

**James H. Pikul**

Assistant Professor, Department of Mechanical Engineering and Applied Mechanics  
University of Pennsylvania  
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**EDUCATION**

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**Doctor of Philosophy in Mechanical Engineering** December 2015

University of Illinois at Urbana – Champaign

*Dissertation title:* “Design and fabrication of high power microbatteries and high specific strength cellular solids from bicontinuous microporous hierarchical materials”

*Advisers:* Professors William P. King and Paul V. Braun

**Master of Science in Mechanical Engineering** May 2011

University of Illinois at Urbana – Champaign

*Thesis title:* “High precision electrohydrodynamic printing of polymer onto microcantilever sensors”

*Advisers:* Professor William P. King

**Bachelor of Science in Mechanical Engineering** May 2009

University of Illinois at Urbana – Champaign

Highest Honors and Bronze Tablet

Minors: Heoft Technology and Management Program, International Minor in Engineering – Japanese Studies

**RESEARCH EXPERIENCE**

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**Assistant Professor** May 2017 – present

*Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania*

- My lab seeks to make transformative advances in energy storage, multifunctional materials, and robotics by understanding and exploiting electrochemistry and soft matter physics.

**Postdoctoral Associate** November 2015 – May 2017

*Department of Mechanical and Aerospace Engineering and Department of Physics, Cornell University*

*Advisers:* Professors Robert Shepherd (Mechanical Engineering) and Itai Cohen (Physics)

**Design and fabrication of shape transforming stretchable surfaces**

- Drew inspiration from cephalopod skin musculature to solve the design and control challenges of programming 2-D stretchable surfaces that reversibly inflate into target 3-D shapes. This technology, for the first time, enabled highly textured features that can be programmed to complex 3-D shapes and dynamically camouflage into natural environments.
- Developed a thiol-ene based 3-D printing resin for low modulus and highly stretchable elastomers.
- Guided 7 undergraduates in the development and testing of an underwater hydrojetting engine powered by combustion in stretchable membranes, designed for a robotic rover to operate in extraterrestrial oceans.

**Department of Energy Office of Science Graduate Fellow** August 2011 – November 2015

*Department of Mechanical Engineering, University of Illinois at Urbana-Champaign*

*Advisers:* Professors William P. King (Mechanical Engineering) and Paul Braun (Materials Science)

### **High power lithium ion microbatteries**

- Fabricated high power microbatteries with 3-D interdigitated bicontinuous architecture that allowed nm – cm control of ion and electron transport physics. The microbatteries had 7.4 mW cm<sup>-2</sup> μm<sup>-1</sup> power density, which is similar to supercapacitors, 100X more powerful than conventional batteries, and a 2,000X improvement over other microbatteries.
- The high power architecture reduces adiabatic temperature rise in batteries by more than 50% at low discharge rates: demonstrating a new architecture based approach for improving battery safety.
- Modeled ion and electron transport physics to simulate battery discharge performance at up to 600 C rate discharges, higher than the 25 C rate in previous models, and guide battery design.

### **High strength cellular solids**

- Developed large area cellular solids from self-assembly, having 230 MPa/(Mg m<sup>-3</sup>) specific strengths and controllable specific moduli between 4-20 GPa/(Mg m<sup>-3</sup>). The cellular solids are stronger than most engineering alloys and the moduli are comparable to wood and bone.

### **College of Engineering Carver Fellow**

August 2009 – May 2011

*Department of Mechanical Engineering, University of Illinois at Urbana-Champaign*

- Developed a method to deposit picogram droplets of molten polymer on to microsensors using electrohydrodynamic jet printing – a rapid nanomanufacturing technology.

### **National Institute for Nano-engineering Intern**

July – August 2010

*Sandia National Laboratory (Albuquerque, New Mexico)*

- Demonstrated self-assembly of micelles using surface energy and surface charge functionalization.
- Developed imprint lithography based fabrication of regular 2-D templates for self-assembly.

### **Intern - large scale manufacturing of micro structures**

June – August 2008

*10X Technologies*

- Headed the research, development and prototyping for a “next generation” micro-razor funded by a Fortune 500 company. Managed a two person development team.
- Assisted with the design/operation of large scale micro-embossing manufacturing equipment.

## **TEACHING AND MENTORING EXPERIENCE**

### **Assistant Professor**

May 2017 – Present

- Teach graduate level electrochemistry (MEAM 580-Electrochemistry for Energy, Nanofabrication and Sensing) and Introduction to Mechanics (MEAM 110) for freshman.
- Advise 4 Ph.D. students as their primary mentor and 1 post-doc.
- Mentored 3 masters students and 11 undergraduate research assistants, 6 of which are women.

