Introduction

The science and engineering of systems in which fluid behaviour differs from conventional flow theory primarily due to the small length scale of the system is called Microfluidics.

A key component of Microfluidic systems is micropump and there have been several attempts to develop a high flow rate, high pressure rise, robust and reliable micropump with mixed success. Our aim is to develop a micropump initially with CPU liquid cooling in mind. The development of efficient and reliable micropumps is currently one of the constraints on development of the next generation of microprocessors. In the longer term the micropump can be used in different microfluidic applications, such as lab-on-a-chip (LOC) devices, fuel cells and micro-reactors.

Valveless rectification micropumps are chosen for this study. This type of micropumps do not have moving valves and are less susceptible to wear, fatigue, and clogging. In addition, the pressure drop is lower across the rectifying elements in comparison to movable valves.

Methods

In this study an integrated approach is applied to understand the underlying physics of valveless micropumps. Mathematical modelling, simulation, and experiment are three main parts of this study.

By modelling and simulation of the system we are able to design and optimise robust and high performance micropumps.

Results

The flow driven by a valveless micropump with a single cylindrical pump chamber and two diffuser/nozzle elements is studied theoretically using a one-dimensional model. The analytical results agree with numerical calculations and are in the same order of magnitude as the experimental results.

The developed model is used to define boundary conditions for the CFD (Computational Fluid Dynamics) simulation.

Conclusions

The significance of this work is that we developed a model that can replace the current widely accepted expressions developed by Stemme and Stemme [2]. This model can be used to expedite the development of micropumps. This can resolve the microelectronic cooling problem and remove the constraints on development of the next generation of microprocessors which means smaller, faster, and less noisy computers.

Now we are in the stage of designing, optimising, and testing new micropumps based on this study.

References
