Direct writing for microfluidics

Laser photoablation in microfluidics

Photoablation for microfluidics allows to shape microfluidic channels by eliminating material from a thin layer of thermoplastic substrate with a forceful pulsed laser light.

In photoablation, tiny volumes of material absorb a pinnacle of laser energy. This assimilation initiates tough electronic transitions that induce a shock wave in the substrate which engenders bond breaking in the polymer chain. The decomposed molecular fragments then expand in a plasma plume that clears thermal energy away from the workpiece, forming a precise photoablated cavity. The depth and width of the channels are determined by the laser energy and by the repetition frequency of the pulse applied along the same channel.

Photoablation can be performed by exposing the substrate with a mask delineating the zone to be ablated, or by using a direct-write without mask.

Photoablation can be used with almost any material. It allow to produce very sharp features and creative patterns in a short time even though they can sometimes be hard to reproduce. However particles residues can be hard to remove, causing contamination and lack of reliability of the final device. Hence, photoablation cannot be exercised in any type of environment. Besides, the cost of the device can substantially vary depending on the type of laser used and the choice of the photoablating technique. Another drawback is that photoablation produces rather large channels and low resolution.

Micro-milling in microfluidics

Micro-milling is a micromachining process involving the mechanical carving of a substrate material by inserting a workpiece in a rotating drum with multiple cutting teeth.

In microfluidics, micro-milling is the removal of material thanks to adapted cutting tools. It utilizes a drum with lots of very tightly spaced teeth. While the drum turns, the teeth are brought into contact with the substrate in order to remove excess material. The sharp tool induces breakage in the material along established paths enabling to remove the unnecessary part of the material.

The smoothness of the micro-milled substrate depends on various parameters including the spindle speed, the cut of depth, the feed rate as well as the operating environment. It is important to carefully apply force onto the substrate to control the removal of material especially in the particulate level.

Micro-milling has a lot of advantages, such as low cost, flexibility, fast fabrication or the ability to fabricate complicated structures. Processed surfaces can be micro-milled to any desired shape. One of the most attractive

facets of micro-milling is the possibility to design 3D features characterized by high aspect ratios and high geometric complexity. Besides, this technology is adapted for both serial and small quantity production.

## Reference

Phenomenology as Qualitative Research: A Critical Analysis of Meaning Attribution (Routledge Advances in Research Methods Book 20)

Creativity: Research, Development, and Practice