<Professor Hyunjoo. J. Lee's Lab.>

Brain/Bio Medical Microsystems Lab

■ **Contact information**

Professor : hyunjoo.lee@kaist.ac.kr TEL. :+82-42-350-7436

Lab. : E3-2 Room 4232 TEL. :+82-42-350-7536

Website : https://bmm.kaist.ac.kr

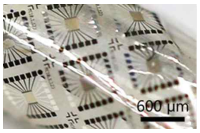
■ **Current state of the Lab. (in 2025 Spring Semester)**

Postdoctoral Fellows : 0 PhD Students: 13 Master's Student: 8

■ **Research Areas**

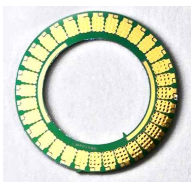
Our lab aims to develop novel systems for biomedical applications such as early detection of disease, therapeutics, and investigation of underlying mechanism of brain diseases. In specific, we focus on 1) developing Neural interface 2) developing miniaturized ultrasound transducers for ultrasound diagnostics and therapeutics, and 3) brain stimulation for neural circuits

Neural Interface



We develop advanced technologies to evaluate electrogenic cells, both in vivo (mouse brains) and in vitro (brain or cardiac organoids). Our research includes fabricating multi-electrode arrays (MEAs) on flexible substrates for precise, long-term recordings of electrophysiological activities. The mechanical compliance of these polymer-based MEAs minimizes tissue damage and ensures conformal contact with tissues, enabling stable chronic measurements. Additionally, we design bidirectional interfaces incorporating optical and electrical stimulation, develop electrochemical sensors to assess organoid metabolic states, and integrate microfluidic channels to broaden applications.

Miniaturized Ultrasound Transducers



Our team pioneers innovative solutions for miniaturized ultrasound transducers in diagnostics and therapeutics. We have created a high-frequency linear piezoelectric ultrasound transducer (PUT) for 3D organoid tomography and a 2D wearable phased array for blood flow monitoring. Capacitive micromachined ultrasound transducers (CMUTs), based on silicon microfabrication, enable compact, IC-compatible designs with benefits like mass production, wide bandwidth, and high sensitivity. CMUT arrays are widely used in biomedical applications such as acoustic holography and imaging. Additionally, piezoelectric micromachined ultrasound transducers (PMUTs) have been developed as flexible, wearable devices for glucose-related disease treatment.

Brain stimulation for neural circuits

We conduct integrative neuroscience research that leverages low-intensity ultrasound and light to modulate brain circuits and analyze the resulting behavioral changes. Our work includes the development of integrated systems that combine ultrasound stimulation with optical imaging, dynamic spatial ultrasound modulation technologies, and optoacoustic neuromodulation methods. We also extend our studies to stimulation experiments in freely moving animal models and midbrain organoids, as well as therapeutic applications in disease models such as glaucoma. Ultimately, we aim to uncover principles of brain function modulation and develop novel neuromodulation technologies.

■ **Recommended courses & Career after graduation**

Recommended courses include fabrication, nano/bio electronics, and MEMS. Careers in semiconductor and medical industries as well as academia are possible.

■ **Introduction to other activities besides research**

Spring walk, Strawberry party, National teacher's day, Graduation party, and other many extra activities to accommodate friendship.

■ **Introduction to the Lab.**

Due to the interdisciplinary research field, our lab consists of a diverse group of students from different backgrounds such as electrical engineering, materials science, and chemistry.

■ **Recent research achievements ('23~'25)**

[1] Y. Jo†, X. Liang†, H. H. Nguyen, Y. Choi, M. Choi, G. Bae, Y. Cho, J. Woo, H. J. Lee* (2025). Selective manipulation of excitatory and inhibitory neurons in top-down and bottom-up visual pathways using ultrasound stimulation. ***Brain Stimulation***, 18, 848-862.

[2] S. Bang†, C. Oh, S.-M. Lee, S. Kim, T. Lee, S. Nam, J. Jung, and H. J. Lee* (2025). Fabrication of Capacitive Micromachined Ultrasonic Transducers With High-k Insulation Layer Using Silicon Fusion Bonding. ***Journal of Microelectromechanical Systems,*** 34, 65-72.

[3] C. Oh†, H. J. Lee* (2024) Turning integrated circuits into ultrasound transducers. ***Nature Electronics***, 7, 1070-1071.

[4] K. Kim†, Y. Lee, K. B. Jung, Y. Kim, E. Jang, M.-O. Lee*, M.-Y. Son*, and H. J. Lee* (2024). Highly stretchable 3D microelectrode array for non-invasive functional evaluation of cardiac spheroids and midbrain organoids. ***Advanced materials,*** 37, 2412953.

[5] Y. Kim†, E. C. Chica-Carrillo†, and H. J. Lee* (2024). Microfabricated sensors for non-invasive, real-time monitoring of organoids. ***Micro and Nano Systems Letters,*** 12, 1-10.

[6] H. Kim†, S. Nam†, M. B. Durukan, H. E. Unalan, and H. J. Lee(2023). Self-Charging Dual-Modal Sensor for Glucose Monitoring Based on Piezoelectric Nanowire/Mircogel Hybrid Film. ***Advanced Functional Materials,*** 34, 2308086.