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Silicon Micromachined Energy Concentrating Acoustic Transducers for Biomedical Applications

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Silicon's high maximum ultrasonic particle velocity, high thermal conductivity, and low internal loss, make it an ideal material for for high-intensity ultrasonic actuators. We have designed and microfabricated silicon ultrasonic horns, which when actuated at their $\lambda/2$ longitudinal resonance (using ceramic PZT transducers) concentrate ultrasonic energy and magnify displacements. By incorporating microprobes at the high energy sites we have successfully demonstrated reduction of penetration force on biological tissues. We have also reported cardiac action potential measurement from multiple sites simultaneously within the heart wall by incorporating platinum electrodes on the microprobes. We have reported on mechanical and spatial characterization of seminiferous tubules in the testis in order to extract sperm for artificial insemination. We are currently exploring silicon ultrasonic horns in detecting testicular and prostate cancer in the early stages. In addition, silicon ultrasonic horns can be used for low power ultrasonic pumping and also atomization. By using bulk micromachining techniques an enclosed conduit is opened along the horn. Due to the highly amplified acoustic field at the tip, fluid enclosed in the channel can be atomized from the tip. Reversibly when the tip is immersed in fluid, fluid can also be pumped into the channel due to changing boundary conditions.