

# A multi-resonances valveless micropump with high fluid transportation efficiency

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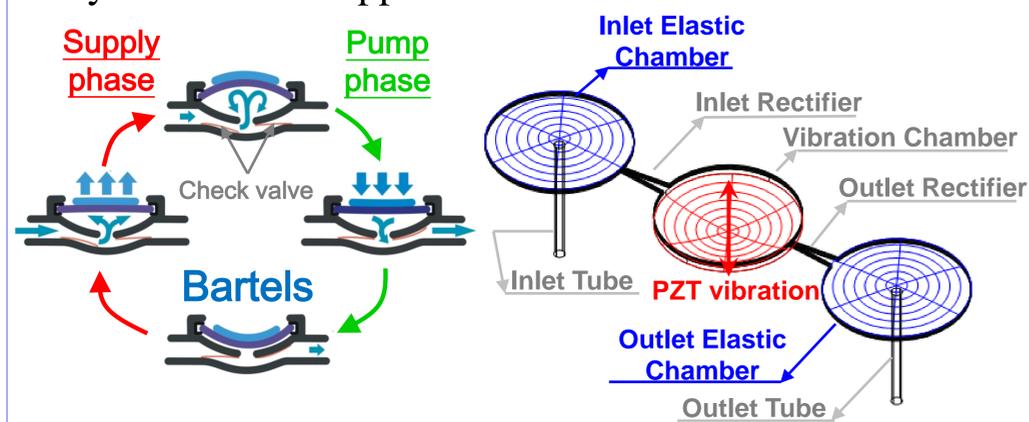
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## Abstract

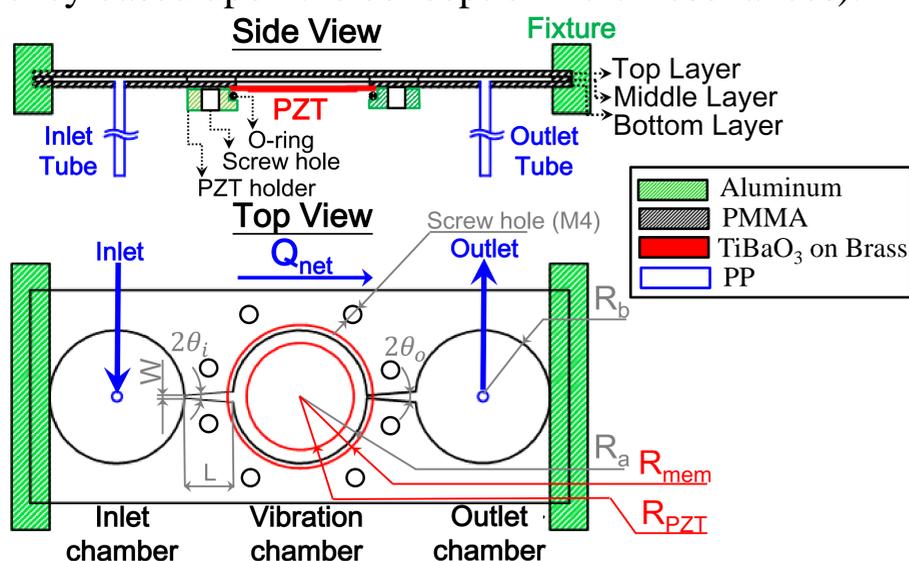
In this research, the concept of multiple resonances was proposed to solve the low efficiency problem of valveless pumping. The elastic chambers of intendedly-designed stiffness were equipped at inlet/outlet of valveless micropump. The second resonance was successfully induced for the enhancement of efficiency of fluid transportation by the interaction of fluid and structure with elastic boundaries. The experiments showed that the size of elastic chamber had great effects on the operating frequency range and net flow rate. As  $R_b/R_a=1.2$ , the maximum net flow rate is 15 times larger than the model of  $R_b/R_a=0.12$ . Besides, a theoretical model based on "Electric-Hydraulic-Analogy" was proposed to effectively predict the dynamic behavior of valveless micropump utilized in miscellaneous microfluidic applications.

## Introduction & Method

Valveless pumping is an ideal and biomimetic way of fluid transportation due to its simplicity and absence of moving elements which may cause fatigue problems. However, the issue of low efficiency makes it hard to be implemented in many microfluidic applications.



