ON-CHIP ACTUATION OF POLYMER SHELLED MICROBUBBLES

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1. Introduction

Micro-sized gas bubbles (MBs) are used as a contrast agent for diagnostic ultrasound imaging as well as drug or gene transfection due to their stable oscillation under ultrasound exposure [1]. The acoustically driven microfluidic chip is utilized for cell/microparticle manipulations and cell-cell interactions [2]. The motion of thin protein/lipid shelled MBs are shown to be controlled by acoustic standing wave in a bulk situation [3]. However, drug loaded thin shelled MBs are mechanically unstable in the circulation. In contrast, having relatively stiff and thick shell polymer MBs offers increase stability both mechanical and chemical [4]. As a result we focus on the study the interaction of thick shelled MBs and cells under ultrasound exposure. The preliminary aim of this study is to observe the acoustical behaviour of thick polymer shelled MBs in a microfluidic chip.

2. Method

A 4 cm long microfluidic chip (GeSim GmbH, Dresden, Germany) containing two rectangular and two oval sono-cages of varying geometries was utilized. A 4×7 mm PZT piezoceramic element was glued on one sided of microfluidc chip. The fundamental resonance frequency of the transducer was about 2.4 MHz. The chip contains one inlet and one outlet. Polymer shelled MBs with a concentration of 10^8 MBs/ml was diluted 1000 times and injected through inlet. The chip was placed under the transmission light microscope. The light transmitted through a 300×300×110 μm^3 sized sono-cage was captured by CCD camera [5]. The chip was kept under stationary position for some time to avoid pressure gradient. The excitation voltage of the transducer was varied between 1 Vp-p to 10 Vp-p and the frequencies were changed within the range of 2.3 MHz to 2.8 MHz.

3. Results

As shown in Figure (1a), there were no movements in MBs below 7 Vp-p and at 7 Vp-p the MBs started to actuate rapidly and trapped at pressure node as shown in Figure (1b). When the driving frequency was changed from 2.3 MHz to 2.8 MHz, the trajectories of MBs motions were varied.

4. Discussion and Conclusion

Initial observation indicates that the polymer shelled MBs behave as polystyrene micro beads of size around 5µm and cells [2]. Therefore polymer MBs and cells could be trapped in close proximity if introduced simultaneously. This makes it possible to study one to one interaction between cell and MB that may provide an opportunity to study cavitations associated mechanism, for e.g., sonoporation, drug delivery mechanism and cell lysis.

References

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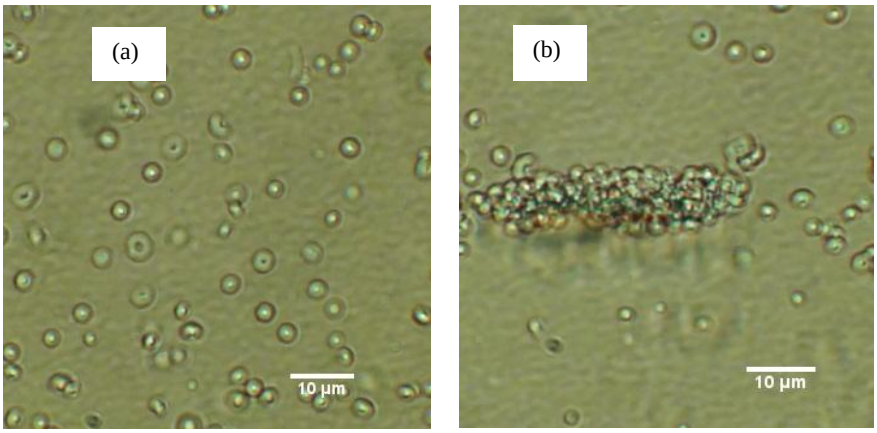

Figure.1 Micrographs of microfluidic chip filled with polymer shelled MBs (a) below 7 Vp-p (b) above 7 Vp-p