Inertial Dispensing Mechanism for Droplets On Chip

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The research presented here explores dispensing of droplets for digital microfluidic lab-on-a-chip applications using inertial force. ElectroWetting-On-Dielectric (EWOD) is an attractive underlying actuation mechanism that allows microfluidic operations such as moving, cutting, merging, and creating droplets on chip. More applications are possible if processed droplets can be printed from the chip onto another surface, likely a target substrate. An existing printing technology demonstrated with EWOD chip is known as soft printing, where the EWOD chip is lowered until the droplet contacts the target surface, causing the droplet to be transferred to the surface without any solid-to-solid contact. But soft printing is limited by the inability to print onto rough or uneven surfaces; our new device overcomes these limitations by avoiding the solid-liquid-solid interface. The basic principle behind our droplet dispensing mechanism is to provide a pattern of acceleration and deceleration to the droplets such that inertial force can overcome adhesion force, resulting in droplet detachment from the device. To obtain the pattern of acceleration necessary for droplet dispensing, we explored different types of experimental setups including piezoelectric stack actuator, solid-to-solid impact, and mechanical stop. The dynamics of droplet detachment were analyzed using a high-speed video camera. The displacement, velocity, and acceleration characteristics of the stage housing the EWOD were obtained. This new way of dispensing droplets might open up new application possibilities in nanotechnology and biomedical areas.