Large scale fabrication scheme for all-polymer multilevel nano-microfluidic Lab-on-Chip (LoC) systems: the PolyNano approach

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In recent years polymers have drawn more and more interest as materials for large scale fabrication of microfluidic and Lab-on-Chip (LoC) devices over more traditional ones such as silicon and glass[1,2]. Although many polymer fabrication methods are quite mature, main drawbacks are present when it comes to industrial production and cost efficiency. We here present a fabrication scheme (figure 1) for all-polymer devices made by means of dry etching and injection molding. Such a scheme, suitable for large scale manufacturing, is used within the PolyNano consortium[3]. The aim of PolyNano is to provide a competitive edge for biotech companies launching LoC products, by removal of the technology barrier between lab-scale proof-of-principle and high-volume low-cost production of LoCs, and further enable new research by easy access to LoC technology. The technique we describe here[4,5] allows the combination of structures with depths as small as tens of nanometers and as big as hundreds of microns on the same polymer chip. Such result is obtained by overlapping standard RIE and modified BOSCH processes during the master (here referred to as shim) fabrication. The shims are used to fabricate Topas™ polymer chips on which standard luer connectors are coupled to micro and nanofluidic networks to assure optimal interfacing. Topas is chosen for its good thermal properties and for its resistance to many solvents[6]. The chips can be then thermally bonded with Topas lids of same grade and different thickness[5]. The polymer lids may also be patterned to include either electrodes (Au or polymer) or waveguides used for electrochemical or optofluidic purposes respectively. The implementation of such a method on a large scale opens a great number of possibilities in the field of liquid manipulation at the micro and nanoscale and of LoCs. To describe the potential of our fabrication and characterization methods, details of its use for specific applications such as single and multiple cell electrochemistry, DNA elongation and electroporation will be described (figure 2).

References

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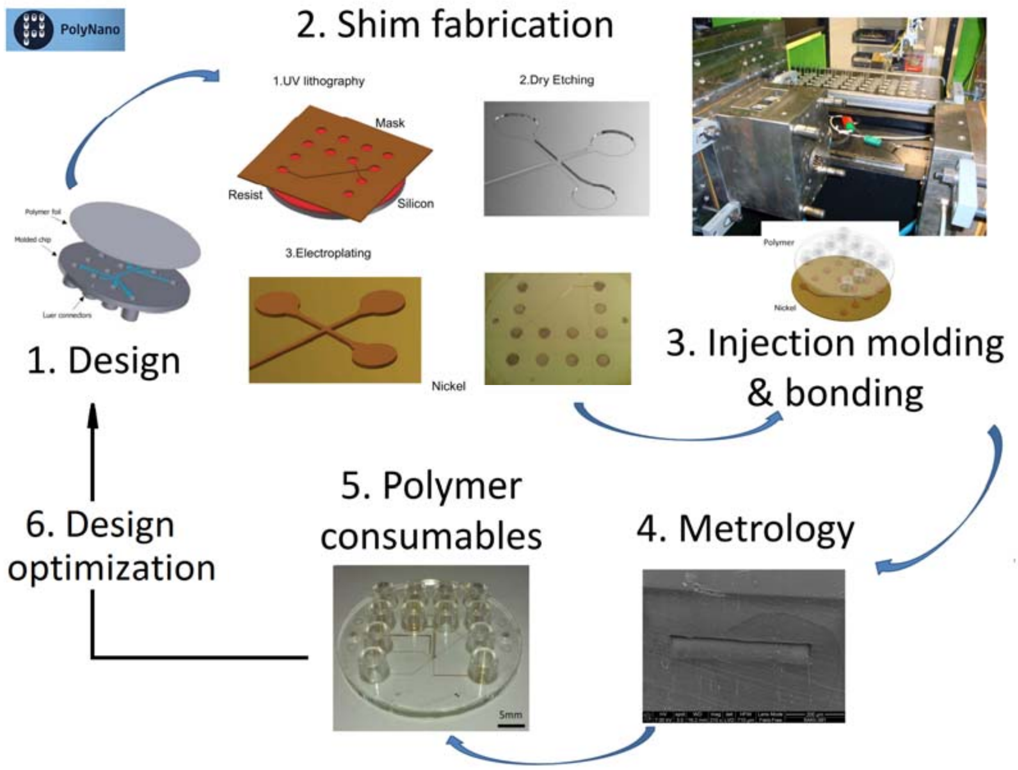

Figure 1. The PolyNano scheme for fabrication of all-polymer LoCs.

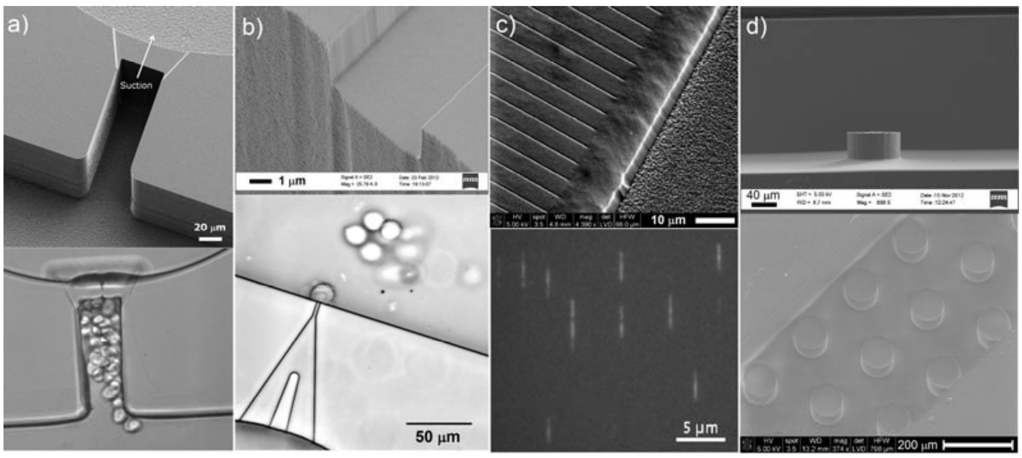

Figure 2. Silicon master and final polymer chips for capture of PC 12 cells a), and single HeLa cells b). Detail of the polymer chip with nanochannels for λ-DNA elongation and fluorescence microscopy measurements c). Section of a Si channel of 250 µm depth with embedded pillars (d, top) and polymer chip for optofluidic detection (d, bottom).