FAST AND EFFICIENT SINGULARIZATION OF GLASS MICRODEVICES USING SPARK-ASSISTED CHEMICAL ENGRAVING

Guillaume Villeneuve¹, Rolf Wuthrich², Lucas Hof³
¹Département de génie mécanique, École de Technologie Supérieure, Montréal, Canada
²Department of Mechanical and Industrial Engineering, Concordia University, Montréal, Canada
³guillaume.villeneuve.1@ens.etsmtl.ca; rolf.wuthrich@concordia.ca; lucas.hof@etsmtl.ca

ABSTRACT

Glass has many applications in Micro-Electromechanical Systems (MEMS), optics and microfluidics attributable to its mechanical, chemical, and optical properties. Micromachining of glass presents many challenges due to its hardness and brittleness. Mechanical, thermal, and chemical machining processes for glass suffer from limitations in processing speed, feature limitations, and/or high costs. Moreover, there is an increasing trend in the demand for glass microsystems. Furthermore, fast production and repeated rapid prototyping are becoming the norm in industry.

Spark-Assisted Chemical Engraving (SACE), also known as Electro-Chemical Discharge Machining (ECDM), is a hybrid machining process where chemical and thermal effects are combined to precisely remove material. A tool-electrode is used to accurately apply electrical discharges to a workpiece, which is submerged in an electrolytic solution. The chemical attack is locally accelerated by the targeted heating, resulting in a removal of material with minimal thermal stress. In addition, SACE-cut surfaces are immediately adapted to glass-to-glass bonding without requiring cleaning and polishing steps.

This study proposes a method of scoring glass using SACE to prepare it for mechanical breaking. A shallow groove is SACE-machined into the glass substrate, serving as a guide for clean mechanical separation. Tool geometry, depth of cut and feed rate were studied to optimize processing speed while maintaining high cut quality and low failure rate. A single 25-µm deep pass at 20 mm/min was sufficient to create a score leading to a clean break of a 1-mm glass slide. In this way, complex geometries can be rapidly and repeatably cut into glass substrates for rapid singularization of glass microdevices.

The manufacturing of a packaged glass device includes multiple operations such as drilling, milling, and cutting; it has been previously shown that the SACE process can accomplish many of these operations in a single machining setup, eliminating lengthy installation and alignment steps needed when using separate equipment. This study further increases the SACE process’ versatility by adding one more processing step that it can accomplish. This study shows potential for glass microdevices manufactured using only SACE and glass bonding, in contrast to traditional methods requiring multiple different glass machining technologies in addition to cleaning, polishing, and bonding.