A Planar Micropump Utilizing Thermopneumatic Actuation and In-Plane Flap Valves

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Motivation

- Micropumps necessary for stand-alone microfluidic systems.
  - Mixing
  - Drug Delivery
  - Sampling
- Precise control of fluid positioning minimizes sample volume and assay time.
- Mechanical micropump performance dictated by quality of valves used. Current planar valves insufficient.

Planar Micropump Design

Two Major Improvements:

1) Pre-loaded, in-plane one-way valves with hole-in-the-wall valve seats
2) Insulating Buffer Channels
In-Plane One-Way Valves

Flap Seals
Hole-in-the-Wall

Valve Inlet
In-Plane One-Way Valves

"Hole-in-wall" Forward flow

Bent flap (open position)

Fluidic Resistance Ratio >1300

Buffer Channel
Results

\[ P = C_1 + C_2 \exp(C_3 C_4 t) \]

- 132 mW
- 80 mW

Results

\[ P = C_1 + C_4 \dot{V} \]

- 132 mW
- 80 mW
Conclusion

132 mW (20% duty cycle, 10 Hz)
- 6.5 kPa Maximum Pressure
- 5.0 µL/min Maximum Flow Rate

227 mW (20% duty cycle, 5 Hz)
- 13.8 kPa Maximum Pressure

Wafer-Level Fabrication
Future Work

Test with biological fluids
Evaluate buffer channel
Integrate pumps into pulsatile mixing system