- Google Scholar: https://scholar.google.com/citations?user=x2ulDUIAAAAJ&hl=en

Teaching

COURSES

2024-25

- Mechanics of Materials: ME 80 (Aut)
- Soft Composites and Soft Robotics: MATSCI 333, ME 303 (Aut, Spr)

2023-24

- Continuum Mechanics: ME 338 (Spr)
- Mechanics of Materials: ME 80 (Win)

- Seminar in Solid Mechanics: ME 395 (Aut, Win, Spr)
- Soft Composites and Soft Robotics: MATSCI 333, ME 303 (Aut)

2022-23

- Continuum Mechanics: ME 338 (Spr)
- Mechanics of Materials: ME 80 (Win)
- Seminar in Solid Mechanics: ME 395 (Aut, Win, Spr)
- Soft Composites and Soft Robotics: MATSCI 333, ME 303 (Aut)

2021-22

- Mechanics of Materials: ME 80 (Spr)
- Seminar in Solid Mechanics: ME 395 (Win, Spr)
- Soft Composites and Soft Robotics: ME 303 (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Fredrik Samdal Solberg

Postdoctoral Faculty Sponsor

Je Seung Lee, Lu Lu, Luyuan Ning, Xiao Yang

Doctoral Dissertation Advisor (AC)

Sam Averitt, Larry Chang, Sophie Leanza, Jay Sim

Master's Program Advisor

Eric Abdulaziz, Cassie Chen, Jack Eisentrout, Parth Prashant Lathi, Hannah Lin, Jocelyn Liu, Sam Morstein, Trevor Perey, Mathusha Rao, Kai Rayle, Shergaun Roserie, Tom Soulaire, Tianyu Tu, Elvy Yao, Michelle Yao, Hang Yin, Zhongchun Yu

Doctoral Dissertation Co-Advisor (AC)

Enquan Chew

Doctoral (Program)

Margaret Gao, Kayla Hellikson

Publications

PUBLICATIONS

- **Selective Actuation Enabled Multifunctional Magneto-Mechanical Metamaterial for Programming Elastic Wave Propagation** *ADVANCED FUNCTIONAL MATERIALS*
  Sim, J., Wu, S., Hwang, S., Lu, L., Zhao, R.
  2024
- **Mechanics of magnetic-shape memory polymers** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*
  Lu, L., Wu, S., Zhao, R.
  2024; 190
- **The elastica with pre-stress due to natural curvatures** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*
  Leanza, S., Zhao, R., Hutchinson, J. W.
  2024; 190
- **Special Issue Editorial: Advanced Materials for Additive Manufacturing.** *Advanced materials (Deerfield Beach, Fla.)*