### **Founder**

June 2012 – February 2015

*TFC*

- Founded TFC and grew it from 4 to 26 members in year one. TFC is a group of local entrepreneurs and students who who discuss topics from innovation, to science and great books.

- Fostered an environment that resulted in the formation of two companies, Perform Electronics Inc. and Petronics Inc., and \$2,000,000+ in outside funding. Several other companies including OSO Technologies and WinginOut LLC. also received collaborative support from members.

**Graduate mentor**

August 2011 – May 2014

*Department of Materials Science and Engineering, University of Illinois*

- Mentored two undergraduates in experimental design, material synthesis, and data analysis for a total of 5 years. One student won a NSF graduate fellowship and attends MIT for graduate school.

**National Nanotechnology Infrastructure Network Winter School (Bangalore, India) Jan. 2011**

- One of thirteen graduate students in the United States chosen to attend a one week interactive course on nanotechnology with Indian students and faculty.
- Spent the second week in rural India learning the needs of rapidly growing micro-economies, how to leverage emerging technologies in the developing world, and educating youth scientists.

**PROFESSIONAL EXPERIENCE**

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**Co-founder**

August 2020 – present

*Metal Light Inc*

- Developing metal-air scavenging innovations to power off-grid electronics and back up utilities with cheap and prevalent metal sheets and hydrogel electrolytes.

**Co-founder**

May 2014 – May 2016

*Petronics Inc.*

- Conducted product development, business strategy, and marketing for in-home robotic platforms that uses artificial intelligence and adaptive sensing to sense and react to humans and animals.
- Lead the marketing for our Mousr Kickstarter campaign where we raised \$116,965.

**President and Co-founder**

April 2013 - present

*Jád Naturals Inc.*

- Created a natural skin care line for consumers with dry skin, sensitive skin, psoriasis, and rosacea.
- Developed the formula and chemical processing for three natural, preservative free, hypoallergenic, and filler free skin care products that retain the feel of conventional skin care products.
- Conducted product development, marketing, branding, and sales of our growing product lines which are currently sold online, in five stores, and a medical practice.
- Customer Feedback: “The roll on body serum has transformed my 10-year old's psoriasis in about 3 weeks. Seriously, he has had it for years, and it is almost gone! ... We have completely stopped using steroidal creme. My son asked me to write you immediately because we are both feeling grateful”.

**HONORS AND AWARDS**

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2020 Moore Inventor Fellow

September 2020

2020 Toyota Programmable System Innovation Fellowship

September 2020

- Best Paper Award at The 19th International Conference on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (IEEE PowerMEMS), Krakow, 2019 December 2019
- NSF CAREER award in ECCS - CCSS November 2019
- Scialog Fellow through the Research Corporation for Science Advancement – Advanced Energy Storage, October 2019 October 2019
- Office of Naval Research Young Investigator Award January 2019
- Materials Research Society Gold Award December 2013
- Students who show promise for significant achievement in materials science.
  - The top student award for the international Materials Research Society.
- Materials Research Society Science as Art Silver Award December 2013
- Award for a scientific image that transcends its role as a medium for transmitting information into objects of beauty and art.
- Lisle Abbot Rose Memorial Award May 2009
- For academic excellence and cultural breadth, depth, and sensitivity.
- Several fellowships including the Department of Energy Office of Science Graduate Fellowship, College of Engineering Carver Fellowship, and IPENG International Engineering Fellowship.

### **INVITED TALKS**

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- “Robots that eat, breath, and bleed”, Johns Hopkins Applied Physics Lab, Lexington Park, Maryland, 2020.
- “Electrolytic Vascular Systems for Energy Dense Soft Robots”, Soft Robotics and Robot Learning Workshop, New York City, New York, 2019
- “Self-assembly of ultra-high strength nanoporous metals for multifunctional coatings and free-standing films”, 2019 International Conference on Metallurgical Coatings and Thin Films, San Diego, CA, 2019
- “Electrochemistry for morphogenesis, energy transduction, and energy transport”, “Chemo-structural Dynamics” Army Science Planning and Strategy Meeting, Rice University, Houston, TX, 2019
- “Ultra-high strength nanoporous foams as a platform for multifunctional structural materials”, Texas A and M University Seminar, College Station, TX, 2018.
- “Performance modeling and design of ultra-high power microbatteries”, Beyond Li-ion XI, NASA Glenn Research Center, OH, 2018
- “High strength and high performance hierarchical materials through nanoscale engineering”, Engineering Precision Dental Medicine Workshop, University of Pennsylvania, May 2018
- "Developing revolutionary high power lithium ion microbatteries", The Battery Show, Novi, MI, 2013
- "High power lithium ion microbatteries", Nano-EP, Urbana, IL, 2013
- "High power lithium ion microbatteries", Xerion Advanced Battery Corp., Champaign, IL, 2012
- “Soft robots: from locomotion to texture morphing skins”, Matter Design Computation Symposium, Ithaca, NY, 2017

