FARBICATION OF NON-BIOFOULING POLYETHYLENE GLYCOL MICRO- AND NANOCHANNELS

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ABSTRACT

Microfluidic systems have served as important platforms for cell-based sensing, biochemical analysis, and biological analysis because of many advantages such as size reduction of operating systems, flexibility of fabrication, reduced use of reagents, reduced production of wastes, increased speed of analysis, and portability. In particular, silicon or glass-based microfluidic devices have been extensively employed as an analytical tool or an implantable microsystem. However these surfaces create a negative charge at neutral pH, resulting in non-specific adsorption of reagent/sample molecules from the surrounding fluid (so called "biofouling"). In addition, several properties of silicon and glass could limit their use in microfluidic devices including limited biocompatibility, intrinsic stiffness and the need for expensive clean room facilities to fabricate.

To overcome some of the above-mentioned limitations, poly(dimethylsiloxane) (PDMS) is widely used to fabricate microfluidic channels because of its favorable mechanical/optical properties and its simple manufacturing by rapid prototyping. However, the ability to prevent biofouling and subsequent malfunction of the device is still limited by hydrophobic interactions between PDMS surface and biological samples. When small sample quantities, such as rare proteins are involved, any loss of sample through the system may result in critical error in the final analysis. To solve this challenge, silicon-based (e.g., silicon, glass, quartz, and PDMS) platforms have been modified by a non-biofouling material such as polyethylene glycol (PEG)-based polymer.

Here, we present a simple and fast method to fabricate PEG-based micro- and nanochannels by using UV-assisted irreversible sealing. While microfluidic tectonics is currently available to create PEG-based channels using photolithography, our method can reduce the channel size down to ~50 nm without using a sophisticated experimental setup. In our experiments, replica molding was used to create micro/nanoscale bas-relief patterns on a surface, without the use of a clean-room facility. The resulting PEG channels exhibit robust sealing with minimal swelling effects and can be used without additional modification of the surface, thus significantly enhancing reliability and durability of microfluidic devices.