Zhou, K., Zhao, R. R., Qi, H. J.
2024; 36 (34): e2410446

- **Multistability of segmented rings by programming natural curvature.** *Proceedings of the National Academy of Sciences of the United States of America*
  Lu, L., Leanza, S., Dai, J., Hutchinson, J. W., Zhao, R. R.
  2024; 121 (31): e2405744121
- **Machine learning-enabled forward prediction and inverse design of 4D-printed active plates.** *Nature communications*
  Sun, X., Yue, L., Yu, L., Forte, C. T., Armstrong, C. D., Zhou, K., Demoly, F., Zhao, R. R., Qi, H. J.
  2024; 15 (1): 5509
- **Minimal Design of the Elephant Trunk as an Active Filament.** *Physical review letters*
  Kaczmarski, B., Leanza, S., Zhao, R., Kuhl, E., Moulton, D. E., Goriely, A.
  2024; 132 (24): 248402
- **Stiffness Change for Reconfiguration of Inflated Beam Robots.** *Soft robotics*
  Do, B. H., Wu, S., Zhao, R. R., Okamura, A. M.
  2024
- **A multiscale anisotropic polymer network model coupled with phase field fracture** *INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN ENGINEERING*
  Arunachala, P., Vajari, S., Neuner, M., Sim, J., Zhao, R., Linder, C.
  2024
- **Recent Advances in 4D Printing of Advanced Materials and Structures for Functional Applications.** *Advanced materials (Deerfield Beach, Fla.)*
  Wan, X., Xiao, Z., Tian, Y., Chen, M., Liu, F., Wang, D., Liu, Y., Bartolo, P. J., Yan, C., Shi, Y., Zhao, R. R., Qi, H. J., Zhou, et al
  2024: e2312263
- **Magneto-Mechanical Metamaterials: A Perspective** *JOURNAL OF APPLIED MECHANICS-TRANSACTIONS OF THE ASME*
  Sim, J., Zhao, R.
  2024; 91 (3)
- **On the elastic stability of folded rings in circular and straight states** *EUROPEAN JOURNAL OF MECHANICS A-SOLIDS*
  Leanza, S., Zhao, R., Hutchinson, J. W.
  2024; 104
- **Perspective: Machine Learning in Design for 3D/4D Printing** *JOURNAL OF APPLIED MECHANICS-TRANSACTIONS OF THE ASME*
  Sun, X., Zhou, K., Demoly, F., Zhao, R., Qi, H.
  2024; 91 (3)
- **Elephant Trunk Inspired Multimodal Deformations and Movements of Soft Robotic Arms** *ADVANCED FUNCTIONAL MATERIALS*
  Leanza, S., Lu-Yang, J., Kaczmarski, B., Wu, S., Kuhl, E., Zhao, R.
  2024
- **Machine learning and sequential subdomain optimization for ultrafast inverse design of 4D-printed active composite structures** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*
  Sun, X., Yu, L., Yue, L., Zhou, K., Demoly, F., Zhao, R., Qi, H.
  2024; 186
- **Effects of symmetry-breaking mechanisms on the flow field around magnetic-responsive material appendages that mimic swimming strokes** *PHYSICAL REVIEW FLUIDS*
  Mohaghar, M., Connor, A. A., Wu, S., Zhao, R., Webster, D. R.
  2024; 9 (2)
- **Reconfiguration of Electromagnetic Metasurfaces Using Tunable Shape Morphing Structures**
  West, D., Pavlick, W., Sim, J., Dai, J., Wu, S., Eichenberger, J., Zhao, R., Ghalichechian, N., IEEE
  IEEE.2024
- **Physics-aware differentiable design of magnetically actuated kirigami for shape morphing.** *Nature communications*