## JOURNAL PUBLICATIONS

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25. Zhimin Jiang, Zakaria Hsain, and **James H. Pikul**. "Thick free-standing metallic inverse opals enabled by new insights into the fracture of drying particle films" *Langmuir*, 2020.
24. Xiujun Yue, Jessica Grzyb, Akaash Padmanabha, and **James H. Pikul**. "A Minimal Volume Hermetic Packaging Design for High-Energy-Density Micro-Energy Systems" *Energies* vol. 13, no. 10, pp. 2492, 2020.
23. Min Wang, Unnati Joshi, **James H. Pikul**, "Powering electronics by scavenging energy from external metals" *ACS Energy Letters*, vol. 5, no.3, pp. 758-765, 2020.
22. Michael Synodis, **James Pikul**, Sue Ann Bidstrup Allen, and Mark G. Allen. "Vertically integrated high voltage Zn-Air batteries enabled by stacked multilayer electrodeposition", *Journal of Power Sources*, vol. 449 pp. 227566, 2020.
21. **James H. Pikul**, Jeffrey W. Long, "Architected materials for advanced electrochemical systems", *MRS Bulletin*, vol. 44, no. 10, pp. 789-795, 2019. [Invited by Julia Greer and Vikram Deshpande]
20. Zakaria Hsain, **James H. Pikul**, "Low-energy Room-temperature Healing of Cellular Metals", *Advanced Functional Materials*, pp. 1905631, August 2019.
19. Cameron A. Aubin, Snehashis Choudhury, Rhiannon Jerch, Lynden A. Archer, **James H. Pikul**, Robert F. Shepherd, "Electrolytic Vascular Systems for Energy Dense Robots", *Nature*, 1, June, 2019.
18. **James H. Pikul**, Sezer Özerinç, Burigede Liu, Runyu Zhang, Paul V. Braun, Vikram S. Deshpande, William P. King, "High strength metallic wood from nanostructured nickel inverse opal materials", *Scientific Reports*, 9.1, 2019. **Top 100 downloaded materials science papers for Scientific Reports in 2019.**
17. Steven Ceron, Itai Cohen, Robert F. Shepherd, **James H. Pikul**, Cindy Harnett, "Fiber Embroidery of Self-Sensing Soft Actuators", *Biomimetics*, vol. 3, September 2018.
16. **James H. Pikul**, Hailong Ning, "Powering the internet of things", *Joule*, vol. 2, pp. 1036–1038, June 20, 2018.
15. T.J. Wallin, **James Pikul**, Robert F. Shepherd, "3D printing of soft robotic systems", *Nature Reviews Materials*, May 4, 2018.
14. Dean Keithly, John Whitehead, Alexandra Voinea, Diego Horna, Samantha Hollenberg, Mason Peck, **James Pikul**, Robert F. Shepherd, "A cephalopod-inspired combustion powered hydro-jet engine using soft actuators", *Extreme Mechanics Letters*, January 6, 2018.
13. **James H. Pikul**, Shuo Li, Hedan Bai, Roger T. Hanlon, Itai Cohen, Robert F. Shepherd, "Stretchable surfaces with programmable 3-D texture morphing for synthetic camouflaging skins", *Science*, vol. 358, pp. 210-214, October 18, 2017.
12. T.J. Wallin, **J.H. Pikul**, S. Bodkhe, B.N. Peele, B.C. Mac Murray, D. Therriault, B.W. McEnerney, R.P. Dillon, E.P. Giannelis, R.F. Shepherd, "Click chemistry stereolithography for soft robots that self-heal", *Journal of Materials Chemistry B*, vol. 5, pp. 6249-6255, 2017.
11. **James H. Pikul**, Paul V. Braun, William P. King, "Performance modeling and design of ultra-high power microbatteries", *Journal of the Electrochemical Society*, vol. 164.11, pp. E3122-E3131, 2017.
10. **James H. Pikul**, Jinyun Liu, Paul V. Braun, William P. King, "Integration of high capacity materials into interdigitated mesostructured electrodes for high energy and high power density primary microbatteries", *Journal of Power Sources*, vol. 315, pp. 308-315, 2016.

