Medical Applications of Piezoelectric Microelectromechanical Systems

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Bulk piezoelectric ceramics and single crystals are widely used in medical applications, including medical ultrasonic imaging, therapeutic ultrasound, and drug delivery. This paper reviews possibilities for thin film micromachined components as alternatives to the bulk devices. Particular emphasis is placed on the development of a CMOScompatible ultrasound system. For this purpose, a piezoelectric ultrasound system on a Si substrate was fabricated using a diaphragm geometry transducer with PZT films. A 1-D array of 8 elements was designed and fabricated using 4 photolithography steps. Cavities under the resonating elements were obtained by XeF_2 etching from the top-side of the wafer. Capacitance and admittance spectra showed a resonance at ∼ 42 MHz for the fabricated structures with a quality factor of 2.1, this resonance was higher than the one predicted by the natural frequency equation for circular plate. Catch- and pitch-mode tests were performed in water. Sensing and actuating functionalities were demonstrated for the fabricated devices, with collected signals of 40 mV peak-to-peak at a distance of 7.2 mm during the catch-mode test and amplitudes as high as 15 mV peak-to-peak at a distance of 7.4 mm during the pitch-mode test. A bandwidth of 83% was calculated during pitch-mode test.