Wang, L., Chang, Y., Wu, S., Zhao, R. R., Chen, W.
2023; 14 (1): 8516

- **Mechanics of hard-magnetic soft materials: A review** *MECHANICS OF MATERIALS*
  Lu, L., Sim, J., Zhao, R.
  2024; 189
- **Curved Ring Origami: Bistable Elastic Folding for Magic Pattern Reconfigurations** *JOURNAL OF APPLIED MECHANICS-TRANSACTIONS OF THE ASME*
  Dai, J., Lu, L., Leanza, S., Hutchinson, J. W., Zhao, R.
  2023; 90 (12)
- **Tailoring the mechanical and combustion performance of B/HTPB composite solid fuel with covalent interfaces** *COMPOSITES SCIENCE AND TECHNOLOGY*
  Jiang, Y., Leem, J., Robinson, A. M., Wu, S., Huynh, A. H., Ka, D., Zhao, R., Xia, Y., Zheng, X.
  2024; 245
- **Multiple equilibrium states of a curved-sided hexagram: Part I-stability of states** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*
  Lu, L., Dai, J., Leanza, S., Zhao, R., Hutchinson, J. W.
  2023; 180
- **Multiple equilibrium states of a curved-sided hexagram: Part II-Transitions between states** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*
  Lu, L., Dai, J., Leanza, S., Hutchinson, J. W., Zhao, R.
  2023; 180
- **Origami With Rotational Symmetry: A Review on Their Mechanics and Design** *APPLIED MECHANICS REVIEWS*
  Lu, L., Leanza, S., Zhao, R.
  2023; 75 (5)
- **Liquid Crystal Elastomer - Liquid Metal Composite: Ultrafast, Untethered, And Programmable Actuation by Induction Heating.** *Advanced materials (Deerfield Beach, Fla.)*
  Maurin, V., Chang, Y., Ze, Q., Leanza, S., Wang, J., Zhao, R. R.
  2023: e2302765
- **Magneto-Mechanical Bilayer Metamaterial with Global Area-Preserving Density Tunability for Acoustic Wave Regulation.** *Advanced materials (Deerfield Beach, Fla.)*
  Sim, J., Wu, S., Dai, J., Zhao, R. R.
  2023: e2303541
- **Autonomous alignment and healing in multilayer soft electronics using immiscible dynamic polymers.** *Science (New York, N.Y.)*
  Cooper, C. B., Root, S. E., Michalek, L., Wu, S., Lai, J. C., Khatib, M., Oyakhire, S. T., Zhao, R., Qin, J., Bao, Z.
  2023; 380 (6648): 935-941
- **Active Materials for Functional Origami.** *Advanced materials (Deerfield Beach, Fla.)*
  Leanza, S., Wu, S., Sun, X., Qi, H. J., Zhao, R. R.
  2023: e2302066
- **Easy snap-folding of hexagonal ring origami by geometric modifications** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*
  Lu, L., Leanza, S., Dai, J., Sun, X., Zhao, R.
  2023; 171
- **4D Printing of Freestanding Liquid Crystal Elastomers via Hybrid Additive Manufacturing.** *Advanced materials (Deerfield Beach, Fla.)*
  Peng, X., Wu, S., Sun, X., Yue, L., Montgomery, S. M., Demoly, F., Zhou, K., Zhao, R. R., Qi, H. J.
  2022: e2204890
- **Hexagonal Ring Origami Assemblies: Foldable Functional Structures With Extreme Packing** *JOURNAL OF APPLIED MECHANICS-TRANSACTIONS OF THE ASME*
  Leanza, S., Wu, S., Dai, J., Zhao, R.
  2022; 89 (8)

