Numerical simulation of dynamic particle focusing for multi-particle suspensions

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Abstract

In microchannels, flowing particles can laterally migrate across streamlines and focus into some particular regions within the cross section of the channel (Fig. 1). This particle focusing facilitates continuous, high-throughput manipulation of particles in microchannels [1]. Although numerical studies can provide rich insights into the unique, complex dynamics in confined channel flows, there have been very few that highlighted the focusing dynamics for multi-particle suspensions [2]. In this study, to simulate multi-particle focusing dynamics, we develop a new Lagrangian particle tracking method that couples the computational fluid dynamics (CFD) for fluid dynamics and direct numerical simulation (DNS) [3] for particle-fluid interaction. By this method, we numerically demonstrate that the focusing dynamics exhibits unique, different patterns as a function of Reynolds number and channel geometry. We then study the effect of Reynolds number and channel geometry on the dynamics of particle focusing. Our model is thus verified with good agreement with previous observations. This study indicates that our method can offer more rich and detailed guidelines to engineer microchannel designing and flow control using microfluidic devices than experimental methods.

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Keywords: Inertial microfluidics, Manipulation of particles, Microchannels, DNS, CFD, DEM, Multi-phase flow

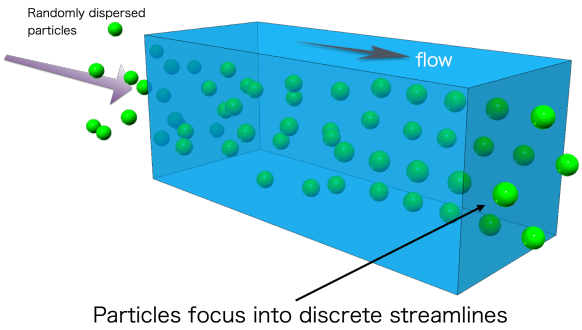

Fig. 1 Focusing behaviour of particles flowing in square microchannels.

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