9. Hailong Ning, **James H. Pikul**, Runyu Zhang, Xuejiao Li, Sheng Xu, Junjie Wang, John A. Rogers, William Paul King, and Paul V. Braun, " Holographic Patterning of High Performance on-chip 3D Lithium-ion Microbatteries", Proceeding of the National Academy of Sciences, vol. 112, no. 21, pp. 6573-6578, 2015.
8. **James H. Pikul**, Paul V. Braun, and William P. King, "Micromechanical devices with controllable stiffness fabricated from regular 3D porous materials", Journal of Micromechanics and Microengineering, vol. 24, 105006, 2014
7. Jinyun Liu, Huigang Zhang, Junjie Wang, Jiung Cho, **James Pikul**, Eric Scott Epstein, Xingjiu Huang, Jinhuai Liu, Paul V. Braun, "Hydrothermal Fabrication of Three-Dimensional Secondary Battery Anodes", Advanced Materials, vol. 26, no. 41, pp. 7096-7101, 2014.
6. **James H. Pikul**, Huigang Zhang, Jiung Cho, Paul V. Braun, and William P. King, "High power lithium ion micro batteries from interdigitated three-dimensional bicontinuous nanoporous electrodes", Nature Communications, vol. 4, pp. 1732, 2013
5. Xueqiu You, **James H. Pikul**, William P. King, and James J. Pak, "Zinc oxide inverse opal enzymatic biosensor", Applies Physics Letters, vol. 102, pp. 253103-5, 2013.
4. Elise A. Corbin, Larry J. Millet, **James H. Pikul**, Curtis L. Johnson, John G. Georgiadis, William P. King & Rashid Bashir, " Micromechanical properties of hydrogels measured with MEMS resonant sensors", Biomedical Microdevices, vol. 15, pp. 311 - 319, 2013.
3. Paul V. Braun, Jiung Cho, **James H. Pikul**, William P. King, and Huigang Zhang, "High power rechargeable batteries", Current Opinion in Solid State & Materials Science, vol. 16, pp. 186 - 198, 2012.
2. **James H. Pikul**, Phillip Graf, Sandipan Mishra, Kira Barton, Yong-Kwan Kim, John A. Rogers, Andrew Alleyne, Placid M. Ferreira, and William P. King, "High precision electrohydrodynamic printing of polymer onto microcantilever sensors", IEEE Sensors Journal, vol. 11, pp. 2246 - 2253, 2011.
1. Kevin A. Arpin, **James H. Pikul**, William P. King, H. Fan, and P. V. Braun, "Template directed assembly of dynamic micellar nanoparticles", Soft Matter, vol. 7, pp. 10252-10257, 2011.

## **CONFERENCE PRESENTATIONS**

12. Xiujun Yue, Alissa C. Johnson, Zhimin Jiang, **James. H. Pikul**, "Ultra-High Current Mechanical Energy Harvester Based on Lithium Cobalt Oxide", ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS), 2020.
11. Alissa C. Johnson, **James H. Pikul**, "Perfluorocarbon Emulsions for High Energy Density Synthetic Vascular Systems", ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS), 2020.
10. Min Wang, Unnati Joshi, **James H. Pikul**, "A Metal-Air Scavenger from Hydrogel Electrolytes for Powering Robotics", The Electrochemical Society Fall meeting, 2019, Atlanta, Ga.
9. Zakaria Hsain, **James H. Pikul**, "Electrochemical healing of cellular metals at room temperature", ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS), 2019, Louisville, Ky.
8. Zakaria Hsain, **James H. Pikul**, "Electrochemically-driven transport for room-temperature healing of metallic cellular materials with synthetic vascular systems", Materials Research Society Spring Meeting 2019, Phoenix, Az.
7. Hang Yuan, **James Pikul**, Cynthia Sung, "Programmable 3-D surfaces using origami tessellations", 7th International Meeting on Origami in Science, Mathematics and Education, Oxford, 2018.

