Sensors and Actuators, A: Physical, vol. 204, 2013, pages 107-113

Bidirectional flow micropump based on dynamic rectification

Abstract

This paper proposes a new bidirectional pumping principle based on a dynamic rectification mechanism. The pump is composed of a moveable actuation platform and a gourd-shaped chamber, whose role is to behave as both a rectification and a pumping structure. An asymmetrically deflected membrane induces a differential pressure across the chamber and thus generates a pumping effect. The stream flow field inside the chamber was verified by numerical simulations. Furthermore, the feasibility of the pump was examined by developing a poly-dimethylsiloxane (PDMS)-based prototype using micro-electromechanical (MEMS) fabrication technology. Because the pumping performance is directional, the micropump characteristics were evaluated at different actuation points along the membrane. In addition, the operating performance was assessed over a range of low driving frequencies (1-10 Hz, in 1 Hz increments) and over a nominal frequency ranges (5-55 Hz, in 5 Hz increments). The proposed micropump exhibits maximum flow rates of 1.52 ml/min in the forward direction and 1.48 ml/min in the reverse direction, with resonance frequencies of 15 Hz and 20 Hz, respectively. The presented pump offers advantage in future disposable microfluidics applications due to its bi-directional properties, low fabrication cost and modular architecture.

Keywords

Bi-directional micropumps; Dynamic structure valve; Electromagnetic actuation; Numerical simulation