Rapid and low-cost prototyping of lab-on-a-chip devices for inertial microfluidic applications

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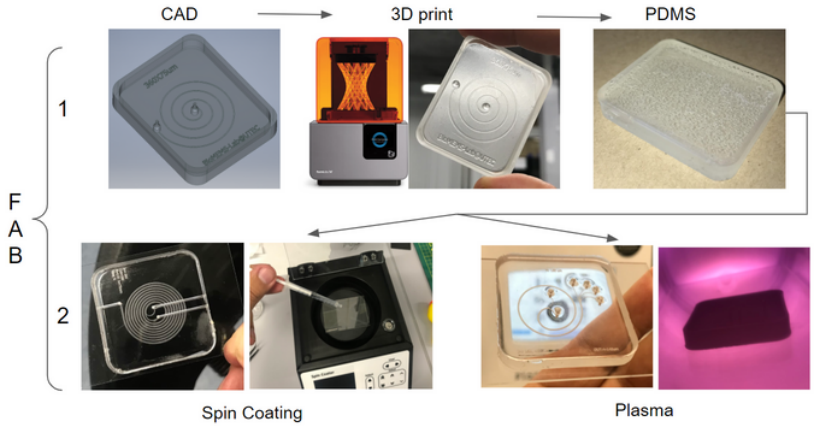
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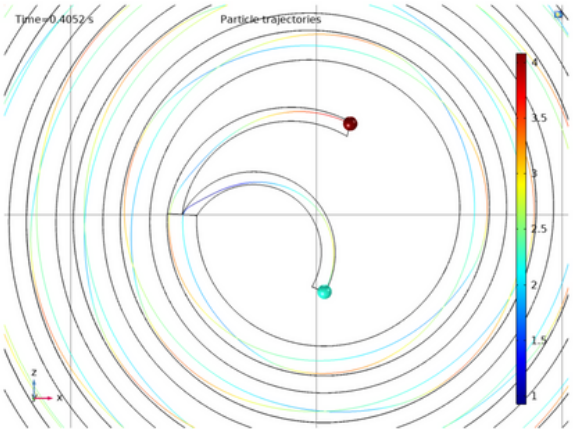
INTRODUCTION

Microfluidic and Lab-on-a-Chip devices are revolutionizing the field of medicine by providing new tools and methods for diagnosing diseases. In this work, three inertial microfluidic devices were developed with rapid and low-cost prototyping techniques (rapid soft lithography) to assess the feasibility of creating truly functional devices for future diagnostic applications of diseases such as Peruvian malaria.

FABRICATION METHODS

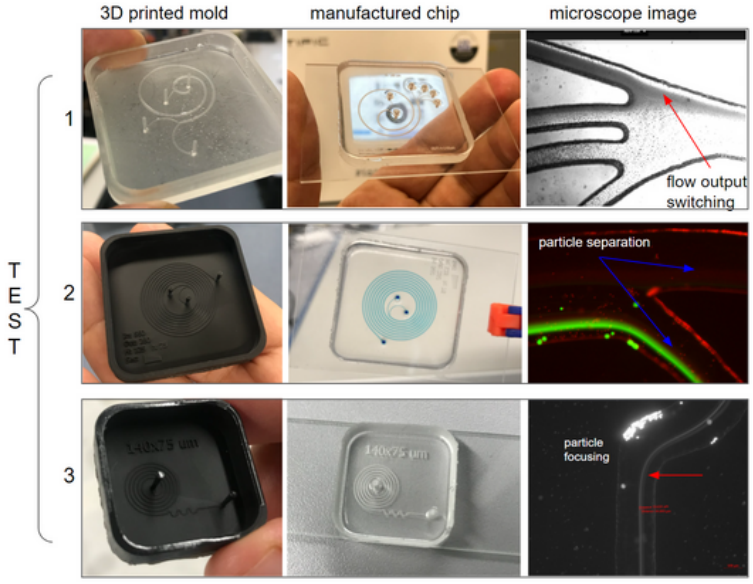
The molds were printed with a 3D-SLA printer (1) with two types of resin: clear and black.
The chips were manufactured with PDMS into the 3D-printed molds (1), then dried in an oven at 80 °C for 90 minutes.
Two types of bonding with a flat surface counterpart were tested for the PDMS substrate: plasma and spin coating (2).





SIMULATIONS

Computational simulations of laminar flow and particle trajectories were performed using COMSOL Multiphysics.
These simulations were used to identify the steady state flow of particles of different sizes (5, 10, 20 and 50 μm) and diameters. In the simulation shown, a rigidity based microparticle separation was performed, scale represents particle speed, red = solid particle, light blue = liquid particle, 0.10696 ml/s flow rate.



RESULTS

The devices were tested with distilled water with Sodium dodecyl sulfate (SDS) containing fluorescent PS microparticles of 5 and 10 μm in diameter. During the tests we observed: flow output switching control(1); size based particle separation(2), and a single line of microparticles focused in the center of the microchannel due to inertial effects(3). The devices were tested at different flow rates between 10-100 μl/s . Plasma bonded chips withstood flow rates up to 45 μl/s while spin coating bonded chips withstood flow rates up to 80 μl/s.

CONCLUSION

- Rapid soft lithography allows the fabrication of functional inertial microfluidic devices.
- 3D printed molds have advantages such as the incorporation of pillars (eliminates the need for a biopsy-puncher), repeated use of a single mold without damaging the microchannels' walls, and the possibility of easily manufacturing lateral tubing interfaces.
- Printing with clear resin is better for plasma bonding.
- Spin coat bonding was 40% stronger than plasma bonding.