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Highlights

Multidisciplinary research background experienced and specialized in design and development of soft/stretchable, curvilinear electronics including curved imaging sensors and stretchable circuits and implantable electronic devices such as biosensors, wireless stimulators, and health monitoring devices for applications in advanced imaging, biomedical diagnosis and therapy by combining efforts in manufacturing technologies, materials engineering, mechanical design, and electronics and sensors development.

Dr. Rao's academic achievement could be summarized:

- ✓ Authored 28 publications with 4 in Nature Electronics, 6 in Science Advances, 2 in Nature Communications, and among several other journals. (8 first/co-first authored papers)
- ✓ Participated in and drafted grant proposals (40+).
- ✓ Mentoring students and managing lab operation for 5 years.

A. EDUCATION

Ph.D. in Materials Science and Engineering, University of Houston, USA — Dec. 2021
Advisor: Dr. Cunjiang Yu

MS in Chemistry, University of Science & Technology of China, China — Jun. 2015
Advisor: Dr. Yujie Xiong

BS in Chemistry, Xidian University, China — Jul. 2012

B. PROFESSIONAL EXPERIENCE

Postdoctoral fellow, Department of Engineering Science and Mechanics, Pennsylvania State University, Pennsylvania, USA,
Advisor: Dr. Cunjiang Yu, Jan. 2022– Jan. 2025
Visiting scholar, Materials Research Laboratory, University of Illinois Urbana-Champaign, Illinois, USA,
Advisor: Dr. Cunjiang Yu, Jul. 2024– Dec. 2024

C. RESEARCH EXPERIENCE

Direction 1: Soft optoelectronic interface for noninvasive, untethered modulation of cells and tissues

- ➢ Innovate a soft, substrate-free, untethered, and non-genetic cardiac stimulator in a rubbery format.
- ➢ Modulated activities of excitable cells using soft, ultrathin optoelectronic devices as prosthesis.
- ➢ Designed and developed soft electrode arrays to interface biological tissues including cardiomyocytes, neuron organoid, and spine cord for recording and stimulation.

Direction 2: Soft and curvilinear electronics for healthcare and hemispherical biomimicry imaging

- Initiated and developed novel kirigami-structured silicon optoelectronic array with simultaneously high stretchability and high pixel fill factor for shape-adaptable, curvy imager with reduced optical aberration and biomimetic accommodation.
- Design and solution-processed fabrication of soft unnoticeable multifunctional electronics including transistors, memory, and temperature, strain, and UV sensors based on indium zinc oxide to build a closed-loop human-machine interface.

Direction 3: Rubbery electronics for artificial skins and seamlessly interfacing biological species

- Developed rubbery artificial skin with transistor multiplexed pressure sensitive active matrix, where the mobility of rubbery semiconductor is improved by 10 times through metallic CNTs doping.
- Employed all organic rubbery electronic materials to build a transistor multiplexed pressure sensitive active matrix for artificial robotic skin.
- Developed fully soft adaptive autonomous robot based on electronized magnetic actuator with abilities in detecting optical stimuli, deforming soft body, and examining the actuation.
- Multifunctional rubbery epicardial heart patch that matches the mechanical softness of heart tissue and can perform spatiotemporal mapping of electrophysiological activity, as well as strain and temperature sensing.

D. HONORS & AWARDS

- 2021, Chinese Government Award for Outstanding Students Studying Abroad
- 2020, Mechanical Engineering Graduate Scholarship, University of Houston
- 2019, Mechanical Engineering Graduate Scholarship, University of Houston
- 2019, Cora Hawley Scholarship from TcSUH, University of Houston
- 2015, P&G Outstanding Graduates Scholarship, Chinese Academy of Sciences
- 2015, Excellent Graduate Award, Anhui Province

E. JOURNAL PUBLICATIONS

1. **Z. Rao**, F. Ershad, Y. Guan, F. Mesquita, E. Costa, M. Morales-Garza, A. Moctezuma-Ramirez, B. Kan, Y. Lu, S. Patel, H. Shim, K. Cheng, W. Wu, T. Haideri, X. L. Lian, A. Karim, J. Yang, A. Elgalad, C. Hochman-Mendez, and C. Yu. Ultrathin rubbery bio-optoelectronic stimulators for untethered cardiac stimulation, *Science Advances,* 2024, 10, eadq5061.
2. F. Ershad[#], **Z. Rao**[#], S. Maharajan[#], F. Mesquita, J. Ha, L. Gonzalez, T. Haideri, E. Curty da Costa, A. Moctezuma-Ramirez, Y. Wang, S. Jang, Y. Lu, S. Patel, X. Wang, Y. Tao, J. Weygant, C. Garciamendez-Mijares, L. lark, M. Zubair, X. L. Lian, A. Elgalad, J. Yang, C. Hochman-Mendez, Y. S. Zhang, C. Yu, Bioprinted optoelectronically active cardiac tissues. *Science Advances,* 2025, 1, eadt7210. (# equal contribution)
3. **Z. Rao**, Y. Lu, Y. Liu, and C. Yu. Microprinting on curved surfaces with sugar. Matter, 2023, 6(3): 671-673.
4. **Z. Rao**[#], Y. Lu[#], Z. Li, K. Sim, Z. Ma, J. Xiao, and C. Yu. Curvy, shape-adaptive imagers based on printed optoelectronic pixels with a kirigami design. Nature Electronics, 2021, 4(7): 513-521. (# equal contribution)
5. **Z. Rao**, A. Thukral, P. Yang, Y. Lu, H. Shim, W. Wu, A. Karim, and C. Yu. All-polymer based stretchable rubbery electronics and sensors. Advanced Functional Materials, 2021, 32(15): 2111232.

