3-D Flow Visualization of Acoustic Streaming Flow Induced by Solid and Bubble Obstructions

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HIGHLIGHTS

- 3-D acoustic streaming flow patterns in microfluidic devices are successfully reconstructed by a new multispectral 3-D µ-PTV system. The system is capable of capturing the microscale 3-D flow features with high resolution and better image quality, due to the improved three-camera optical setup and illumination method.
- The streaming flow patterns of induced by bubble and solid obstructions are compared. It is found that flow patterns from a bubble induced streaming flow significantly different than the solid obstruction induced one. The streaming flows induced by gas bubble are much stronger than the ones induced by solid obstructions, and the larger obstruction size also increased the magnitude of the streaming flow velocity.
- Larger obstruction size has an impact on the flow symmetry. The flows become asymmetric and 3-D flow patterns become even more different for the bubble and solid obstruction configurations.

ABSTRACT

Acoustic streaming refers to a steady streaming flow induced by high-frequency oscillation of the flow and interactions to obstructions in the flow regime. It has recently found applications in particle manipulation, micro mixing and active flow control. One method to generate such a steady streaming flow is through oscillation of air bubbles inside a microchannel induced by piezoelectric transducers, and another method is based on the oscillatory perturbation of the solid boundaries and obstructions in the flow field. To understand and compare the differences between these two methods of producing acoustic streaming flows, two configurations of microfluidics devices are made, and the streaming flow is triggered at 2 kHz range. The 3-D flow visualization is done by using a new multispectral 3-D µ-PTV technique. The experimental results show that flow patterns from a bubble induced streaming flow is significantly different than the solid obstruction induced one. The streaming flows induced by gas bubble are much stronger than the ones induced by solid obstructions, and the larger obstruction size also increased the magnitude of the streaming flow velocity. The larger obstruction size also has an impact on the flow symmetry, making the flow patterns asymmetric and even more different for the bubble and solid obstruction configurations.
**Fig. 1** Comparison of the 3-D flow field on the XY plane at $Z/D = 0.9$ for (a) bubble (b) solid induced streaming flow at 2 KHz.