Yun Bai

Ni Research Group
Mechanical Engineering and Materials Science
Duke University

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Education

Duke University, Durham, NC
Ph.D. in Mechanical Engineering and Materials Science   Jun 2021 – present
Advisor: Xiaoyue Ni
Thesis: *Adaptive smart metamaterial platform for advancing intelligent matter.*

Northwestern University, Evanston, IL
M.S. in Materials Science and Engineering   Sep 2019 – Dec 2020
Advisor: John A. Rogers

Huazhong University of Science and Technology, Wuhan, Hubei, China
B.S. in Materials Science and Engineering   Sep 2015 – Jun 2019
Advisor: Wei Wang
Thesis: *Enhanced degradation of organic contaminants in Fenton-like system.*

Research Interests

Programmable materials, active mechanical metamaterials, robotic materials and smart structures, flexible electronics, precision measurement, non-destructive testing

Journal Publications

Equal Contribution†, Corresponding Author∗

Selected publications

1. **Yun Bai**†, Heling Wang†, Yeguang Xue, Yuxin Pan, Jin-Tae Kim, Xinchen Ni, Tzu-Li Liu, Yiyuan Yang, Mengdi Han, Yonggang Huang∗, John A. Rogers∗ and Xiaoyue Ni∗, "A dynamically reprogrammable surface with self-evolving shape morphing." *Nature*, 609, 701–708 (2022) [pdf]

2. Xinchen Ni, Haiwen Luan, Jin-Tae Kim, Sam I Rogge, **Yun Bai**, Jean Won Kwak, Shangliangzi Liu, Da Som Yang, Shuo Li, Shupeng Li, Zhengwei Li, Yamin Zhang, Changsheng Wu, Xiaoyue Ni∗, Yonggang Huang∗, Heling Wang∗, and John A. Rogers∗, "Soft shape-programmable surfaces by fast electromagnetic actuation of liquid metal networks." *Nature Communications*, 13, 5576 (2022) [pdf]

3. Yixin Wu†, Mingzheng Wu, Abraham Vázquez-Guardado, Joohee Kim, Xin Zhang, Raudel Avila, Jin-Tae Kim, Yujun Deng, Yongjoon Yu, Sarah Melzer, **Yun Bai**, Hyoseo Yoon, Lingzi Meng, Yi Zhang, Hexia Guo, Liu Hong, Evangelos E. Kanatzidis, Chad R. Haney, Emily A. Waters, Anthony R. Banks, Ziying Hu, Ferrona Lie, Leonardo P. Chamorro, Bernardo L. Sabatini, Yonggang Huang∗, Yevgenia Kozorovitskiy∗ and John A. Rogers∗, "Wireless multi-lateral optofluidic microsystems for real-time programmable optogenetics and photopharmacology." *Nature Communications*, 13, 5571 (2022) [pdf]

Other publications

4. **Yun Bai**†, Doudou Wu, Wei Wang∗, Pei Chen, Fatang Tan, Xinyun Wang, Xueliang Qiao, Po Keung Wong, "Dramatically enhanced degradation of recalcitrant organic contaminants in MgO_2/Fe(III) Fenton-like system by organic chelating agents." *Environmental Research*, 192, 110242, (2021) [pdf]

5. Doudou Wu†, **Yun Bai**, Wei Wang∗, Hongliang Xia, Fatang Tan, Shenghua Zhang, Bin Su, Xinyun Wang, Xueliang Qiao, Po Keung Wong, "Highly pure MgO_2 nanoparticles as robust solid oxidant for enhanced Fenton-like degradation of organic contaminants." *Journal of hazardous materials*, 374, 319-328, (2019) [pdf]

6. Xiaogang Guo[†], Xiaoyue Ni, Jiahong Li, Hang Zhang, Fan Zhang, Huabin Yu, Jun Wu, **Yun Bai**, Hongshuai Lei, Yonggang Huang, John A. Rogers[*] and Yihui Zhang[*], "Designing mechanical metamaterials with kirigami-inspired, hierarchical constructions for giant positive and negative thermal expansion." *Advanced Materials*, 33, 2004919, (2021) [pdf]

7. Da Som Yang[†], Yixin Wu[†], Evangelos E. Kanatzidis[†], Raudel Avila, Mingyu Zhou, **Yun Bai**, Shulin Chen, Yurina Sekine, Joohee Kim, Yujun Deng, Hexia Guo, Yi Zhang, Roozbeh Ghaffari[*], Yonggang Huang[*], and John A. Rogers[*], "3D-printed epidermal sweat microfluidic systems with integrated microcuvettes for precise spectroscopic and fluorometric biochemical assays." *Materials Horizons*, 4992-5003 (2023) [pdf]

   Manuscript in preparation

8. **Yun Bai**[†], Xuebo Yuan, Weng Yang, Heling Wang[*] and Xiaoyue Ni[*], "Digital solid-liquid composite with reprogrammable mechanical behaviors." (to be submitted)

