Ultrasonic Micro-Machining of Ceramics and Glass With Batch Mode Pattern Transfer

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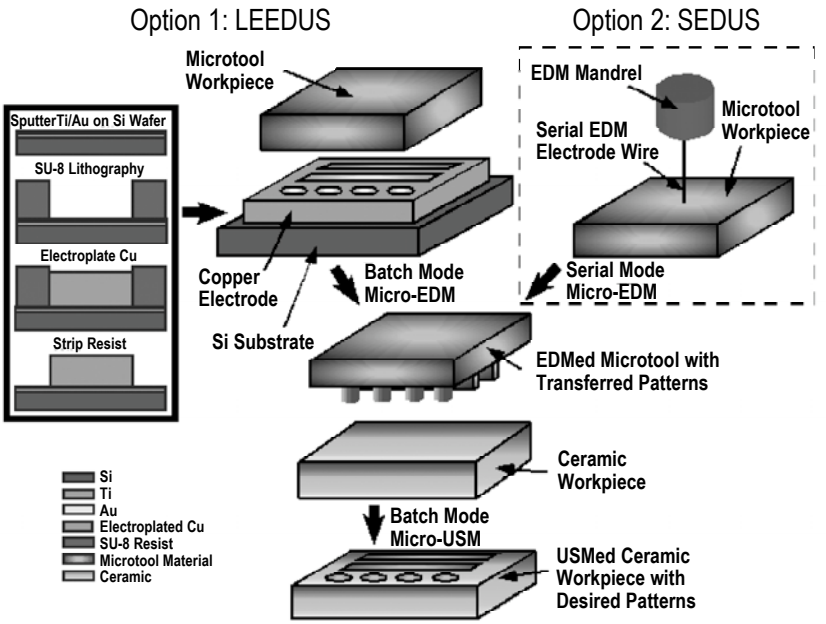

Process flow for batch mode ultrasonic micromachining.

This project aims to develop a batch mode micromachining process for ceramics and glasses with high-aspect-ratio and high-throughput pattern transfer capability. It uses ultrasonically induced vibrations and mask-customized microtools to fabricate microstructures in batch mode on hard, brittle, and nonconductive materials, such as ceramics (including PZT), glass, and silicon. As shown in the figure, a copper pattern is made by electroplating and used to make a hard-metal microtool at die-scale (eventually wafer-scale) by batch mode microelectro-discharge machining (μEDM). The microtool is then mounted on a custom-designed setup for batch mode micro ultrasonic machining (μUSM) of a workpiece to make the desired pattern. Non-lithographic rapid-prototyping can also be performed for simple patterns using option 2, which uses serial μEDM to quickly shape patterns on a microtool. Feature sizes of 25μm have been demonstrated on the glass-mica (Macor™) ceramic plate with a 4.5 x 4.5mm^2 die size, 34μm cutting depth, and 18μm/min. machining rate. Spiral shape micro-actuators fabricated from bulk PZT using this process were also demonstrated. This project is supported by the Engineering Research Centers Program of the National Science Foundation under Award Number EEC-9986866.