

Vibrating membrane with discontinuities for rapid and efficient microfluidic mixing

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Supporting information

Videos

Acoustic Membrane Video 1: Particles visualisation of streaming by the membrane.

In this video, we make use of particles to visualise the streaming vortices generated by the membrane. Two fluid streams of 2%wt PEG in water solution are pumped into the channel at 5 $\mu\text{l}/\text{min}$ each. The bottom stream contains 2.01 μm fluorescent particles mixed at 5% v/v in the PEG-water solution.

The channel is 1000- μ -wide and 80- μm -high, the membrane's side length is 455 μm and the hole's diameter is 200 μm . The flow is from right to left.

The streaming vortices shown in Fig. 5(a) and (c) are extracted from this video, but are mirrored about the horizontal line.

Acoustic Membrane Video 2: Mixing at 60 $\mu\text{l}/\text{min}$ total flow rate.

This video shows mixing at 60 $\mu\text{l}/\text{min}$ total flow rate (Peclet number is approximately 8000) using a membrane with a circular hole. The mixing time is 3 ms, and the mixing efficiency is 90%.

The channel is 1000- μ -wide and 80- μm -high, the membrane's side length is 455 μm and the hole's diameter is 200 μm . The flow is from right to left.

All videos are recorded and played at 15 frames per second.

Materials properties

COMSOL: Thermal distribution

¹P. B. Muller, R. Barnkob, M. J. H. Jensen and H. Bruus, Lab Chip, 2012, **12**, 4617–4627.

²S. Hawley, J. Allegra and G. Holton, J. Acoust. Soc. Am., 1970, **47**, 137–143.

Table 1: List of materials properties used in COMSOL simulations

LPCVD Silicon nitride (SiN)			
Density	ρ_{SiN}	3000	kg m^{-3}
Young's modulus	E	290	GPa
Poisson's ratio	ν_{SiN}	0.27	
Water ¹			
Density	ρ	998	kg m^{-3}
Dynamic viscosity	μ	0.893	mPa s
Bulk viscosity ²	μ_B	2.18	mPa s
Speed of sound	c	1495	m s^{-1}
Thermal conductivity	k_{th}	0.603	$\text{W m}^{-1} \text{K}^{-1}$
Specific heat capacity	C_p	4183	$\text{J kg}^{-1} \text{K}^{-1}$
Specific heat ratio	γ	1.014	
Thermal diffusivity	D_{th}	1.43×10^{-7}	$\text{m}^2 \text{s}^{-1}$
Thermal expansion coefficient	α	2.97×10^{-4}	K^{-1}
Isentropic compressibility	β_0	448.319×10^{-12}	Pa^{-1}

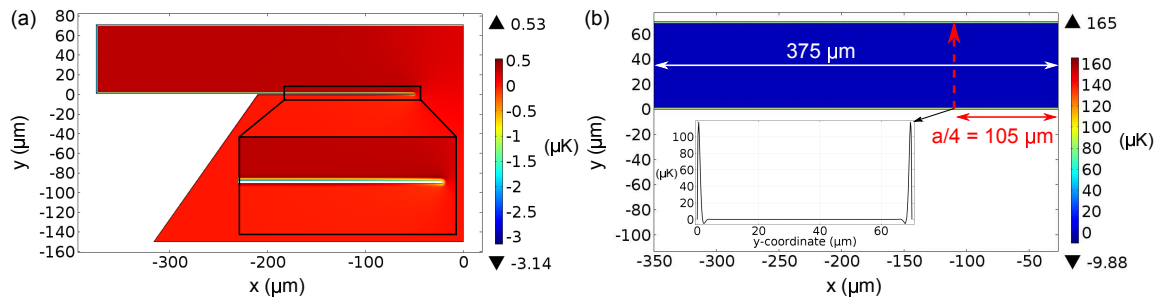


Figure 1: First-order temperature field T_1 of the membrane with (a) and without (b) the hole.