

HAI LIU, Ph.D.

Assistant Professor
School of Electrical, Computer and Energy Engineering
Ira A. Fulton Schools of Engineering | Arizona State University
Tempe, AZ 85287
Email: hailiu@asu.edu

Education

University of Southern California , Los Angeles, CA, USA	Aug. 2016 – Aug. 2022
Ph.D. in Electrical Engineering	
Harbin Institute of Technology , Harbin, Heilongjiang, China	
M.S. in Materials Science	Sep. 2004 - July 2006
B.S. in Metal Materials Engineering	Sep. 2000 - July 2004

Academic Experience

Assistant Professor	August 2026 – present
Electrical, Computer and Energy Engineering, Arizona State University, Tempe, Arizona, USA	
Responsibilities:	
Research and teach advanced semiconductor electronics/photonics packaging and micro-electro-mechanical systems (MEMS), bridging device innovation with applications in computing, communication, sensing, and healthcare.	

Research Assistant (PhD student)	May 2016 - July 2022
Electrical and Computer Engineering, University of Southern California, Los Angeles, CA, USA.	
Advisor: Prof. Eun Sok Kim	
Responsibilities:	
Research and develop innovative MEMS sensors and actuators for healthcare.	

Key achievements

- Designed, modeled, fabricated, and characterized novel piezoelectric MEMS resonant microphone arrays (RMAs) for lung sound monitoring, achieving high sensitivity and a signal-to-noise ratio (SNR) of 79–98 dBA. Integrated the RMAs with machine learning for lung sound classification, demonstrating improved detection of wheezing compared to conventional microphones and paving the way for wearable electronic stethoscopes. Awarded the Outstanding Student Paper Award (18/275) at IEEE MEMS 2020, Vancouver, Canada.
- Researched active noise cancellation (ANC) for hearing aids, developing two RMAs to separately capture speech and noise. Compared to traditional microphones, this approach achieved greater noise cancellation in the ANC, reducing noise levels by -20 to -25 dB, particularly in low-noise environments, due to the RMAs' high SNR.
- Researched novel MEMS ultrasound transducers for acoustic tweezers to trap and rotate particles in liquid for potential biomedical applications. The transducers were fabricated from lead zirconate titanate (PZT) with a patterned polydimethylsiloxane (PDMS) membrane, using soft lithography to achieve the desired acoustic performance.
- Developed two MEMS renewable energy generators: a pyroelectric lithium niobate device for wireless IC tamper detection, and a micro-fabricated coil-and-magnet device for non-resonant broadband vibration energy harvesting in IoT electronics, achieving a power density of up to 200.4 $\mu\text{W}/\text{cm}^3$.

Industrial Experience

Hardware Engineering Technical Leader

Feb 2025 – July 2026

Cisco Systems, Inc., Holmdel, NJ, USA

Responsibilities:

- Research and develop advanced microelectronics packaging for semiconductor electronic IC (EIC) and Si photonics IC (PIC)

Key achievements:

- Led development of 3D packaging integrating a Si photonics IC, electronic driver, and transimpedance amplifier for high-speed optical transceivers supporting AI data communication.
- Led development of optical engines for client optics and co-packaged optics (CPO), integrating PIC, EIC, and a Si switch within a single package for data center applications.

Staff Package Assembly Engineer

July 2022 – Feb 2025

InvenSense, Inc., San Jose, CA, USA

Responsibilities:

- Research and develop advanced microelectronics packaging for MEMS sensors and semiconductor application-specific integrated circuits (ASIC)

Key achievements:

- Led development of an ultra-thin MEMS ultrasonic fingerprint sensor for wearable electronics using wafer-level chip-scale packaging (WLCSP) with through-silicon vias (TSV), resulting in a miniaturized, low-cost, and highly reliable product.
- Led development of a bottom-port, open-cavity package for MEMS ultrasonic time-of-flight sensors used in ranging and presence sensing, resulting in a cost-effective, high-performance solution with strong manufacturability.
- Led development of high-density packaging for MEMS inertial measurement units (IMUs) used in motion sensing.
- Developed the course of WLCSP with MEMS and ASIC Integration.
- Streamlined package development procedures and documentation.

Engineering Summer Intern

May 2017 – August 2017

TE Connectivity Ltd., Fremont, CA, USA.