- **Deep Learning-Accelerated Designs of Tunable Magneto-Mechanical Metamaterials** *ACS APPLIED MATERIALS & INTERFACES*
  Ma, C., Chang, Y., Wu, S., Zhao, R.
  2022; 14 (29): 33892-33902
- **Deep Learning-Accelerated Designs of Tunable Magneto-Mechanical Metamaterials.** *ACS applied materials & interfaces*
  Ma, C., Chang, Y., Wu, S., Zhao, R. R.
  2022
- **Magnetically Actuated Reconfigurable Metamaterials as Conformal Electromagnetic Filters** *ADVANCED INTELLIGENT SYSTEMS*
  Wu, S., Eichenberger, J., Dai, J., Chang, Y., Ghalichechian, N., Zhao, R.
  2022
- **Phase diagram and mechanics of snap-folding of ring origami by twisting** *INTERNATIONAL JOURNAL OF SOLIDS AND STRUCTURES*
  Sun, X., Wu, S., Dai, J., Leanza, S., Yue, L., Yu, L., Jin, Y., Qi, H., Zhao, R.
  2022; 248
- **Spinning-enabled wireless amphibious origami millirobot.** *Nature communications*
  Ze, Q., Wu, S., Dai, J., Leanza, S., Ikeda, G., Yang, P. C., Iaccarino, G., Zhao, R. R.
  2022; 13 (1): 3118
- **Hexagonal ring origami-Snap-folding with large packing ratio** *EXTREME MECHANICS LETTERS*
  Wu, S., Dai, J., Leanza, S., Zhao, R.
  2022; 53
- **Multi-Color 3D Printing via Single-Vat Grayscale Digital Light Processing** *ADVANCED FUNCTIONAL MATERIALS*
  Peng, X., Yue, L., Liang, S., Montgomery, S., Lu, C., Cheng, C., Beyah, R., Zhao, R., Qi, H.
  2022
- **Soft robotic origami crawler.** *Science advances*
  Ze, Q., Wu, S., Nishikawa, J., Dai, J., Sun, Y., Leanza, S., Zemelka, C., Novelino, L. S., Paulino, G. H., Zhao, R. R.
  2022; 8 (13): eabm7834
- **Machine Learning-Evolutionary Algorithm Enabled Design for 4D-Printed Active Composite Structures** *ADVANCED FUNCTIONAL MATERIALS*
  Sun, X., Yue, L., Yu, L., Shao, H., Peng, X., Zhou, K., Demoly, F., Zhao, R., Qi, H.
  2021
- **Deciphering and engineering tissue folding: A mechanical perspective** *ACTA BIOMATERIALIA*
  Zhu, Y., Deng, S., Zhao, X., Xia, G., Zhao, R., Chan, H.
  2021; 134: 32-42
- **Stretchable origami robotic arm with omnidirectional bending and twisting.** *Proceedings of the National Academy of Sciences of the United States of America*
  Wu, S., Ze, Q., Dai, J., Udipi, N., Paulino, G. H., Zhao, R.
  2021; 118 (36)
- **Ring Origami: Snap-Folding of Rings with Different Geometries** *ADVANCED INTELLIGENT SYSTEMS*
  Wu, S., Yue, L., Jin, Y., Sun, X., Zemelka, C., Qi, H., Zhao, R.
  2021; 3 (9)
- **Magnetic Dynamic Polymers for Modular Assembling and Reconfigurable Morphing Architectures** *ADVANCED MATERIALS*
  Kuang, X., Wu, S., Ze, Q., Yue, L., Jin, Y., Montgomery, S., Yang, F., Qi, H., Zhao, R.
  2021; 33 (30): e2102113
- **Adaptive and multifunctional hydrogel hybrid probes for long-term sensing and modulation of neural activity** *NATURE COMMUNICATIONS*
  Park, S., Yuk, H., Zhao, R., Yim, Y., Woldeghebriel, E. W., Kang, J., Canales, A., Fink, Y., Choi, G. B., Zhao, X., Anikeeva, P.
  2021; 12 (1): 3435
- **Preface: Forum on Novel Stimuli-Responsive Materials for 3D Printing** *ACS APPLIED MATERIALS & INTERFACES*
  Qi, H., Ionov, L., Zhao, R.

2021; 13 (11): 12637-12638

- **Magnetic Multimaterial Printing for Multimodal Shape Transformation with Tunable Properties and Shiftable Mechanical Behaviors** *ACS APPLIED MATERIALS & INTERFACES*
  Ma, C., Wu, S., Ze, Q., Kuang, X., Zhang, R., Qi, H., Zhao, R.
  2021; 13 (11): 12639-12648

- **Local Shape-Preserving Formation Maneuver Control of Multi-agent Systems: From 2D to 3D**
  Wan, C., Jing, G., Dai, R., Zhao, R., IEEE
  IEEE.2021: 6251-6257

- **Multifunctional magnetic soft composites: a review.** *Multifunctional materials*
  Wu, S., Hu, W., Ze, Q., Sitti, M., Zhao, R.
  2020; 3 (4): 042003

- **Magneto-Mechanical Metamaterials with Widely Tunable Mechanical Properties and Acoustic Bandgaps** *ADVANCED FUNCTIONAL MATERIALS*
  Montgomery, S., Wu, S., Kuang, X., Armstrong, C. D., Zemelka, C., Ze, Q., Zhang, R., Zhao, R., Qi, H.
  2021; 31 (3)

- **Untethered control of functional origami microrobots with distributed actuation** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Novelino, L. S., Ze, Q., Wu, S., Paulino, G. H., Zhao, R.
  2020; 117 (39): 24096-24101