Research Experience

Ni Research Group, Duke University, Durham, NC
Graduate Research Assistant, Jan 2021 - present
Advisor: Xiaoyue Ni
Research: **Programmable materials and shape-morphing metasurface for on-demand adaptability**
– Proposed and developed a digital composite material made of liquid metal-filled voxels in a silicone matrix, capable of switching between soft and rigid states via digitally controlled joule heating, enabling on-demand programming of mechanical properties; this work is the first to demonstrate programmable matter at the materials level, addressing the challenge of achieving true 3D structural and property integrity, and enabling reprogrammable, cohesive, and multidirectional functionality suitable for bulk 3D applications.
– Proposed and developed a programmable metasurface with self-evolving capabilities, composed of filamentary metal traces activated by Lorentz forces from electrical currents within a magnetic field, enabling rapid, complex shape morphing through a stereo-imaging feedback system and optimization algorithm, with applications in precision-driven dynamic soft matter design.
– Investigated a fast, programmable shape-morphing device using liquid metal in elastomeric microfluidics, achieving real-time, reversible 3D transformations via Lorentz forces under a magnetic field, with advancements in smooth, continuous surfaces validated by 3D-DIC, a large shape library for rapid programming, and reprogrammable, load-supporting shape fixation.
– Contributed to diverse collaborative projects in the Ni Lab, including developing a liquid metal-based soft shape sensor, a wearable ultrasound imager, a living matter platform to control bacterial growth, and a deployable shape-morphing device.

Rogers Research Group, Northwestern University, Evanston, IL
Graduate Research Assistant, Sep 2019 - Dec 2020
Advisor: John A. Rogers
Research: **Flexible electronics and microfluidic sweat sensing device**
– Participated in the development and manufacturing of a wireless, battery-free, programmable multilateral optofluidic platform with user-selected modalities for optogenetics, pharmacology, and photopharmacology, featuring mechanically compliant microfluidic and electronic interconnects, dynamic drug delivery control, and real-time programmability for up to 256 devices, enabling in vivo motor behavior control in grouped mice and expanding wireless techniques for studying neural processing in animal models.
– Developed a 3D-printed hard-core/soft-shell microfluidic system that integrates microcuvettes, offering skin-compatible mechanics for wearable microfluidic sensing technologies, with field studies demonstrating applications in evaluating copper, chloride, glucose concentrations, and sweat pH with laboratory-grade accuracy and sensitivity.

Nanomaterials and Surface Technology Lab, HUST, Wuhan, Hubei, China
Undergraduate Research Assistant, Dec 2017 – May 2019
Advisor: Wei Wang
Research: **Nanoparticle oxidants for organic contaminants degradation in water purification**
– Synthesized high-purity MgO_2 nanoparticles and characterized the as-prepared nanoparticles using XRD, SEM, TEM, and FTIR techniques.

- Optimized the preparation method of MgO_2 nanoparticles based on surface oxygen vacancy simulations and validated their activity through degradation experiments of organic dyes and antibacterial tests.
- Investigated the application of chelating agents to enhance the degradation performance of the MgO_2/Fe(III) system, significantly improving the removal of persistent organic contaminants.

Teaching and Mentoring Experience

Teaching assistant
Responsibilities included holding office hours, assisting lecturers in creating homework, guiding laboratory sections, preparing solutions, and grading homework and exams.
- *Structure and Properties of Solids ME221DL*, Jan 2022 - May 2022. Instructor: Prof. Patrick McGuire
- *Structure and Properties of Solids ME221L*, Jan 2023 - May 2023. Instructor: Prof. Xiaoyue Ni

Mentor for Summer undergraduate research program
Supervised two undergraduate research assistants
- Xiangyu Lu (Currently at University of Michigan), Aerospace Engineering, Tsinghua University, Jun 2023 – Sep 2023
- Muyan Zhang, Materials Science and Engineering, Tsinghua University, Jun 2024 – Sep 2024

Research mentor
Supervised two undergraduate research assistants
- David Prada, Mechanical Engineering and Materials Science, Duke University, Sep 2022 – Jun 2024
- William Yunseung Kim, Mechanical Engineering, Duke University, Mar 2022 – Sep 2022

Honors and Awards

MRS Graduate Student Gold Award, USA, 2025
Best Research Poster Award at the Gordon Research Conference, USA, 2024
Chinese Government Award for Outstanding Self-financed Students Abroad, (Exceptional excellence), China, 2022
University Merit Student Scholarship, Wuhan, China, 2018
Learning Merit Scholarship, Wuhan, China, 2018
Scholarship for Academic Progress , Wuhan, China, 2017

Conference Presentations

Oral Presentations

1. "Digital composite with reprogrammable mechanical behaviors" MRS spring, San Seattle, WA, Apr 2025
2. "Robotic surface with closed-loop shape morphing" MRS spring, San Francisco, CA, Mar 2023
   (served as Symposium Assistant)

Poster Presentations

1. "Digital composite with independently programmable mechanical properties" Gordon Research Conference, Ventura, CA, Feb 2024
2. "Digital composite with programmable mechanical behaviors" Duke Advanced Multifunctional Metamaterials (AMM) Workshop, Durham, NC, Nov 2024