

# James H. Pikul

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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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### 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  $7.4 \text{ mW cm}^{-2} \mu\text{m}^{-1}$  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  $230 \text{ MPa}/(\text{Mg m}^{-3})$  specific strengths and controllable specific moduli between  $4\text{-}20 \text{ GPa}/(\text{Mg m}^{-3})$ . 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.

July – August 2010

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

*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**

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### **Founder**

June 2012 – February 2015

*Technology Fight Club (TFC)*

- Founded TFC and grew it from 4 to 26 members in year one. TFC is a group of local entrepreneurs and students 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 almost \$200,000 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)**

January 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**

May 2014 – present

*Petronics Inc.*

- Conduct product development, business strategy, and marketing for Mousr, the first intelligent cat toy that uses artificial intelligence and adaptive sensing to sense and react to intelligent stimuli.
- 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, or rosacea.
- Developed the formula and chemical processing for three natural, preservative free, hypoallergenic, and filler free skin care products that retain the luxurious feel of conventional skin care products.
- Conducted product development, marketing, branding, and sales of our growing product lines which are currently held in five grocery stores and a family 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”.

May 2007

### **Technology and Management China Trip**

- Toured manufacturing plants in Tianjin, Nanjing, Beijing, and Shanghai.
- Discussed American business strategy in China with executives from companies including Motorola, Boeing, BP, and Xin Ao

## **HONORS AND AWARDS**

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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.

December 2013

Materials Research Society Science as Art Silver Award

- 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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"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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**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.

**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.

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.

**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

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.

**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 [**Cited 86 times in Web of Science**]

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.

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.

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.

**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.

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.

## JOURNAL PUBLICATIONS IN PREPARATION

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**James H. Pikul**, Sezer Ozerinc, Runyu Zhang, Paul V. Braun, and William P. King, "High strength metallic wood from nickel inverse opal materials", (in preparation)

**James H. Pikul**, Paul V. Braun, and William P. King, "Heat Generation in High Power Battery Architectures", (in preparation)

## CONFERENCE PRESENTATIONS

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**James H. Pikul**, Shuo Li, Itai Cohen, and Rob Shepherd, "Texture morphing camouflaging skins", Materials Research Society Spring Meeting 2017, Pheonix.

- James H. Pikul**, Paul V. Braun, and William P. King, "High power primary lithium ion microbatteries", Materials Research Society Fall Meeting 2013, Boston.
- James H. Pikul**, Paul V. Braun, and William P. King, "High power primary lithium ion microbatteries", IEEE PowerMEMS 2013, London, UK.
- 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.
- 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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- 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.
- 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.
- 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.
- 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.
- 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**

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- 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.