- **Self-adaptive flexible valve as passive flow regulator** *EXTREME MECHANICS LETTERS*
  Zhang, Q., Peng, X., Weng, S., Zhang, R., Fang, D., Zhao, R., Qi, H.
  2020; 39

- **Micromechanics Study on Actuation Efficiency of Hard-Magnetic Soft Active Materials** *JOURNAL OF APPLIED MECHANICS-TRANSACTIONS OF THE ASME*
  Zhang, R., Wu, S., Ze, Q., Zhao, R.
  2020; 87 (9)

- **Evolutionary Algorithm-Guided Voxel-Encoding Printing of Functional Hard-Magnetic Soft Active Materials** *ADVANCED INTELLIGENT SYSTEMS*
  Wu, S., Hamel, C. M., Ze, Q., Yang, F., Qi, H., Zhao, R.
  2020; 2 (8)

- **Magnetoactuated Reconfigurable Antennas on Hard-Magnetic Soft Substrates and E-Threads** *IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION*
  Alharbi, S., Ze, Q., Zhao, R., Kiourti, A.
  2020; 68 (8): 5882-5892

- **Magnetic Shape Memory Polymers with Integrated Multifunctional Shape Manipulation** *ADVANCED MATERIALS*
  Ze, Q., Kuang, X., Wu, S., Wong, J., Montgomery, S., Zhang, R., Kovitz, J. M., Yang, F., Qi, H., Zhao, R.
  2020; 32 (4): e1906657

- **Symmetry-Breaking Actuation Mechanism for Soft Robotics and Active Metamaterials** *ACS APPLIED MATERIALS & INTERFACES*
  Wu, S., Ze, Q., Zhang, R., Hu, N., Cheng, Y., Yang, F., Zhao, R.
  2019; 11 (44): 41649-41658

- **Mechanics of hard-magnetic soft materials** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*
  Zhao, R., Kim, Y., Chester, S. A., Sharma, P., Zhao, X.
  2019; 124: 244-263

- **Soft wall-climbing robots** *SCIENCE ROBOTICS*
  Gu, G., Zou, J., Zhao, R., Zhao, X., Zhu, X.
  2018; 3 (25)

- **Controlled crack propagation for atomic precision handling of wafer-scale two-dimensional materials** *SCIENCE*

Shim, J., Bae, S., Kong, W., Lee, D., Qiao, K., Nezich, D., Park, Y., Zhao, R., Sundaram, S., Li, X., Yeon, H., Choi, C., Kum, et al
2018; 362 (6415): 665-+

- **Folding artificial mucosa with cell- laden hydrogels guided by mechanics models** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Chan, H., Zhao, R., Parada, G. A., Meng, H., Leong, K. W., Griffith, L. G., Zhao, X.
  2018; 115 (29): 7503-7508
- **Printing ferromagnetic domains for untethered fast-transforming soft materials** *NATURE*
  Kim, Y., Yuk, H., Zhao, R., Chester, S. A., Zhao, X.
  2018; 558 (7709): 274-+
- **Kirigami enhances film adhesion** *SOFT MATTER*
  Zhao, R., Lin, S., Yuk, H., Zhao, X.
  2018; 14 (13): 2515-2525
- **Multimodal Surface Instabilities in Curved Film-Substrate Structures** *JOURNAL OF APPLIED MECHANICS-TRANSACTIONS OF THE ASME*
  Zhao, R., Zhao, X.
  2017; 84 (8)
- **The primary bilayer ruga-phase diagram I: Localizations in ruga evolution** *EXTREME MECHANICS LETTERS*
  Zhao, R., Zhang, T., Diab, M., Gao, H., Kim, K.
  2015; 4: 76-82
- **Ruga mechanics of creasing: from instantaneous to setback creases** *PROCEEDINGS OF THE ROYAL SOCIETY A-MATHEMATICAL PHYSICAL AND ENGINEERING SCIENCES*
  Diab, M., Zhang, T., Zhao, R., Gao, H., Kim, K.
  2013; 469 (2157)