Batch Mode Ultrasonic Micromachining of Ceramics and Application to Sensors and Actuators

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This project develops the batch mode ultrasonic micromachining process which can achieve transfer of lithographic patterns onto hard, brittle, and non-conductive materials such as ceramics (including PZT) and glass with high throughput and resolution. It uses ultrasonically induced vibrations from steel microtools to fabricate microstructures in batch mode onto the workpieces. These microtools are themselves fabricated by batch mode microelectrodischarge machining (μEDM). The developed process is then used to create a micromachined biopsy tool with integrated sensors to provide real-time guidance for the medical procedure of fine-needle aspiration (FNA) biopsy (Figure a). PZT discs batch-fabricated from bulk PZT material using the process have been integrated at the tip of a biopsy needle which was processed by μEDM (Figure b). Experimental results with porcine tissue demonstrated contrast detection between fat and muscle samples. An empirical tissue contrast model (Figure c) shows an approximately proportional relationship between measured resonant frequency shift and sample acoustic impedance. This project is supported by the Engineering Research Centers Program of the National Science Foundation under Award Number EEC-9986866.

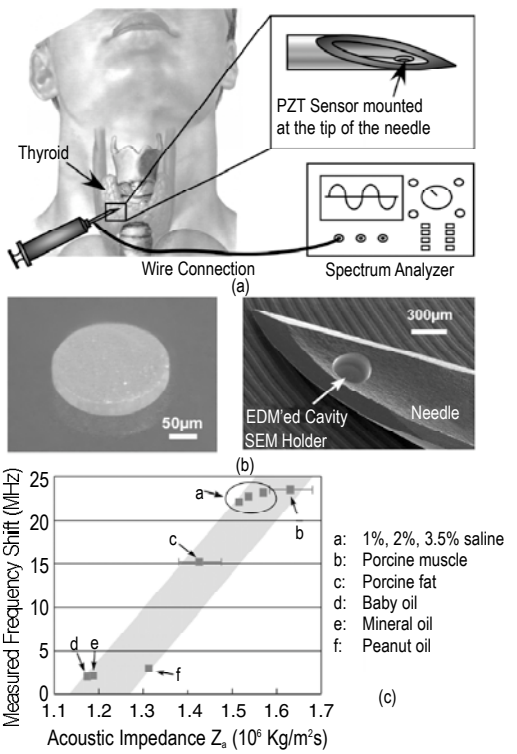

Figure (a) – System diagram, (b) Photos of a batch-fabricated PZT disc and μEDM'ed needle tip, and (c) Measured resonant frequency shift vs. sample acoustic impedance.