

# Abstract

Microfluidics offers an effective means to carry out a wide range of transport processes within a controlled microenvironment by drawing on the benefits imparted by increasing surface area to volume ratio at the microscale. Critical to the impact of microfluidics on integrated devices in the fields of bioengineering and biomedicine is the ability to transport fluids and biomolecules effectively particularly at the size scales involved. In this context a bio-inspired pumping mechanism, the valveless impedance pump, was explored for applications in microfluidics ranging from micro total analysis systems to microchannel cooling. Adhering to the basic principles of the impedance pump mechanism, pumps have been constructed at a variety of size scales from a few centimeters to a few hundred microns. The micro impedance pump is valveless, bidirectional, and can be constructed simply from a wide range of materials. Depending on the size of the pump flow rates range from nL/min to mL/min and pressures can be generated that exceed 20 kPa. Another benefit of the impedance pump is the pulsatile flow output which can be used in the context of microfluidic applications to enhance transport at low Reynolds numbers as well as metering in drug delivery.

Pulsatile flow was therefore investigated as a method of augmenting transport in microfluidic systems. Micro PIV was used to study the affect of both steady and pulsatile flows on transport at low Reynolds number was examined in microscale rectangular cavities. Ventilation of the cavity contents was examined in terms of the residence time or average time a particle remains in the cavity region. Lagrangian coherent structures (LCS) were applied to empirical velocity fields to determine the impact of unsteadiness on time dependent boundaries to fluid transport present in the flow. Experimental results show that there are both frequencies which are beneficial and detrimental to cavity ventilation as well as certain frequencies which more evenly distribute particles originating in the cavity throughout the freestream.