- Researched and integrated MEMS pressure sensors into invasive medical catheters for fractional flow reserve (FFR) measurement in coronary arteries.

Semiconductor Packaging R&D Engineer

July 2006 - July 2016

Samsung Semiconductor China R&D Co. Ltd., Suzhou, Jiangsu, China

Responsibilities:

- Research and develop advanced semiconductor packaging for high-density memory, advanced processors, and power management integrated circuits.

Key achievements

- Developed a range of advanced semiconductor packaging products, including multi-chip package (MCP) for high-density memory, quad flat no-lead package (QFN) for power management ICs, flip-chip plastic ball grid array (FC PBGA) for TV processors, and chip-on-board (COB) for communication devices.
- Developed Cu wire bonding, offering lower cost and higher performance than traditional Au wire bonding, despite added process and reliability challenges, and led its first high-volume manufacturing (HVM) ramp-up at Samsung, earning the Samsung Electronics R&D Gold Prize.
- Researched the reliability of Cu and Au-Ag wire bonding, identifying key material and process factors affecting reliability in humid environments and exploring solutions for improvement. These

findings were published in top IEEE electronics packaging conferences (ECTC, EPTC) and have been widely cited.

- Researched solder joint reliability across various pad structures and finishes, including dent pads with Cu-OSP finish and flat pads with Ni-Au and various Ag finishes, for the advanced high-density FBGA package.
- Invented novel pad surface finishes, including a hybrid Ni/Au-and-OSP finish offering strong temperature cycle (TC) and drop reliability, and a low-cost Ni-Cu-OSP finish offering strong TC performance to replace the traditional, more expensive Ni/Au finish, resulting in U.S. Patents 9,504,152 B2 and 10,049,970 B2.
- Published 6 peer-reviewed papers and was granted 6 patents.

Honors and awards

- | | |
|--|-----------------------|
| • Outstanding Reviewer Award, Nature Microsystems & Nanoengineering. | Jan. 2024 |
| • Outstanding Student Paper Award Finalist at MEMS 2020 (18/275). | Jan. 2020 |
| • Annenberg Fellowship at USC. | Aug. 2016 – July 2020 |
| • Best Technical Lecturer Award at Samsung | 2013 |
| • Samsung Electronics R&D Gold Prize | 2009 |

Service

- Academic Journal reviewer
 - Springer Nature: Scientific Reports (2023, 2024), Microsystems and Nanoengineering (2023), Microsystem Technologies (2023, 2024)
 - ASME: Journal of Electronics Packaging (2023, 2024, 2025)
 - IEEE: Electronic Device Letter (2023, 2025), IEEE Transactions on Components, Packaging and Manufacturing Technology (2023, 2024), Sensors Journal (2025)
 - MDPI: Micromachines (2023), Sensors (2023, 2024, 2025), Remote Sensing (2023, 2024), Energies (2023), ENG (2023), Applied Science (2023)
 - IOP Publishing: Engineering Research Express (2024), Smart Materials and Structures (2024), Journal of Micromechanics and Microengineering (2025)
 - Other: AME Journal of Thoracic Disease (2023)
- Academic Conference Review Committee - IEEE Sensors 2023, 2024.
- IEEE Senior Members Application Review Panel (2025)

Membership

- IEEE Senior Member

Publications

Semiconductor Packaging

- [1] Liu, Hai, Li Jin, Liqun Gu, Juanjuan Li, Ying Li, Qiang Chen, Maouha Du, Jianwei Zhou, and TaeSub Chang. "Solder joint reliability with various silver finish on PCB." In 2014 15th International Conference on Electronic Packaging Technology, pp. 396-400. IEEE, 2014.
- [2] Liu, Hai, Zhenqing Zhao, Qiang Chen, Jianwei Zhou, Maohua Du, Senyun Kim, Jonghyun Chae, and Myungkee Chung. "Reliability of copper wire bonding in humidity environment." In 2011 IEEE 13th Electronics Packaging Technology Conference, pp. 53-58. IEEE, 2011.
- [3] Chen, Qiang, Zhenqing Zhao, Hai Liu, Jonghyun Chae, Senyun Kim, and Myungkee Chung. "Investigation of various pad structure influence for copper wire bondability." In 2011 12th International Conference on Electronic Packaging Technology and High Density Packaging, pp. 1-4. IEEE, 2011.

