

# The fabrication and application of a robust and intelligent digital microfluidics

Jie Gao, Tianlan Chen, Cheng Dong, Jie Gao, Yanwei Jia, Pui-In Mak and R. P. Martins

## Abstract

Recently, digital microfluidics has obtained much attention in both microfluidics and micro-electronics communities because of its flexibility in manipulating droplets. However, there are still some issues need to be solved before it can be applied to applications such as high throughput drug screening. First, a low actuation voltage keeping a reasonable actuation speed to meet CMOS source-drain voltage needs to be achieved in order to integrate CMOS-based logic switches in digital microfluidic chips, and to take good advantage of the high logic control ability of these switches. Second, robust and flexible software-driven logic control and feedback control modules, which are based on in-situ measurement of droplet characteristics, need to be established to conduct precise, flexible and self-identified manipulation on a certain droplet.

Here, we report two solutions: 1) A novel coating process of high dielectric permittivity materials, Ta<sub>2</sub>O<sub>5</sub> and parylene C, was investigated and optimized; 2) Programmable manipulability of multi-droplet routings under countermeasure decisions in real time, preventing droplet-to droplet or task-to-task interference. As a result, a CMOS-compatible voltage as low as 5 volts, was achieved. Furthermore, the first modular DMF system with built-in electronic-control software-defined intelligence to enhance the fidelity and reliability of each droplet operation, allowing future manufacturability of a wide range of life science analyses and combinatorial chemical screening applications.