PPDO-134

Design and Fabrication of a Digital Microfluidic Reactor

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Abstract

Current microfluidic devices are based on continuous flow of liquids through micro-channels designed on a solid substrate. These devices are, however, plagued by the problems of contamination, fouling and inaccurate quantitative analysis. They are also not suitable for various micro-reaction engineering requiring batch or semi-batch operations. Digital microfluidics, in which microdroplets of liquids are propelled on a surface, can potentially circumvent many of the problems. However, the main barrier to the design of such a reactor stems from the lack of adequate techniques of drop propulsion. The Lehigh group demonstrated that microdrops can be passively propelled on a surface with the aid of a surface tension gradient. It was also demonstrated that a surface tension gradient in conjunction with an induced shape fluctuation of the liquid drop can be used to actuate, transport and fuse microdrops on surfaces. More recently, however, the Lehigh group discovered that shape fluctuation of a drop with an asymmetric vibration alone can carry out all-of-the above unit operations with the additional benefits gained from the reversibility of drop motion.

The research proposed here will combine the expertise of the Carnegie Mellon group in dynamic wetting with the previous research and expertise in microdrop manipulation of the Lehigh group to design a prototype micro-reactor capable of carrying out simple biochemical reactions. In our research, we will address a critical bottleneck in the development of this technology, optimizing the behavior of the contact line dynamics during the drop motion, as well as design and fabricate a digital drop reactor.