- [4] Liu, Hai, Qi Chen, Zhenqing Zhao, Qian Wang, Jianfeng Zeng, and Jonghyun Chae. "Reliability of Au-Ag alloy wire bonding." In 2010 Proceedings 60th Electronic Components and Technology Conference (ECTC), pp. 234-239. IEEE, 2010.
- [5] Zhang, Jing, Hai Liu, and Jaisung Lee. "Board level cyclic bending test for MCP package." In 2007 9th Electronics Packaging Technology Conference, pp. 459-462. IEEE, 2007.
- [6] Liu, Hai, Jing Zhang, Song Chen, Maohua Du, Nufeng Feng, Qian Wang, and Taekoo Lee. "Board level thermal cycle reliability of BGA for a new type of pad structure with OSP surface finish." In 2007 8th International Conference on Electronic Packaging Technology, pp. 1-3. IEEE, 2007.

MEMS Resonant Microphone Array (RMA)

- [7] Sengupta, Anik, Akash Roy, Hongxiang Gao, Matin Barekatin, Hai Liu, and Eun Sok Kim. "Wearable Stethoscope Based on Resonant Microphone Array with Wireless Data Transfer." In 2024 IEEE 37th International Conference on Micro Electro Mechanical Systems (MEMS), pp. 101-104.
- [8] Liu, Hai, M. Barekatin, A. Roy, S. Liu, Y. Cao, Y. Tang, A. Shkel and E.S. Kim, "MEMS Piezoelectric Resonant Microphone Array for Lung Sound Classification," *Journal of Micromechanics and Microengineering*, 33, No. 4 (2023), 044003.
- [9] Dodson, A., A. Jostes, D. Cerrone, H. Liu, E. S. Kim, and R. M. Kato. "Electronic Stethoscope Lung Sounds Analysis Versus Spirometry to Detect Change With Bronchodilator Use in Pediatric Asthma Patients." In American Thoracic Society International Conference Meetings Abstracts, vol. 207, no. Supplement_1, pp. A2951-A2951. Oxford University Press, 2023.
- [10] Liu, Hai, Song Liu, Anton A. Shkel, Yongkui Tang, and Eun Sok Kim. "Multi-band MEMS resonant microphone array for continuous lung-Sound monitoring and classification." In 2020 IEEE 33rd International Conference on Micro Electro Mechanical Systems (MEMS), pp. 857-860. IEEE, 2020. Outstanding Student Paper Award Finalist (18/275)
- [11] Liu, Hai, Song Liu, Anton A. Shkel, and Eun Sok Kim. "Active noise cancellation with MEMS resonant microphone array." *Journal of Microelectromechanical Systems* 29, no. 5 (2020): 839-845.
- [12] Liu, Hai, Song Liu, Anton A. Shkel, Yongkui Tang, and Eun Sok Kim. "MEMS resonant microphone array for lung sound classification." In 2019 IEEE International Electron Devices Meeting (IEDM), pp. 34-4. IEEE, 2019.

MEMS Energy Generators

- [13] Barekatin, Matin, Hai Liu, and Eun Sok Kim. "Wireless and Battery-Less Tamper Detection With Pyroelectric Energy Converter and High-Overtone Bulk Acoustic Resonator." *IEEE Sensors Journal* 22, no. 14 (2022): 14639-14646.
- [14] Fan, Shuyu, Yongkui Tang, Lurui Zhao, Hai Liu, Yufeng Wang, Dibo Hou, and Yunqi Cao. "Design optimization of microfabricated coils for volume-limited miniaturized broadband electromagnetic vibration energy harvester." *Energy Conversion and Management* 271 (2022): 116299.

