SURFACE ACOUSTIC WAVE BASED RED BLOOD CELLS PATTERN USING A STRAIGHT SINGLE PHASE UNIDIRECTIONAL TRANSDUCER

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Recently, polydimethylsiloxane (PDMS) based microfluidic channels have been integrated with standing surface acoustic wave (SSAW) devices for various applications like the cell or particle manipulation [1]. The SSAW is formed by direct interference of two or more surface acoustic waves which are generated by the interdigital transducers pairs [2-4]. The suspended cells/particles in the SSAW field experience acoustic radiation forces and are pushed to the pressure node or anti-node [5]. However, we use a straight single-phase unidirectional transducer (SSPUT) to generate surface acoustic wave (SAW) which can pattern cells in fluid. When the SAW is applied, the red blood cells are driven by the acoustic radiation force and patterned into the parallel lines, which indicates that a SSAW field is formed in the PDMS microchannel.

As shown in Figure 1, the SSPUT (Cr/Au, 50nm/300nm) is fabricated on a 128° Y-cut, X-propagating lithium niobate ($LiNbO_3$) substrate by the lift-off process. The PDMS micro-channel fabricated using the standard soft lithography technique is bonded on the $LiNbO_3$ substrate. The SSPUT has 20 pairs of electrodes whose widths and spacing gaps are 0.09 mm respectively. As shown in Figure 2, the S11 parameter of the device is measured using a vector network analyzer to determine the resonant frequency which represents the energy transmission capacity of the device. During the experiment, a voltage signal generated by an arbitrary signal generator is applied on the SSPUT to generate SAW. As shown in Figure 3, the red blood cells are suspended evenly in the microchannel when the SAW is off. After exposure to the 10.74 MHz SAW at 10Vpp, most of the red blood cells are patterned into two parallel lines within the channel and few are pushed to the sidewall. This similar phenomenon is more clearly observed at the 19.80MHz SAW and 20.99MHz as shown in Figure 4.

The aforementioned studies show that the interference of two SAWs forms a SSAW field in the microchannel which is placed between two parallel interdigital transducers. However, only a SSPUT is used to generate SAW in our study and the red blood cells are patterned in parallel lines when the SAW is on. It indicates that a SSAW field is formed in the microchannel. Most of the SAW is absorbed in the fluid and few SAW at the fluid/channel interface will reach the PDMS/air interface and bounce back again. Thus, the reflection of SAW at the PDMS/air interface is neglected. The SAW attenuation length on the substrate surface is greater than the channel width, so the SAW can reflect at the boundary between the fluid/ channel interface and the fluid/ substrate interface. The reflected and incident waves interfere to form a SSAW field. The cells are aggregated along the PDMS channel wall when the SSAW is applied because of the small contrast of acoustic impedance at the interface of fluid/ channel [6].

Word Count: = 473

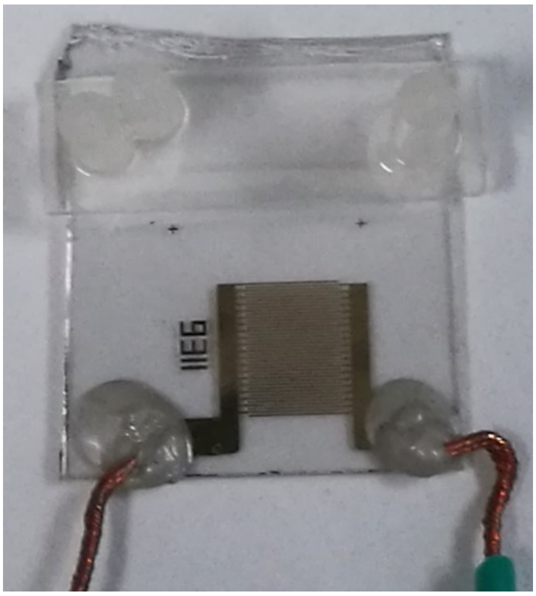

Fig.1 The fabricated SAW device.

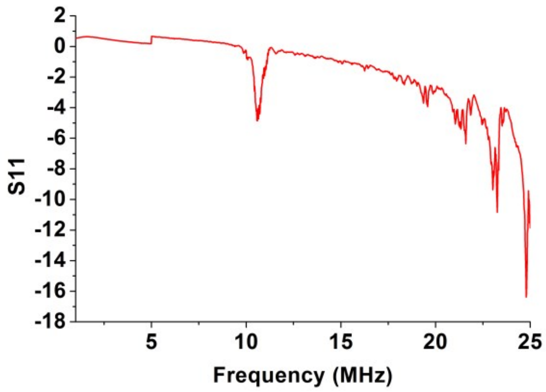

Fig. 2 S11 parameter of the SAW device is measured to determine the resonant frequency.

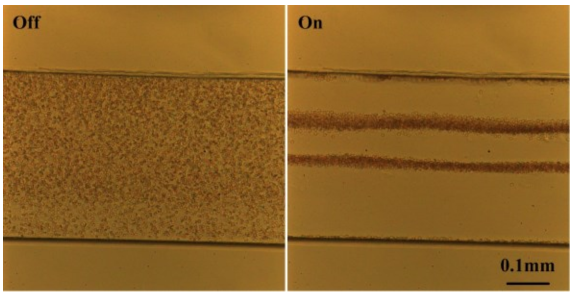

Fig. 3 The red blood cells are patterned in parallel lines in the channel under the 10.74MHz at the 10Vpp and the SSAW field is formed.

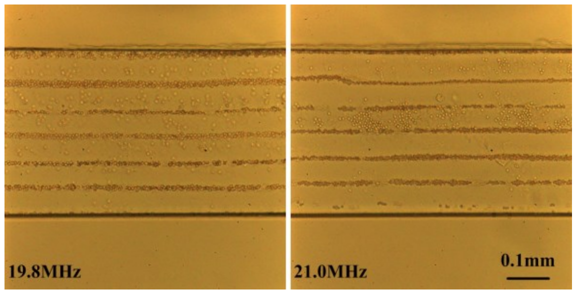

Fig. 4 Similar behaviors of the red blood cells under different SAW frequencies at the 10Vpp.

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