Microfluidics and Lab on a chip: Development of micro-chip manufacturing techniques with PDMS and study of micro fluxes.

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Microfluidics is the science and technology of handling fluids in the μL (10^{-6}) and pL (10^{-12}) scale, using devices encompassing 10-100 μm channels. Microfluidics is used to simulate phenomena of natural sciences, such as biology and informatics that under ordinary conditions would require extensive laboratory equipment. The present work describes the design of micro-devices of simple circuits in the laboratory, using low-cost procedures and common materials, aiming to study microfluidics in biological applications. The objective is to construct microchips made of PDMS,[1] minimizing cost and construction time, while using 3D printing[2] for their construction, ultimately assembling appropriate peripheral equipment (micropumps, tubing and linkages) and pursuing CFD studies. Key points in the effort include the a) design of the flow circuit through appropriate software, b) imprint of the circuit on a copper plate, utilizing either a heated surface with concurrent application of pressure or ethanol and acetone with application of a vertical force, c) etching of copper for designing a mold, which was sequentially tested with aqueous $FeCl_3$, sodium persulphate, and finally aqueous H_2O_2 and HCl, d) use of 3D printing for mold construction using photopolymerizable resin, e) design of a PDMS chip, by placing the mold in an appropriate container with the monomer of polymerization and initiating polymerization (anaerobically), and f) detachment of PDMS from the mold, positioning it on a glass plate and subsequently subjecting it to plasma treatment. The derived chip is firmly placed on a properly configured setup (utilizing the supportive structure) and is connected to a micro-pump. Extensive CFD work on liquid flows through the chip was subsequently carried out.[3] Collectively, this research optimized the methodology for micro-chip construction, in the sense that common lab materials are used and construction time is minimized. The aforementioned technology is of great importance to numerous applications on analysis systems, biomedical devices, micro-systems in fundamental research and devices as valuable tools in biomedical technology.

References:

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