   –Selected as the Back Cover of the issue

6. **Z. Rao**[#], F. Ershad[#], A. Almasri, L. Gonzalez, X. Wu, and C. Yu. Soft electronics for the skin: from health monitors to human–machine interfaces. Advanced Materials Technologies, 2020, 5(9): 2000233. (# equal contribution)

   –Selected as the Frontispiece of the issue

   –Hall of Fame Article of Advanced Materials Technologies.

7. R. Long[#], **Z. Rao**[#], K. Mao, Y. Li, C. Zhang, Q. Liu, C. Wang, Z. Li, X. Wu, and Y. Xiong. Efficient coupling of solar energy to catalytic hydrogenation by using well-designed palladium nanostructures. Angewandte Chemie International Edition, 2015, 127(8): 2455-2460. (# equal contribution)

8. **Z. Rao**, R. Long, and Y. Xiong. One-step synthesized Pd concave nanostructures for HCOOH electrooxidation. Journal of University of Science and Technology of China, 2015, 11: 923-927.

9. J. Hong, **Z. Rao**, S. Duan, S. Xiang, X. Wei, Y. Xiao, Y. Chen, H. Sheng, J. Xia, W. Lei, C. Yu, Q. Shi, J. Wu. A paradigm shift toward active resistive sensing driven by triboelectric nanogenerator, Nano Energy, 2024, 131:110327

10. F. Ershad, M. Houston, S. Patel, L. Contreras, B. Koirala, Y. Lu, **Z. Rao**, Y. Liu, N. Dias, A. Haces-Garcia, W. Zhu, Y. Zhang, and C. Yu. Customizable, reconfigurable, and anatomically coordinated large-area, high-density electromyography from drawn-on-skin electrode arrays. PNAS Nexus, 2023, 2(1), pgac291.

11. Y. Guan, F. Ershad, **Z. Rao**, Z. Ke, E. Costa, Q. Xiang, Y. Lu, X. Wang, J. Mei, P. Vanderslice, C. Hochman-Mendez, and C. Yu. Elastic electronics based on micromesh-structured rubbery semiconductor films. Nature Electronics, 2022, 5(12): 881-892.

12. N. Prodan, F. Ershad, A. Reyes-Alcaraz, L. Li, B. Mistretta, L. Gonzalez, **Z. Rao**, C. Yu, P. H. Gunaratne, N. Li, R. J. Schwartz, B. K. McConnell. Direct Reprogramming of Cardiomyocytes into Cardiac Purkinje-like Cells. iScience, 2022, *25*(11), 105402.

13. S. Patel, F. Ershad, J. Lee, L. Chacon-Alberty, Y. Wang, M. A. Morales-Garza, A. Haces-Garcia, S. Jang, L. Gonzalez, L. Contreras, A. Agarwal, **Z. Rao**, G. Liu, I. R. Efimov, Y. S. Zhang, M. Zhao, R. R. Isseroff, A. Karim, A. Elgalad, W. Zhu, X. Wu, and C. Yu, Drawn-on-Skin Sensors from Fully Biocompatible Inks toward High-Quality Electrophysiology, Small, 2022, 2107099.

    –Selected as the Back Cover of the issue

14. B. Kan, F. Ershad, **Z. Rao**, and C. Yu. Flexible organic solar cells for biomedical devices. Nano Research, 2021, 14: 2891-2903.

15. H. Shim, S. Jang, J. Jang, **Z. Rao**, J. Hong, K. Sim, and C. Yu. Fully rubbery synaptic transistors made out of all-organic materials for elastic neurological electronic skin. Nano Research, 2021, 15: 758–764.

16. M. K. Hogan, S. M. Barber, **Z. Rao**, B. R. Kondiles, M. Huang, W. J. Steele, C. Yu, and P. J. Horner. A wireless spinal stimulation system for ventral activation of the rat cervical spinal cord. Scientific Reports, 2021, 11(1): 14900.

