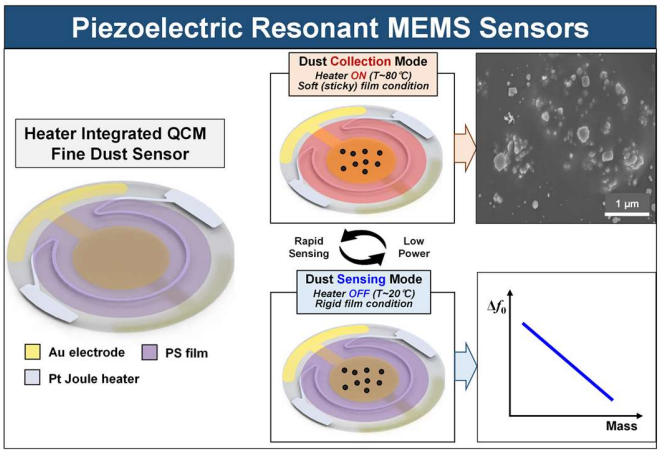
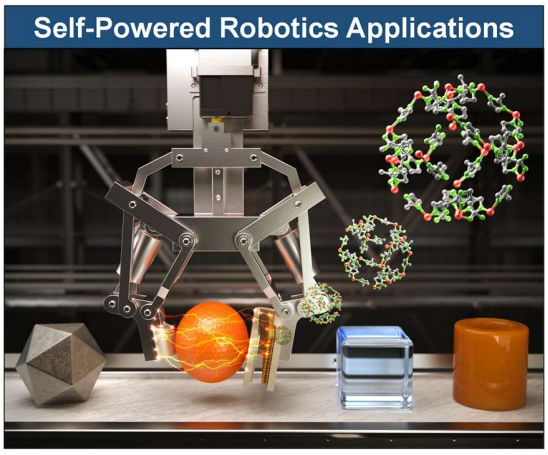
Piezoelectric Smart Sensors and Energy Systems

Abstract

Multi-functional materials that can convert one form of energy to another have drawn immense attention owing to their outstanding conversion efficiency and compatibility with CMOS semiconductor devices. Specifically, piezoelectric materials, which can be patterned in nano-thin-film or nano-particle forms, are suited for sensors, and actuators applications as the material can transduce mechanical energy into electrical signals or vice versa. Moreover, high-efficiency piezoelectric thin films are used for signal processing, and sensing as recent advances in deposition technologies have enabled low-loss and high frequency micro electromechanical systems (MEMS). This talk will introduce piezoelectric MEMS resonant sensors that can detect various environmental factors (i.e., fine dust, humidity, toxic chemicals) with extremely high sensitivity and stability. In addition, the developed sensors exhibit outstanding response time and low power budget, which are crucial for IoT applications. The talk will also cover the future outlook of MEMS environmental sensors and how piezoelectric MEMS can compete with current technologies.

Piezoelectric material is also a promising candidate for building energy harvesting and self-powered sensor systems. Harvesting or scavenging waste energy is in great demand as most electronic, automobile, and manufacturing systems require a constant power supply. Piezoelectric energy harvesters or so-called “nanogenerators” can be one of the solutions, as they can harvest enough energy to power small electronics. In addition, such energy harvesters can detect mechanical events without needing an external power source, enabling self-powered tactile sensors. Here, I will introduce our recent outcomes in energy harvesting using piezoelectric materials and their application in biomechanical sensing and robotics applications.





Speaker Bio

Dr. Hoe Joon Kim received B.S. from Johns Hopkins University (2009) and both M.S. and Ph.D. from the University of Illinois at Urbana-Champaign (2015), all in Mechanical Engineering. His Ph.D. thesis (advisor: William P. King) focused on developing heated MEMS cantilevers for nanometrology and nanomanufacturing. He spent two years at Carnegie Mellon University as a postdoctorate shoclar working on developing GHz-piezoelectric MEMS resonators in the Gian Piazza group in Electrical and Computer Engineering.

Dr. Kim is currently with the Department of Robotics and Mechatronics at DGIST. He is the leading PI of Nano Materials and Devices Lab, which focuses on developing smart sensors and energy systems for environmental monitoring and robotics applications. His group is working on synthesizing multi-functional materials, such as piezoelectric, magnetoelectric, perovskites, and carbon-based nanomaterials, explicitly focusing on integrating novel functional materials into CMOS devices for scalable manufacturing. He is the recipient of numerous honorable awards, including the Young investigator award from KMEMS (2020) and the best researcher award from DGIST (2021). He also authored +70 publications, including journals such as Advanced Functional Materials, Nano Energy, Nano Letters, JMEMS, IEEE Sensors Journal, etc., and international conferences including Transducers, IEEE MEMS, and IEEE Sensors.