Supplementary Material for

Microfluidic on-demand engineering of longitudinal dynamic self-assembly of particles

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1. Device fabrication:

Firstly, a layer of 50 μm thick SU-8 negative photoresist (SU-8 3050, Microchem) was spun onto a cleaned 3-inch single-side-polished silicon wafer using a spin coating procedure. After pre-baking, the photoresist layer was patterned through UV light using a mask aligner (MJB4, SUSS MicroTec) and a printed photomask. Following post-baking, we using the SU-8 developer (PGMEA, MicroChem Corp.) to dissolved the uncured resist, and then a master mold with microchannel structures was obtained. Then, we put the master mold on a hot plane at a high temperature of 200 °C for 5 min to strengthen the master mold. Then, a micro-molding procedure was adopted to replicate the microchannel on the master mold. Firstly, the mixed polydimethylsiloxane (PDMS, Sylgard 184, Dow Corning) liquid with base and curing agent (weight ratio of 10:1) was poured on the obtained SU-8 master mold, then degassing. After curing in the oven at 65 °C for 3h, the PDMS was peeled off from the master mold. Holes were punched at the positions of the inlet and outlet. Finally, the PDMS block was irreversibly bonded with a glass slide using an oxygen plasma machine (PDC-002, Harrick Plasma). The channel devices were kept in the oven at 65 °C for more than half-hour to enhance the bonding strength.

2. Numerical Simulation

The finite element method was employed to solve the incompressible Navier-Stokes equations in the fluid-solid configurations of spherical particles moving in square-

shaped microchannels. In the numerical simulations, the dynamics of the fluid system were updated to achieve a steady-state flow field around the particles by setting the fluid-solid boundary conditions. The inlet velocity was defined as u (0.1 m/s) and could be calculated as the ratio of the flow rate and the cross-section of the channel. We defined the pressure of the outlet to be zero. The velocity of the particles was obtained from the flow field. For simplicity, 2D simulations were conducted to show the flow velocity in the channel. The radius of the particle was set to be 20 μm, and the width of the channel was set to be 50 μm. Laminar flow was added to the inlet of the channel, and the outlet was kept to be zero gradient. Besides, the fluid-solid boundary was assumed to be a non-slip boundary. The fluid density ρ and viscosity μ were set to be the values of water, and the Reynolds Number (Re) of the flow field was 0.02.

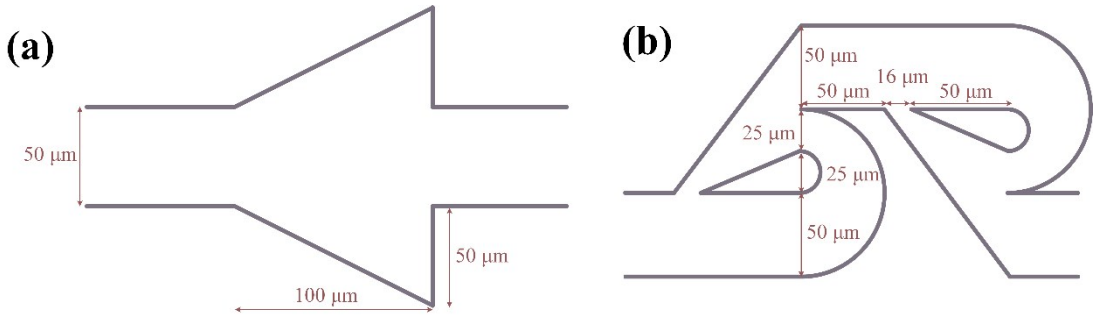

Figure S1. Channel sizes of two functional microstructure.

Movie S1. Longitudinal dynamic self-assembly of a long continuous particle train at the particle volume concentration of 0.52%. Channel dimension: 50 μm wide, 50 μm high. Particle size: 20 μm. The movie is ~400 times slowed from real time. (Multimedia view)

Movie S2. Longitudinal dynamic self-assembly of a long continuous particle train at the particle volume concentration of 0.63%. Channel dimension: 50 μm wide, 50 μm high. Particle size: 20 μm. The movie is ~400 times slowed from real time. (Multimedia view)

Movie S3. Longitudinal dynamic self-assembly of a long continuous particle train at the particle volume concentration of 0.73%. Channel dimension: 50 μm wide, 50 μm high. Particle size: 20 μm. The movie is ~400 times slowed from real time. (Multimedia view)

Movie S4. Longitudinal dynamic self-assembly of a long continuous particle train at the particle volume concentration of 0.84%. Channel dimension: 50 μm wide, 50 μm high. Particle size: 20 μm. The movie is ~400 times slowed from real time. (Multimedia view)

Movie S5. Longitudinal dynamic self-assembly of a long continuous particle train at the particle volume concentration of 0.94%. Channel dimension: 50 μm wide, 50 μm high. Particle size: 20 μm. The movie is ~400 times slowed from real time. (Multimedia view)

Movie S6. Longitudinal dynamic self-assembly of a long continuous particle train at the particle volume concentration of 1.05%. Channel dimension: 50 μm wide, 50 μm high. Particle size: 20 μm. The movie is ~400 times slowed from real time. (Multimedia view)

Movie S7. Longitudinal dynamic self-assembly of a long continuous particle train at the particle volume concentration of 1.15%. Channel dimension: 50 μm wide, 50 μm high. Particle size: 20 μm. The movie is ~400 times slowed from real time. (Multimedia view)