17. Y. Guan, A. Thukral, S. Zhang, K. Sim, X. Wang, Y. Zhang, F. Ershad, **Z. Rao**, F. Pan, P. Wang, J. Xiao, and C. Yu, Air/water interfacial assembled rubbery semiconducting nanofilm for fully rubbery integrated electronics, Science Advances, 2020, 6(38): eabb3656.

18. F. Ershad, A. Thukral, J. Yue, P. Comeaux, Y. Lu, H. Shim, K. Sim, N. Kim, **Z. Rao**, R. Guevara, L. Contreras, F. Pan, Y. Zhang, Y. Guan, P. Yang, X. Wang, P. Wang, X. Wu, and C. Yu, Ultra-conformal drawn-on-Skin electronics for multifunctional motion artifact-free sensing and point-of-care treatment, Nature Communications, 2020, 11(1): 1-13.

    –2020 Top 50 Chemistry and Materials Sciences Articles in Nature Communications

–This work has been highlighted by many media outlets, such as Science Daily, Scientific American, Physics World, EurekAlert, Fast Company, etc.

19. W. Wang, J. Chen, J. Lundh, S. Shervin, S. Oh, S. Pouladi, **Z. Rao**, J. Kim, M. Kwon, X. Li, S. Choi J. Ryou. Modulation of the 2-dimensional electron gas channel in flexible AlGaN/GaN high-electron-mobility transistors by mechanical bending. Applied Physics Letters, 2020, 116(12): 3501.
20. K. Sim, F. Ershad, Y. Zhang, P. Yang, H. Shim, **Z. Rao**, Y. Lu, A. Thukral, A. Elgalad, Y. Xi, B. Tian, D. A. Taylor, and C. Yu. An epicardial bioelectronic patch made from soft rubbery materials and capable of spatiotemporal mapping of electrophysiological activity. Nature Electronics, 2020, 3(12): 775-784.
21. K. Sim, S. Chen, Z. Li, **Z. Rao**, J. Liu, Y. Lu, S. Jang, F. Ershad, J. Chen, J. Xiao, and C. Yu. Three-dimensional curvy electronics enabled by conformal additive stamp printing. Nature Electronics, 2019, 2(10): 471-479.

    –Selected as the Cover the issue
22. H. Shim, K. Sim, F. Ershad, P. Yang, A. Thukral, **Z. Rao**, H. Kim, Y. Liu, X. Wang, G. Gu, L. Gao, X. Wang, Y. Chai, and C. Yu. Stretchable Elastic synaptic transistors for neurologically integrated soft engineering systems. Science Advance, 2019, 5(10): eaax4961.
23. K. Sim, **Z. Rao**, H. Kim, A. Thukral, H. Shim, and C. Yu. Fully rubbery integrated electronics from high effective mobility intrinsically stretchable semiconductors. Science Advances, 2019, 5(2): eaav5749.
24. K. Sim, **Z. Rao**, F. Ershad, and C. Yu. Rubbery electronics fully made of stretchable elastomeric electronic materials. Advanced Materials, 2019, 32(15): 1902417.

    –Selected as Inside Back Cover of the issue
25. K. Sim, **Z. Rao**, Z. Zhou, J. Lei, A. Thukral, J. Chen, Q. Huang, J. Xiao, and C. Yu. Metal oxide semiconductor nano membrane based soft unnoticeable multifunctional electronics for wearable human machine interface. Science Advances, 2019, 5(8): eaav9653.

    –Selected as Cover of the issue
26. K. Sim, **Z. Rao**, Y. Li, D. Yang, and C. Yu. Curvy surface conformal ultra-thin transfer printed Si optoelectronic penetrating microprobe arrays. npj Flexible Electronics, 2018, 2(1): 1.
27. C. Wang, K. Sim, J. Chen, H. Kim, **Z. Rao**, Y. Li, W. Chen, J. Song, R. Verduzco, and C. Yu. Soft ultrathin electronics innervated adaptive fully soft robots. Advanced Materials, 2018, 30(13): 1706695.
28. A. Thukral, F. Ershad, N. Enan, **Z. Rao**, and C. Yu. Soft ultrathin silicon electronics for soft neural interfaces. IEEE Nanotechnology Magazine, 2018, 12(1): 21-34.

F. CONFERENCE PRESENTATION

1. **Z. Rao**, F. Ershad, and C. Yu. Untethered Cardiac Stimulation and Pacing Enabled by Ultra-thin Rubbery Bio-optoelectronic Stimulators, 2024 MRS Spring Meeting & Exhibit, 22-26, Apr. 2024, Seattle, WA, USA.
2. **Z. Rao**, and C. Yu. Shape-Adaptive Curvy Imager Manufactured by Conformal Additive Stamp Printing, Society of Engineering Science 2022; 16-21, Oct. 2022, College Station, TX, USA.

G. TEACHING EXPERIENCE

2016-2017, Mechanical Engineering, University of Houston
Teaching Assistant, Material Science and Engineering