"Lab on chip" – biomimetic channel networks

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The idea to shrink a laboratory down to chip size, or at least to integrate some critical chemistry lab tasks onto micro devices has been around since almost 30 years now. A 10x smaller scale means 100x faster throughput for chemical reactions or separations, if diffusion controlled. In the meantime, the field has grown significantly, many of my students are now professors in this field, the early patents are all expired, small companies use microfluidics for their products, and the main application focus has shifted from analytical chemistry to cell biology and tissue engineering. But where are the throughput benefits for chemical reactions or bioassays?[1]

Microfluidic chips are usually defined by photolithography masks which are generated from straight lines and CAD programs. The manufacturing process needs clean room technology and usually gets more complex if multiple depths, i.e. multiple masks have to be used, and variations in depth profile are difficult to achieve. I will present a simple way of obtaining channel structures which feature gradually increasing or decreasing channel depths, and which also can feature irregularities in its surface. At first sight, this may seem inappropriate, may look "ugly" and not engineering-like. However, in biological surroundings, we can see such structures, and they are fully functional.

Plant leaves are used as templates for channel patterns, including its fine structure and including its macroscopic network pattern. Structures are formed in PDMS and covered by glass slides for microscopic observation[2]. Structures are used for investigating cell behaviour, digital PCR and perfusion of 3d cell cultures.

References

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