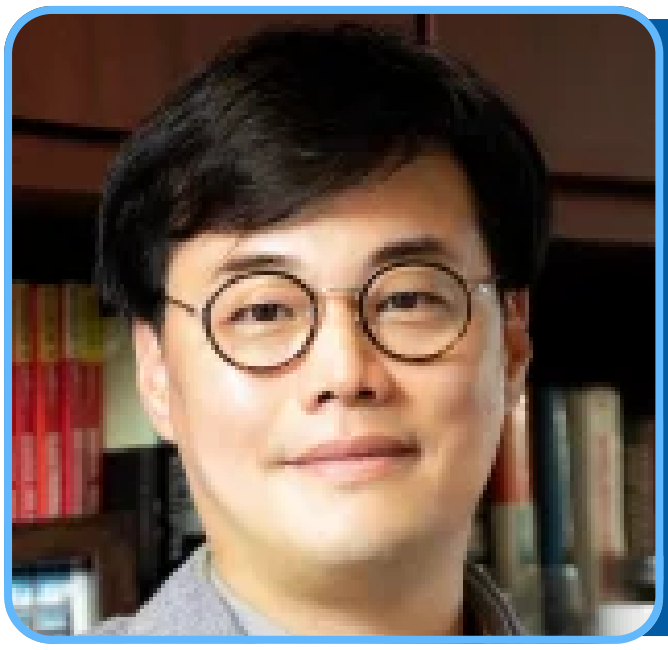
Department of Biomedical Engineering
香港城市大學
City University of Hong Kong



PL6: MEMS/NEMS-Based Electronic Nose Systems and Disease / Metabolic Diagnostics through Breath Analysis

Inkyu Park

Korea Advanced Institute of Science and Technology (KAIST)

Session Chair: Prof Xinge Yu, City University of Hong Kong

THURSDAY
4 December 2025

TIME
08:45-09:30

VENUE
LT-2, 4/F Yeung Kin Man Academic Building

ABSTRACT

Recent advances in nanotechnology, MEMS/NEMS microfabrication, and artificial intelligence (AI) have enabled a new generation of electronic nose (e-nose) systems with significant promise for biomedical applications. Our research has focused on developing multi-transduction MEMS gas sensor arrays that integrate chemiresistive and calorimetric elements on low-power microheater platforms, μLED-photoactivated sensors employing time-variant illumination for dynamic transient responses, and anodic aluminum oxide (AAO)-based microheaters for stable temperature modulation. These devices, when combined with convolutional neural networks (CNN) and other deep-learning strategies, achieve high discrimination accuracies (>96%) across multiple VOC species while operating at low power levels, addressing long-standing challenges of selectivity, stability, and energy efficiency. Building on e-nose technology, we have demonstrated the clinical potential of breathomics: real-time analysis of alveolar versus oral breath revealed strong correlations ($r > 0.95$) between exhaled acetone and blood β-hydroxybutyrate, enabling accurate prediction of exercise-induced fat oxidation. Beyond metabolic monitoring, distinct VOC signatures are increasingly recognized as biomarkers for pathological conditions including diabetes, infectious diseases, and cancers such as lung, gastric, and colorectal types, where specific aldehydes, ketones, and hydrocarbons serve as non-invasive diagnostic indicators. By training high-density sensor arrays with machine-learning models to distinguish disease-related breath fingerprints from environmental noise and biological variability, e-nose systems hold strong potential as portable, point-of-care diagnostic tools. This talk will highlight both the engineering innovations—spanning nanoscale material synthesis, MEMS integration, and optoelectronic actuation—and the translational pathways toward breath-based diagnostics for personalized metabolic health monitoring and early-stage cancer detection.

BIOGRAPHY

Prof. Inkyu Park received his B.S., M.S., and Ph.D. from KAIST (1998), UIUC (2003) and UC Berkeley (2007), respectively, all in mechanical engineering. He has been with the department of mechanical engineering at KAIST since 2009 as a faculty member and is currently a full professor and KAIST Endowed Chair Professor. His research interests are micro/nano-fabrication, smart sensors for healthcare, robotics, metaverse, and environmental and biomedical monitoring, and nanomaterial-based sensors and flexible & wearable electronics. He has published more than 211 international journal articles (SCI indexed) and holds more than 50 registered domestic and international patents in the area of MEMS/NANO engineering. As of Sep 3, 2025, his h-index is 65 and total citation is 20,889. He is a recipient of HP Open Innovation Research Award (2009-2012), KAIST Prize for Academic Excellence (2021), KAIST Grand Prize for Technology Innovation Award (2019), KAIST Endowed Chair Professorship (2017), Nanotechnologies Top 10 of Korea (2023), and NanoKorea 2023 Research Innovation Award – MIST Minster Award (2023). He is currently an editor for Sensors and Actuators B: Chemical, one of the top SCI journals in the sensor technology field.