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Piezoelectric silicon microphones for aeroacoustics applications

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This talk presents the development of several microelectromechanical systems (MEMS)-based piezoelectric measurement microphone technologies for aeroacoustic applications. Piezoelectric MEMS microphones offer the promise of reducing cost, improving performance, and increasing mounting flexibility over existing conventional microphone technologies. Specifically, a microphone with no external power requirement has a key advantage for a large-channel count, widespread deployment. The modeling and design aspects of these devices are reviewed. First, the electroacoustic transduction is predicted via piezoelectric composite plate theory. Lumped element models are then synthesized to describe the dynamic characteristics of the microphone diaphragm and the cavity/vent structure. Constrained nonlinear design optimization using a sequential quadratic programming scheme is then performed to determine the microphone design parameters. From a fabrication perspective, the main drawback to silicon-micromachined piezoelectric devices is material integration and compatibility with standard micromachining. Several different device structures and fabrication approaches will be discussed in this talk. Representative results from a lead zirconate-titanate-based device will then be presented. Finally, unresolved technical issues are summarized for future sensor development.