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RESEARCH PAPER

Programmable LDEP technology to fabricate versatile master molds for PDMS continuous-flow microfluidic applications

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Abstract This paper presents an innovative versatile method aiming at rapid fabrication of a master for polydimethylsiloxane (PDMS) molding. This technology is relying on liquid dielectrophoresis electromechanical microfluidic transduction for programmable ultraviolet (UV) glue manipulation. It enables formation of the master in a tailor-made approach, avoiding the need of micromachined structures unlike in conventional methods. The principle is simple: UV glue, while in liquid phase, is actuated onto an array of electrodes patterned on a Si substrate and cured afterward by UV exposure. The silicon chip and the glue microstructures defined atop of it then play the role of a master for PDMS molding. The glue microstructures' shape is hemispherical which is of high interest for many microfluidic applications. This concept is assessed and validated with two different PDMS chip replica designs, both of them illustrating representative applications in continuous microfluidic: a *T*-junction design for inflow droplet generation and a "Quake" type valve. Lastly, this protocol has shown to be recyclable since the UV glue microstructures once formed can be easily removed by immersion in an acetone bath, such as the chip is reset and can be reprogrammed afterward to build another glue channels geometry.

Keywords Liquid dielectrophoresis · UV glue · PDMS replica

1 Introduction

Microfluidic devices are finding increasing applications as analytical systems, tools for chemistry and biochemistry, drug screening in the pharmaceutical industry, point-of-care diagnosis, and systems for fundamental research. Conventional methods to fabricate microfluidic devices are centered on silicon or glass using photolithographic and etching techniques which have been adapted from the semiconductor industry (Whitesides 2006; De Mello 2002). Polydimethylsiloxane (PDMS) is often considered by far as the dominant polymeric material used for microfluidics (Duffy et al. 1998; McDonald et al. 2000; Berthier et al. 2012). Indeed, production of microfluidic chips made of PDMS offers numerous advantages. Among them, PDMS is transparent (at optical frequencies 240–1,100 nm); with a low autofluorescence, gas permeability, it is considered as biocompatible, easy to use, and is generally preferred to Silicon for its lower manufacturing costs (McDonald et al. 2000; Berthier et al. 2012). However, fabrication of microfluidic chips in PDMS is usually requiring a master mold, built with microelectromechanical system (MEMS) techniques able to construct complex 3D or high aspect ratio micro/nanostructures (made of Silicon or SU-8 resist most of the time). The PDMS (liquid) mixed with curing

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