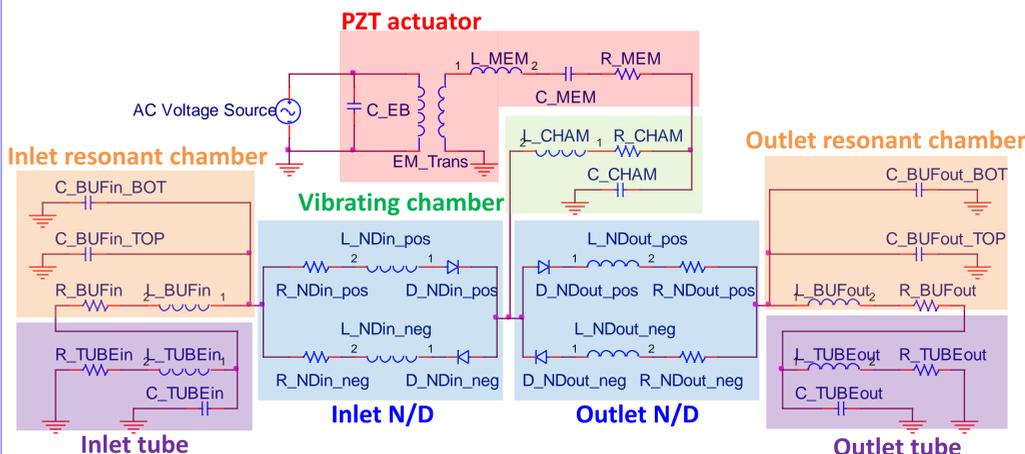
**Fig. 1** Oscillating-membrane micropump (pressure-driven): (a) Commercial one with check valves (Bartels); (b) Valveless design with elastic boundary walls at inlet/outlet (for a critical enhancement of fluid transportation efficiency based upon the concept of multi-resonances).



**Fig. 2** (a) Side view; (b) Top view of valveless micropump.

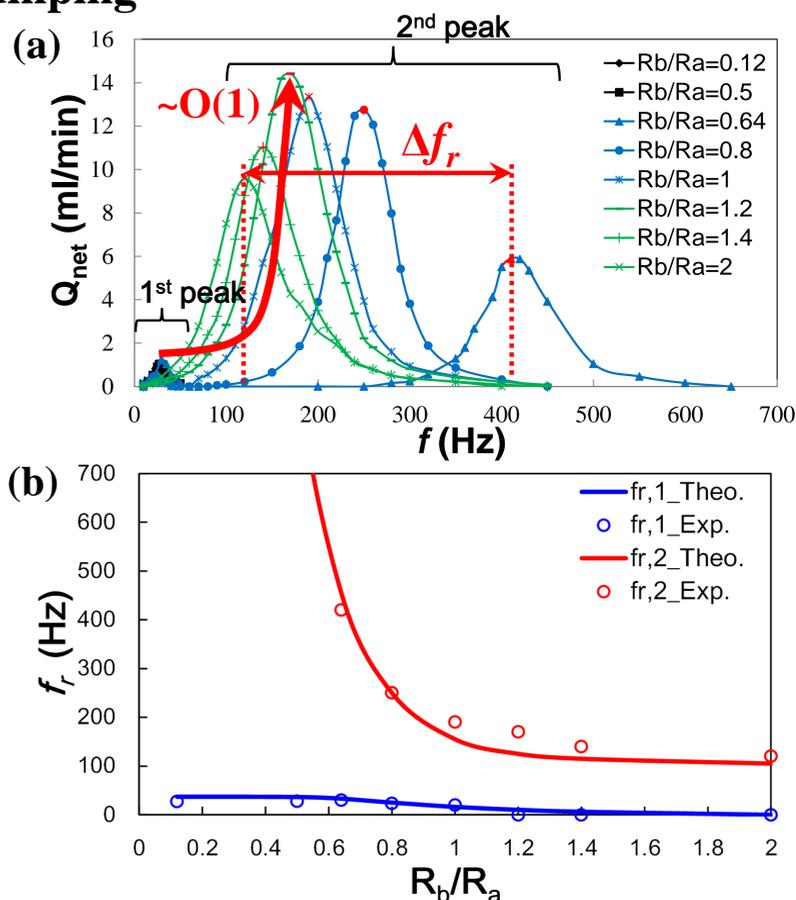
## Results & Discussions

### No-Free-Parameter Theoretical model



**Fig. 3** A theoretical model of piezoelectric valveless micropump by Electric-Hydraulic-Analogy method.

### Multi-resonances phenomenon of valveless pumping



**Fig. 4** (a) Experimental net flow rate ( $Q_{net}$ ) v.s. actuating frequency ( $f$ ); (b) Theoretical prediction of the resonant frequencies ( $f_{r,1}$  &  $f_{r,2}$ ) v.s.  $R_b/R_a$ .

## Conclusions

A multi-resonances valveless micropump equipping with inlet/outlet elastic chambers of intendedly-designed stiffness was successfully realized to solve the low efficiency problem. Besides, a theoretical model based on Hydraulic-electrical-Analogy was also proposed to precisely predict its characteristics of dynamic behavior.

## Acknowledgement

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