World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:10, No:07, 2016

Programmable Microfluidic Device Based on Stimuli Responsive Hydrogels

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Abstract : Processing of information by means of handling chemicals is a ubiquitous phenomenon in nature. Technical implementations of chemical information processing lack of low integration densities compared to electronic devices. Stimuli responsive hydrogels are promising candidates for materials with information processing capabilities. These hydrogels are sensitive toward chemical stimuli like metal ions or amino acids. The binding of an analyte molecule induces conformational changes inside the polymer network and subsequently the water content and volume of the hydrogel varies. This volume change can control material flows, and concurrently information flows, in microfluidic devices. The combination of this technology with powerful chemical logic gates yields in a platform for highly integrated chemical circuits. The manufacturing process of such devices is very challenging and rapid prototyping is a key technology used in the study. 3D printing allows generating three-dimensional defined structures of high complexity in a single and fast process step. This thermoplastic master is molded into PDMS and the master is removed by dissolution in an organic solvent. A variety of hydrogel materials is prepared by dispenser printing of pre-polymer solutions. By a variation of functional groups or cross-linking units, the functionality of the hole circuit can be programmed. Finally, applications in the field of bio-molecular analytics were demonstrated with an autonomously operating microfluidic chip.

Keywords : bioanalytics, hydrogels, information processing, microvalve
Conference Title : ICMN 2016 : International Conference on Microfluidics and Nanofluidics
Conference Location : Prague, Czechia
Conference Dates : July 07-08, 2016