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Piezoelectric Cantilevers for Low-Noise Silicon Microphones

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Microphones fabricated using microelectromechanical systems (MEMS) technology are one of the fastest growing applications of MEMS. Capacitive sensing has been the dominant detection principle used in MEMS microphones. Piezoelectric sensing, however, offers advantages including simpler accompanying circuitry and the possibility for simpler fabrication. Piezoelectric microphones have been limited primarily by a high noise floor, typically at least an order of magnitude higher than, otherwise similar, capacitive microphones. We present a low noise piezoelectric cantilever microphone to overcome the main limitation of previously constructed piezoelectric microphones. Aluminum Nitride (AlN) has been selected as the piezoelectric material because its piezoelectric coupling coefficient, in combination with its electric permittivity, and its piezoelectric loss coefficient enable low-noise devices. Through both mechanical and electrical optimization, models indicate that by combining several short, thin cantilevers made exclusively of Molybdenum and AlN, microphones with a die size of 1mm x 1mm, 10 kHz bandwidth, 2mV/Pa sensitivity, and noise floor below 40 dBA can be constructed using a simple 4 mask process. Analytical and numerical models and experimental results will be presented.