Fabrication of polymer nanofluidic lab on chip devices via PBW and NIL for DNA analysis and particle sorting

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Proton Beam writing (PBW), a new 3D nanolithographic technique is used to produce smooth 3D nanostructures. In combination with UV lithography these structures form masters for soft lithography and nanoimprint lithography. We will demonstrate the successful reproduction of PMMA and PDMS LOC devices featuring details down to 60 nm and or high aspect ratios. These LOC devices are extensively used for DNA single molecule analysis and large scale genome sequencing [1]. A second application in the area of particle separation will also be discussed. Here active particle separation and sorting is achieved harnessing periodically switched magnetic fields and Brownian motion of micro size particles. Here the particle separation is achieved in a compact microfluidic chip with high aspect ratio asymmetric sawtooth sidewalls in the sorting channel. The magnetic field is generated via co-fabricated electromagnet metal solder channels [2].

PBW is an ideal technique to fabricate this type of lab-on-chip devices featuring smooth high aspect ratio structures at the micron as well as at the nano scale. PBW is a new direct write 3D nano lithographic technique which has been developed at the Centre for Ion Beam (CIBA), in the Physics Department of the National University of Singapore. PBW employs a focused MeV proton beam which is scanned in a predetermined pattern over a resist, which is subsequently chemically developed. PBW exhibits low proximity effects coupled with the straight trajectory and even energy deposition along the path of the proton beam results in sidewall smoothness of a few nm root mean square. The high penetration depth of the proton beam enables the production of high aspect ratio, high density 3D micro and nano structures with smooth sidewalls, ideal for high quality mold production for Nano Imprint Lithography (NIL) applications. The PBW system is now able to focus proton beams down to 9.3 x 32 nm^2 [3], allowing high aspect ratio lithography down to 19 nm in HSQ. To achieve polymer nanofluidic circuits down to 19 nm PWB fabricated HSQ resist structures will be replicated in OrmoStampTM (Micro Resist Technology GmbH) to form hard stamps which can be used in thermal NIL. Initial NIL results obtained with these molds are presented in combination with PMMA nanofluidic lab on chip production. To improve on the ultimate feature size and make the PBW system more user-friendly a tabletop PBW system is under construction in CIBA aiming for fast nanofabrication at the single-digit nano meter regime [4].

References:

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