ECE ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY OF MICHIGAN

Electrical and Computer Engineering

ECE Final PhD Defense

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High Aspect-ratio Biomimetic Hair-like Microstructure Arrays for MEMS Multi-Transducer Platform

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Chair: Professor Khalil Najafi

Abstract:

Researchers have continued to explore approaches to develop miniaturized sensors and actuators with improved performance, enhanced functionality, smaller size and lower cost. Innovations are made possible with significant advances in design/analysis techniques, ICs, micro/nano fabrication and packaging technology. Biological systems in nature provide us with inspiration for engineering and one common structure is the “hair”. Large array of hair is promising candidate for a MEMS multi-transducer platform that may offer improved sensitivity and selectivity, redundancy, robustness, and increased dynamic range. In this research, we developed the microfabrication technology to build a unique 3D biomimetic hair structure for multi-transducer platform. Direct integration with CMOS will enable signal processing of dense arrays of MEMS transducers within a small chip area. Based on this structure, we built and tested capacitive and threshold MEMS accelerometer arrays. The novel process circumvents the stringent requirements on DRIE of thick (1mm) silicon. The device can achieve sub-μg resolution (< $1\mu g/\sqrt{Hz}$) and high sensitivity ($1pF/g/mm^2$), having an area smaller than any previous precision accelerometers with similar performance. This technology is suited for forming MEMS transducer arrays including: 1) high performance inertial measurement units that require large dynamic range, high resolution, as well as robustness and fault tolerance; and 2) large arrays of miniaturized detectors and actuators with high temporal and spatial resolution, analogous to high-density CMOS imagers.