6. **James H. Pikul**, Shuo Li, Itai Cohen, and Rob Shepherd, "Texture morphing camouflaging skins", Materials Research Society Spring Meeting 2017, Phoenix, Az.
5. **James H. Pikul**, Paul V. Braun, and William P. King, "High power primary lithium ion microbatteries", Materials Research Society Fall Meeting 2013, Boston, Ma.
4. **James H. Pikul**, Paul V. Braun, and William P. King, "High power primary lithium ion microbatteries", IEEE PowerMEMS 2013, London, UK.
3. **James H. Pikul**, Huigang Zhang, Jiung Cho, Paul V. Braun, and William P. King, "High power lithium ion microbatteries with 3D nanostructured electrodes", Materials Research Society Fall Meeting 2012, Boston, Ma.
2. Kevin A. Arpin, **James H. Pikul**, Hongyu Fan, William P. King, and Paul V. Braun, "Template directed assembly of dynamic micellar nanoparticles," Materials Research Society Fall Meeting 2011, Boston.
1. **James H. Pikul**, Phillip Graf, Sandipan Mishra, Kira Barton, Yong-Kwan Kim, John A. Roger, Andrew Alleyne, Placid M. Ferreira, and William P. King, "High precision polymer deposition onto microcantilever sensors using electrohydrodynamic printing," IEEE Sensors Conference 2010, Hawaii.

## **CONFERENCE PAPERS**

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9. John B. Cook, Alissa Johnson, Xiujun Yue, Ryan Kohlmeyer, Chadd Kiggins, Sungbong Kim Mehmet Nurullah Ates, Aaron Blake, Paul Braun, John D. Busbee, **James H. Pikul**, "Employing Molten Salt Electrodeposition to Produce High Energy Microbatteries for SHort-Range Independent Microrobotic Platforms (SHRIMP)", GOMAC Tech, San Diego, 2020
8. A. Johnson, R. Kohlmeyer, M. N. Ates, C. Kiggins, A. Blake, J. B. Cook, **J. H. Pikul**, "Performance Modeling and Design of High Energy Density Microbatteries", The 19th International Conference on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS), Krakow, 2019 [**Best paper award**]
7. X. Yue, J. Grzyb, A. Padmanabha, **J. H. Pikul**, "A minimal volume hermetic packaging design for high energy density micro energy systems", The 19th International Conference on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS), Krakow, 2019
6. Michael Synodis, **James Pikul**, Sue Ann Bidstrup Allen, and Mark Allen, "Integrated fabrication of serially connected high voltage microbatteries via multilayer electrodeposition", 20th International conference on Solid State Sensors, Actuators, and Microsystems, Berlin, 2019.
5. Hang Yuan, **James Pikul**, Cynthia Sung, "Programmable 3-D surfaces using origami tessellations", 7th International Meeting on Origami in Science, Mathematics and Education, Oxford, 2018.
4. **James H. Pikul**, Sezer Ozerinc, Runyu Zhang, Paul V. Braun, and William P. King, "Micro architected porous material with high strength and controllable stiffness", IEEE Micro Electro Mechanical Systems Conference 2016, Shanghai.
3. **James H. Pikul**, Huigang Zhang, Jiung Cho, Paul V. Braun, and William P. King, "High power lithium ion microbatteries with lithographically defined 3-D porous electrodes," IEEE Micro Electro Mechanical Systems Conference 2013, Taiwan.

2. **James H. Pikul**, Huigang Zhang, Jiung Cho, Tae Wan Kim, Paul V. Braun, and William P. King, "High power lithium ion microbatteries with 3D nanostructured electrodes," Technologies for Future Micro-Nano Manufacturing, Napa, California, 2011.
1. Johnny R. Felts, Patrick C. Fletcher, Suhas Somnath, **James H. Pikul**, Zenting Dai, Woo K. Lee, Paul E. Sheehan, and William P. King, "Nanofabrication using heated probe tips," Micro- and Nanotechnology Sensors, Systems, and Applications III, SPIE Proceedings Volume 8031, 2011.

## **PATENTS**

- James Pikul, Xiujun Yue, Paul Braun, and Sungbong Kim. November 2019. A high energy and power density microbattery with integrated packaging. U.S. Provisional filed Nov. 2019
- James H. Pikul, Min Wang. February 12, 2019. Metal Air Scavenger – An Energy Harvesting Technology For Powering Electronics And Robotics. U.S. Provisional No. 62/804,345.
- James H. Pikul, Zakaria Hsain. November 6, 2018. Healing And Morphogenesis Of Structural Metal Foams and Other Matrix Materials. U.S. Provisional No. 62/756,243.
- James H. Pikul, Itai Cohen, Rob Shepherd. October 13, 2017. Stretchable surfaces with programmable texture. U.S. Provisional No. 62/572,282.
- William P. King, Paul V. Braun, James H. Pikul. Aug. 2, 2016. Three Dimensional (3D) Porous Electrode Architecture for a Microbattery. U.S. 9,406,938 B2.