A NOVEL SHEAR-HORIZONTAL SURFACE ACOUSTIC WAVE BIOSENSOR

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This paper reports a novel biosensor based on shear horizontal surface acoustic wave(SH-SAW) applied in biological detection. we designed a surface acoustic wave resonator as biosensor and integrated it with a waterproof fixture, in which there is a micro-fluidic channel insuring the smooth of liquid flowing, and guarantee the stability during the biological reaction. In this paper, we have studied the feature of the device in liquid-phase, the experimental result indicates that a larger value of phase shift (3 degree) is realized compared with pioneer works[1].

SAW biosensors, as core part of the bio-detection system are powerful and promising in various fields. Particularly for clinical analysis and biochemical, the SH-SAW biosensors are good candidates benefiting from high sensitivity and good repeatability in liquid phase. In this paper, we present a novel SH-SAW biosensor, the device geometry schematically is shown in Fig.1. A 36° rotated Y-cut X propagation lithium tantalate (LiTaO3) piezoelectric single crystal chip is selected as substrate and Au is selected for IDT fingers, electrode and the area of bio-probe grow respectively. In addition, the microfluidics inlet and outlet channels were fabricated by PDMS micro molding technique to insure the smooth flowing of the liquid flow in the sensitive area. Fig.2 and 4 show the inner structure of the PDMS micro-fluidics channel layer and the assembled fixture respectively. Compared to our group's previous research output[1-2], the SH-SAW biosensor reported in this paper posses several advantages: (1) avoid the volatilization of the solution; (2) ease of device miniaturization; (3) the fixture we have designed offers a confined space, which minimizes the air influence , and hence guarantees more enough times of biological reactions performed at certain volume solution provided each time.

The SH-SAW based bio-chip (Fig.1) consists of two sets of gold input and output IDTs mounted on the surface of the $LiTaO_3$ substrate. The SH-SAW is excited by an input electrical signal applied at the input IDTs, and then propagates on the piezoelectric substrate through the delay line and is converted back to an electrical signal[3], while the wave is potentially sensitive to the mass loading on the surface, therefore, the signal phase will shift when the aptamers are fixed on the surface through Au-S bond. The main displacement component of the SH-SAWs is perpendicular to the direction of the propagation and parallel to the propagation surface, and the longitudinal waves will not be reflected at the solid/liquid interface[4], as the biological reactions occur in liquid-phase, so the waves can propagate with minimal dissipation of energy to a liquid at the surface[5]. The detailed parameter of the device can be found in table I.

The measurement system(Fig.7) consists of an Aglient E5080A network analyzer connected to SMA adapter, the spectrogram of the bio-chip is shown in Fig.5. In the experiments, we fixed the aptamers on the sensitive area by sulfhydryl self-assembled method, the phase shift data was analyzed by Matlab and the picture is shown in Fig.6, the phase shift is about 4.5°, and the stability time is less than 10 minutes, which is better than our previous research.

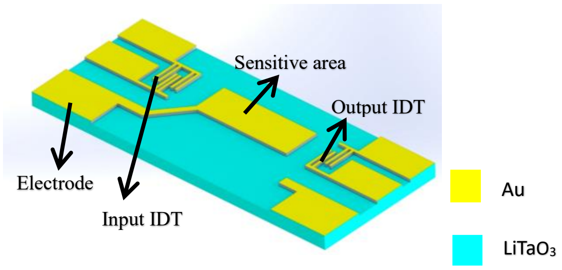

Figure 1 3D graph of the bio-chip

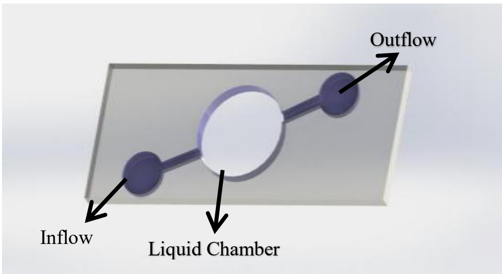

Figure 2 3D graph of PDMS microfluidics chip

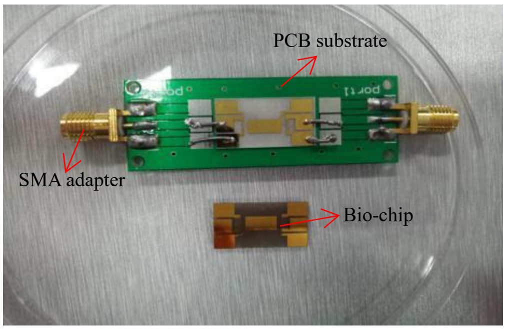

Figure 3 the picture of the bio-chip device and the PCB substrate

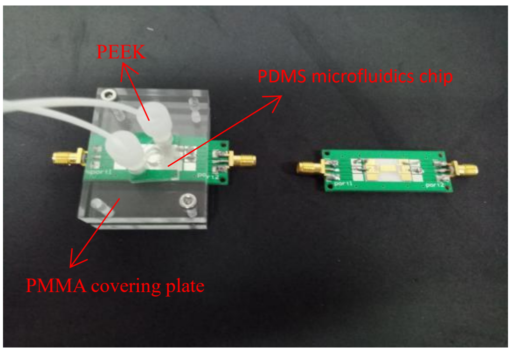

Figure 4 picture of the bio-chip and the testing fixture

Table1 Parameters of the SH-SAW device

Parameters	Value	Unit
SAW velocity	4160	m/s
IDT finger width d=λ/4	5.2	μm
Sensitive area	6×2.5	mm
Thickness of the thin film gold	50	nm
Number of the input and output fingers	18×12	

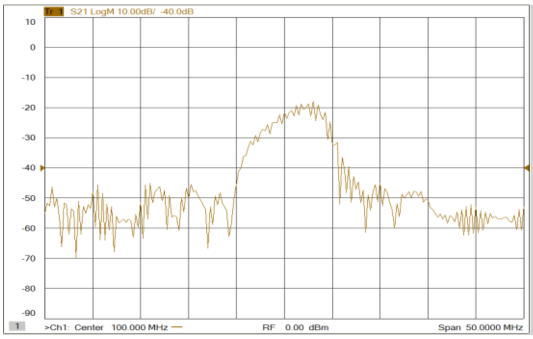

Figure 5: the spectrogram of the bio-chip,the insertion loss S21 is lower than 20dB

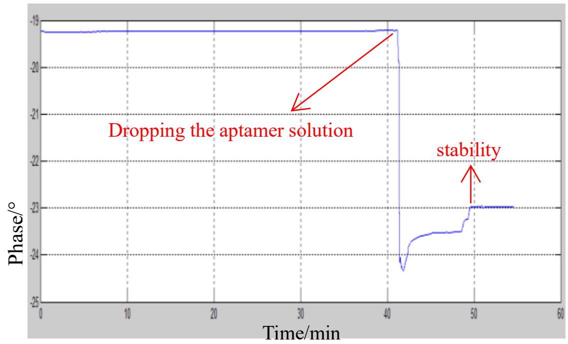

Figure 6：the picture of the phase shift

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