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

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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 microelectrodischarge 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 4.5mm² 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.