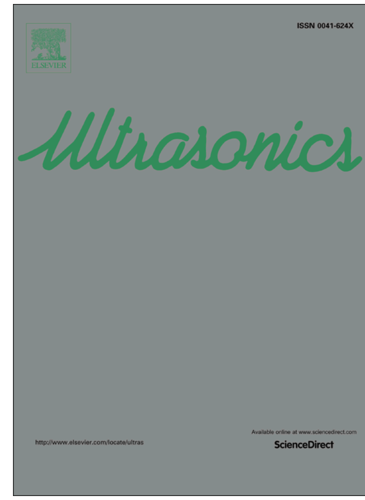
Accepted Manuscript



On-chip ultrasonic manipulation of microparticles by using the flexural vibration of a glass substrate

Ryota Yamamoto, Daisuke Koyama, Mami Matsukawa

PII: S0041-624X(16)30344-4
DOI: http://dx.doi.org/10.1016/j.ultras.2016.11.026
Reference: ULTRAS 5429

To appear in: *Ultrasonics*

Received Date: 1 April 2016
Revised Date: 29 November 2016
Accepted Date: 30 November 2016

Please cite this article as: R. Yamamoto, D. Koyama, M. Matsukawa, On-chip ultrasonic manipulation of microparticles by using the flexural vibration of a glass substrate, *Ultrasonics* (2016), doi: http://dx.doi.org/10.1016/j.ultras.2016.11.026

On-chip ultrasonic manipulation of microparticles by using the flexural vibration of a glass substrate

Ryota Yamamoto[1,2], Daisuke Koyama[2,3], and Mami Matsukawa[2,3]

[1]Faculty of Life and Medical Sciences, Doshisha University, 1-3 Tataramiyakodani, Kyotanabe, Kyoto 610-0321, Japan
[2]Wave Electronics Research Center, Doshisha University, 1-3 Tataramiyakodani, Kyotanabe, Kyoto 610-0321, Japan
[3]Faculty of Science and Engineering, Doshisha University, 1-3 Tataramiyakodani, Kyotanabe, Kyoto 610-0321, Japan

Corresponding author: Daisuke Koyama
E-mail: dkoyama@mail.doshisha.ac.jp

Abstract—As biotechnology develops, techniques for manipulating and separating small particles such as cells and DNA are required in the life sciences. This paper investigates on-chip manipulation of microparticles in small channels by using ultrasonic vibration. The chip consists of a rectangular glass substrate with a cross-shaped channel (cross-section: 2.0×2.0 mm^2) and four lead zirconate titanate transducers attached to the substrate's four corners. To efficiently generate the flexural vibration mode on the chip, we used finite element analysis to optimize the configurations of the glass substrate and transducers. Silicon carbide microparticles with an average diameter of 50 μm were immersed in the channels, which were filled with ethanol. By applying an in-phase input voltage of 75 V at 225 kHz to the four transducers, a flexural vibration mode with a wavelength of 13 mm was excited on the glass substrate, and this flexural vibration generated an acoustic standing wave in the channel. The particles could be trapped at the nodal lines of the standing wave. By controlling the driving phase difference between the two pairs of transducers, the vibrational distribution of the substrate could be moved along the channels so that the acoustic standing wave moved in the same direction. The trapped particles could be manipulated by the two-phase drive, and the transport direction could be switched at the junction of the channels orthogonally by changing the combination of the driving condition to four transducers.

Keywords: Manipulation; lab-on-a-chip; acoustic standing wave; flexural vibration; finite element analysis