

## Supporting Information

### On-demand mixing and dispersion in mini-pillar based microdroplets

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## Experimental

### Materials and instruments

The piezoelectric transducer was purchased from Harbin Core Tomorrow Science and Technology Co. Ltd, China, with the diameter of 6.40 mm and a thickness of 2.00 mm. The polydimethylsiloxane (PDMS) was purchased from Dow Europe GmbH. The photomask with array was custom made from Beijing Zhongjingkeyi Technology Co., Ltd, China. The 3  $\mu\text{m}$  polystyrene nanoparticles (PS) were purchased from Beijing Zhongkeleiming Technology Co. Ltd, China. And the 1  $\mu\text{m}$   $\text{Fe}_3\text{O}_4$  nanoparticles were purchased from Nanjing Nanoeast Biotech Co. Ltd, China. All chemicals were used without any further purification and prepared by dilution using ultrapure water (Milli-Q, 18.2 M $\Omega$ ). A Nikon Eclipse Ni microscope, coupled with a 4 $\times$  objective and a Nikon DS-Ri2 microscope camera are used for recording videos of polystyrene nanoparticles. The motion of  $\text{Fe}_3\text{O}_4$  nanoparticles in the microdroplet was captured by using a macro-lens on a mobile phone, and the corresponding microscope images are obtained by a Nikon ECLIPSE LV100ND.

### Fabrication of mini-pillar-based platform

The solid substrate was a single-sided printed circuit board customized from manufacturer. The PDMS mini-pillar with a diameter about 2.0 mm was prepared by casting in a mold. First, the PDMS prepolymer was mixed with curing agent with the ratio of 10:1, and eliminated bubbles by the vacuum drying oven with about 20 min. The prepolymer afterwards was poured onto the template and transfer to drying oven at 80 °C about 4 h for solidification. Then the piezoelectric transducer and the PDMS mini-pillar were concatenated through the uncured PDMS and curing agent in the drying oven at 60°C about 4 h. The drop of liquid was added to the obtained PDMS mini-pillar array for producing microdroplets array. The continuous sine wave was generated by using the arbitrary waveform generator, which connected to the homemade power amplifier varied from 0 to 10.0 V, and finally transferred to the piezoelectric transducer to produce ultrasonic waves. Each PDMS mini-pillar was connected to a separate controllable piezoelectric transducer for achieving on-demand mixing and disperse droplets onto the mini-pillars array.

### **Supporting Videos**

SI Video 1. The polystyrene nanoparticles with controllable rotating play with double speed.

SI Video 2. The Fe<sub>3</sub>O<sub>4</sub> nanoparticles continuous movement play with double speed.