MEMS Ultrasonic Transducer

- [15] Liu, Song, Pengcheng Sun, Mingyue Wang, Yujie Jiang, Jiaqi Li, Yuyu Jia, Zhenhuan Sun, Hai Liu, Haojian Lu, and Zuankai Wang. "Acousto-dewetting enables droplet microfluidics on superhydrophilic surfaces." *Nature Physics* (2025): 1-9.
- [16] Li, Jiaqi, Z. Sun, H. Liu and S. Liu, "MEMS Amplitude-Gradient Acoustic Transducer (AGAT) for Controllable Particle Transportation," 2025 IEEE International Ultrasonics Symposium (IUS), Utrecht, Netherlands, 2025, pp. 1-4, doi: 10.1109/IUS62464.2025.11201785.
- [17] Li, Jiaqi, Zhenhuan Sun, Hai Liu, and Song Liu. "Obstacle-crossing Self Focused Acoustic Transducer based on Bessel Beams." In 2024 IEEE Ultrasonics, Ferroelectrics, and Frequency Control Joint Symposium (UFFC-JS), pp. 1-4. IEEE, 2024.
- [18] Li, Jiaqi, Zhenhuan Sun, Yuyu Jia, Tang Li, Haojian Lu, Lurui Zhao, Hai Liu, and Song Liu. "MEMS First-Order Bessel Beam Acoustic Transducer for Particle Trapping And Controllable Rotating." In 2023 IEEE 36th International Conference on Micro Electro Mechanical Systems (MEMS), pp. 965-968. IEEE, 2023.

- [19] Jiaqi Li, Zhenhuan Sun, Hai Liu, Lurui Zhao, Teng Li, and Song Liu, "Bottle trap acoustic transducer with PDMS Lens for Particle Trapping", In 2023 IEEE International Ultrasonics Symposium (IUS), IEEE, 2023.
- [20] Sun, Zhenhuan, Jiaqi Li, Hai Liu, Lurui Zhao, Teng Li, and Song Liu. "Rotation-free high order Bessel beam acoustic transducer for particle trapping." In 2023 IEEE International Ultrasonics Symposium (IUS), IEEE, 2023.
- [21] Li, Jiaqi, Zhenhuan Sun, Hai Liu, Lurui Zhao, Teng Li, and Song Liu. "Twin Trap Acoustic Transducer with PDMS Fresnel Lens for Particle Trapping." In 2023 IEEE International Ultrasonics Symposium (IUS), IEEE, 2023.
- [22] Sun, Zhenhuan, Jiaqi Li, Hai Liu, Lurui Zhao, Teng Li, and Song Liu. "Ultrasonic Transducer encoding intersecting Bessel beams for particle patterning." In 2023 IEEE International Ultrasonics Symposium (IUS), IEEE, 2023.
- [23] Jia, Yuyu, Zhenhuan Sun, Jiaqi Li, Lurui Zhao, Hai Liu, Teng Li, and Song Liu. "MEMS Bessel Beam Acoustic Transducer (MEMS-BBAT) with Air-Cavity Lens Based on Spiral Diffraction Grating for Particle Trapping." In 2022 IEEE International Ultrasonics Symposium (IUS), 2022.
- [24] Sun, Zhenhuan, Jiaqi Li, Yuyu Jia, Yuhang Liu, Kunyong Lyu, Hai Liu, Hu Su, Teng Li, and Song Liu. "Particle Trapping and Transportation with MEMS Zeroth-order Bessel Beam Acoustic Transducer (BBAT)." In 2022 IEEE International Conference on Robotics and Biomimetics (ROBIO), pp. 1-6. IEEE, 2022.
- [25] Liu, Hai, A. Roy, Y. Tang, M. Barekatin and E.S. Kim, "Ultrasonic Air-Borne Propulsion Through Synthetic Jets," Solid-State Sensor and Actuator Workshop, Hilton Head Island, SC, June 5 - 9, 2022, pp. 226 - 229.

Granted Patents

- [1] Liu, Hai. "Methods of manufacturing printed circuit board and semiconductor package." U.S. Patent 10,049,970 B2, issued August 14, 2018.
- [2] Liu, Hai. "Printed circuit board for semiconductor package." U.S. Patent 9,504,152 B2, issued November 22, 2016.
- [3] Liu, Hai. Surface Coating and Semiconductor Packaging Including the Surface Coating, Chinese patent 106954335 B, issued September 17, 2019.
- [4] Liu, Hai. Printed Circuit Board and Semiconductor Packaging Including It, Chinese patent 105307386 B, issued July 06, 2018.
- [5] Liu, Hai. A Mixed Surface Coating and Its Manufacturing Method, Chinese patent 103227160 B, issued March 16, 2016
- [6] Lu, Kai, Hai Liu. Mixed Solder Ball Arrangement and Its Formation Method, Chinese patent 103219310 B, issued July 13, 2016.