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RESEARCH ARTICLE

Microfluidic dual loops reactor for conducting a multistep reaction

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Electronic Supplementary Material

The rotary mixing method uses pumps to drive flow in a circular microchannel at the regime of low Reynolds number [s1]. Algebraic stretching of the fluid results in a rapid decrease in the striation length and thus enables mixing (Fig. S1). This microfluidic architecture consists of a rotating cylinder placed eccentrically inside a microchannel where the axis of the cylinder is perpendicular to the flow direction (Fig. S1(a)). It uses a control layer of fluidic channels that can squeeze an underlying layer of channels. A single element can function as a valve, and three elements operating together can function as a pump (Fig. S1(b)). With this basic design of actuating mixing valves and pumps, it is possible to perform complex multiplexed fluidic manipulation. The mixer works by driving fluid flow in a circular microchannel using a pump (Fig. S1(c)). Driving fluid flow around the circular channel results in linear stretching of the fluid inside the channel and the striation length decreases algebraically with time. Complete mixing can be achieved within few second. Three integrated elastomeric mixing valves operating in sequence form a peristaltic pump that drives flow. When a series of on and off actuation sequences such as 100, 110, 010, 011, 001, 101, are applied, the fluid in the loop can be peristaltically pumped in a counter-clockwise direction. The higher the actuation frequency, the faster the fluid rotates in the loop (Fig. S1(c)).

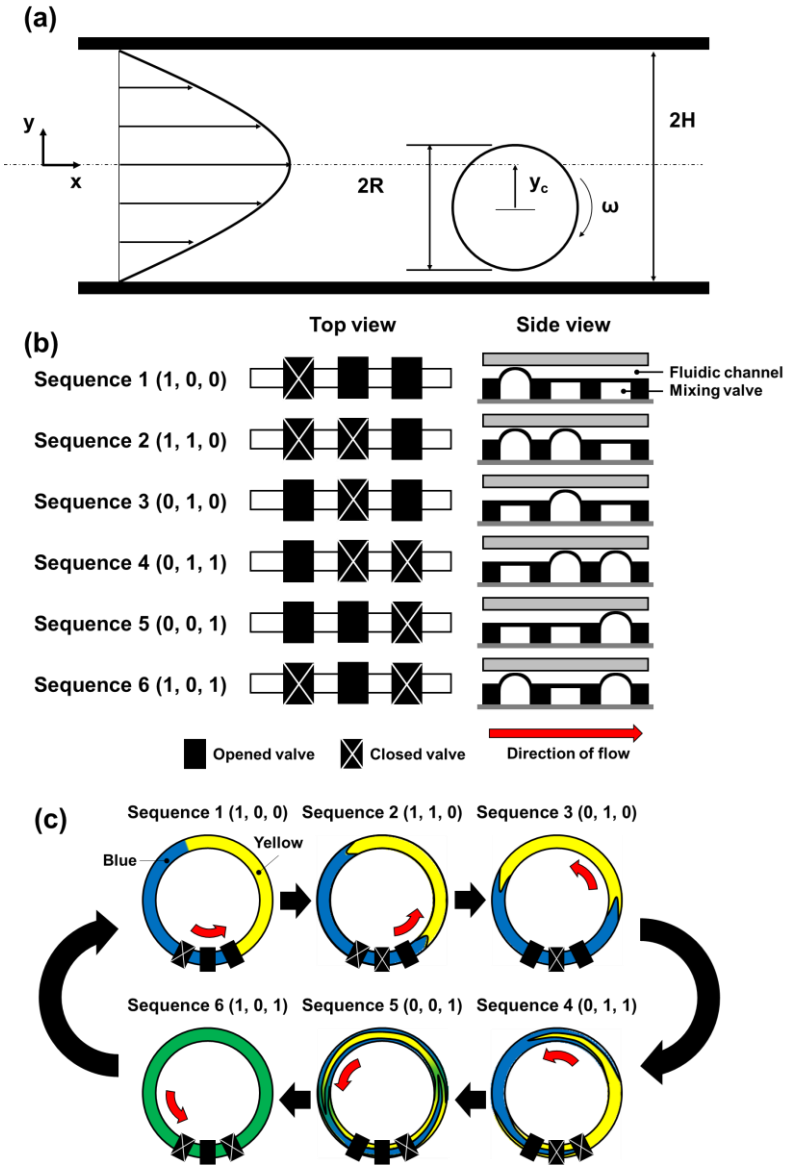

Fig. S1. Schematic illustration of the rotary pumping through actuating three mixing valves. (a) Microfluidic rotary pump and schematic drawing of Laminar flow in a microchannel [s1]. (b) Top and side view of the sequential action of peristaltic pump. Consecutive sequence provides efficient pumping of fluid in a loop microchannel. In this study, "0" and "1" indicate "open (black solid square)" and "close (X patterned square)" status of the valve, respectively. (c) Illustration of peristaltic pumping in a loop. Red arrows indicate the flow direction of the microfluid. Yellow and blue indicate different microfluids and green indicates that the two microfluids are completely mixed. The black solid and X patterned squares indicate the valve opening and closing states, respectively.

[s1] Cetin B, Li D. In Encyclopedia of Microfluidics and Nanofluidics, Li, D., Ed.; Springer US: Boston, MA, 2008, pp 1188-1189.