Laser Engraved Microstructure for Arranging Particle Flowing in a Glass Microfluidic Channel

Div. Mat. Sci., NAIST[1], Sch. Eng., Macquarie Uni.[2], RIKEN BDR[3]

°Tianlong Zhang[1], Yalikun Yaxiaer[1], Kazunori Okano[1],

Yo Tanaka[3], Ming Li[2], and Yoichiroh Hosokawa[1]

E-mail: yaxiaer@ms.naist.jp

Control over the positions of particles into a focused stream serves as a prerequisite step for the downstream processing, such as detection, imaging and separation in microfluidics [1]. In this study, we demonstrate the focusing of polystyrene (PS) particles in a microfluidic channel with a glass surficial pattern achieved by femtosecond pulse (fs) laser micromachining (**Fig. 1**). The fs laser micromachining shows advantages over other methods such as wet etching and deep reactive ion etching (DRIE) for small area direct writing in glasses. Results showed 10-μm PS particles with flow velocity ranging from 600 to 1000 μm/s are able to be driven close to channel center by the pattern induced hydrodynamic forces. Our results hold potential in the development of innovative microfluidic devices requiring the low-speed particle alignment, e.g. contact imaging and fluorescence lifetime-resolved imaging, for wider applications in biology and biomedicine.

The laser pulses from a Ti: sapphire fs laser amplifier (800 nm, 130 fs, 1 kHz, 2.8 μJ/pulse) was employed. The pulses were introduced to a 10× objective lens (NA = 0.25) equipped on an inverted microscope and focused on a glass substrate for engraving. Diameter of the etching spot was ~ 2 μm. The pulses were scanned on the substrate by controlling the electric stage (100 μm/s), and sequential open v-shaped microstructures were patterned in the channel direction. The pulse overlapping number in the process was 20. A PDMS fluidic channel of 20 μm in height and 100 μm in width was mounted on the engraved glass substrate to form an enclosed microfluidic channel.

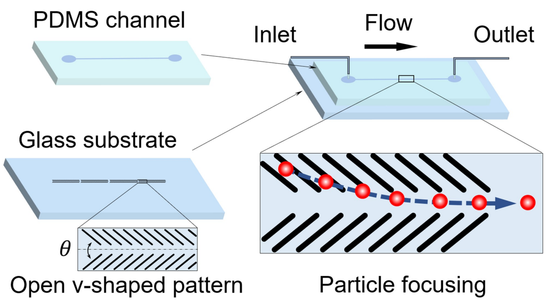

Fig. 1. Schematic for aligning particles with fs laser engraved open v-shaped pattern. $\theta = 60^{\circ}$.

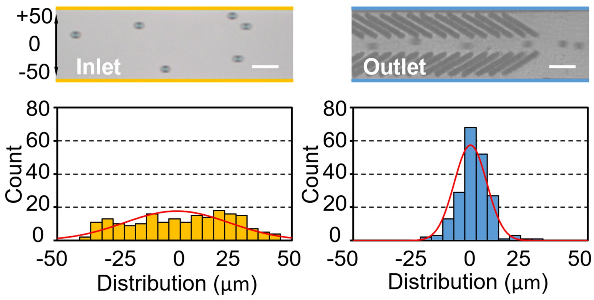

Fig. 2. Particle distribution before and after passing the open v-shaped pattern. N = 200 for each group. Scale bar is 40 μm.

Results demonstrated 10-μm PS particles are randomly distributed at the inlet and are aligned to a focused flow stream at the outlet (**Fig. 2**). Due to the combined effects of hydrodynamic and gravitational forces, particle alignment was achieved horizontally and vertically. Next, we will optimize the microfluidic device regarding the parameters such as angle and depth for the focusing of different types of particles.

[1] Y. Shen, Y. Yalikun, and Y. Tanaka, Sensor Actuat. B-Chem. 282, 268-281 (2019)