3Pb3-3

Proceedings of Symposium on Ultrasonic Electronics, Vol. 32 (2011) pp. 493-494
8-10 November, 2011

Fundamental Study on Odor generator based on SAW Streaming
弾性表面波ストリーミング現象を用いた匂い供給デバイスの基礎検討

Atsushi Saitoh (Shibaura Inst. of Tech.)
齋藤 敦史 （芝浦工業大学）

1. Introduction

Recently, the research on the olfaction display which can stimulate human sense of smell is increased to achieve a higher dimension virtual reality. Odor generator that effectively stimulates our sense of smell is necessary to achieve the olfaction display[1]. Odor is a mixed gas of volatile organic compounds. Therefore, the odor generator should make organic solvents volatilize.

Liquid streaming phenomena on the surface of Surface acoustic wave (SAW) propagating substrate is called SAW streaming[2,3]. Liquid motions such as vibration, flow, and atomization are generated by the phenomena on the SAW propagation surface.

In this paper, an odor generator based on SAW streaming is discribed. SAW device with a liquid pool made of porydimethylsiloxane was developed as an odor ganelator and the basic characteristics of the genelator were examined. As a result, it was found that our proposed device realized to atomize volatile organic compounds (VOCs) and to control the atomized gas concentration of the VOCs.

2. SAW streaming phenomenon

SAW streaming phenomena is caused by the radiation of the energy of a Rayleigh SAW into a liquid which is loaded on the surface of the SAW propagation substrate. The SAW is radiated into the liquid and is exchanged as a longitudinal wave in the liquid. The radiated wave in the liquid generates liquid dynamics called SAW Streaming dependeing upon inputted SAW energy, such as vibration, flow, atomization, and jet stream of the liquid. The phenomenon is called SAW streaming.

Fig.1 shows the SAW streaming phenomenon. θ_R in Fig.1 expressed the radiation angle of the longitudinal wave into a liquid and is called Rayleigh angle. The angle is expressed by following equation.

$$\theta_R = \sin^{-1}(V_L/V_R) \qquad (1)$$

Here, V_L is the velocity of the radiated longitudinal wave into a liquid. And, V_R is the velocity of the Rayleigh SAW propagating on the surface of a SAW device. When a 128 deg.-rotated Y-cut X propagating $LiNbO_3$ piezoelectric crystal is used as the substrate of the device, and the liquid loaded on the device is ethanol or water. Those angles are calculated as 15.7 degrees and each 22 degrees, respectively. In the case of ethanol (also, VOCs), the angle is smaller than the case of water.

The atomization phenomena by SAW streaming is used for our proposed device.

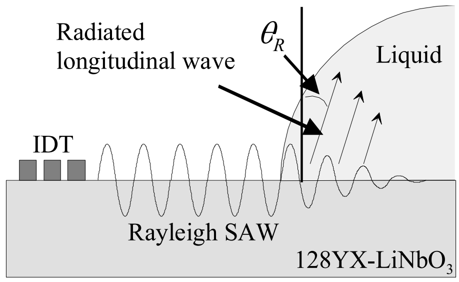


Fig.1. Schematics of SAW streaming phenomenon

3. Odor generator based on SAW streaming

An odor generator based on SAW streaming shown in **Fig.2** was developed. The device was composed by a SAW device with an interdigital transducer and a grating reflector, and a liquid pool. The liquid pool was made of polydimetylsiloxane (PDMS) and was arranged to cover the entire device in order to keep odorous liquid material on the device. And, a paper filter (3mm x 10.5mm x 0.25mm) was enclosed in the pool in order to suppress unnecessary liquid flow.

The SAW device was fabricated on a 128° -rotated Y-cut X propagating $LiNbO_3$ piezoelectric substrate with the center frequency about 96MHz. The IDT with 20 finger pairs, apertures of 1mm and the grating reflector with 60 elements were designed and fabricated on the substrate.

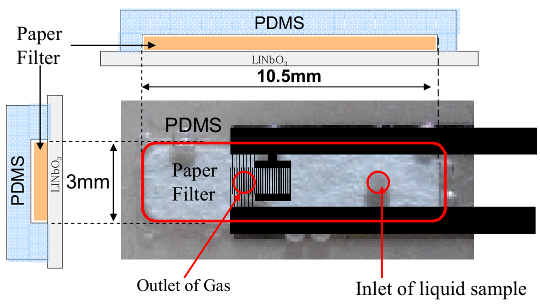
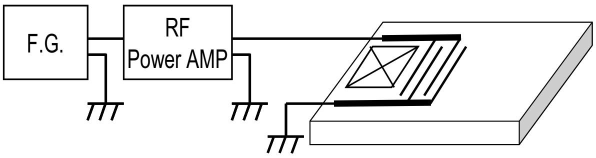


Fig.2. Odor generator using SAW with liquid pool.

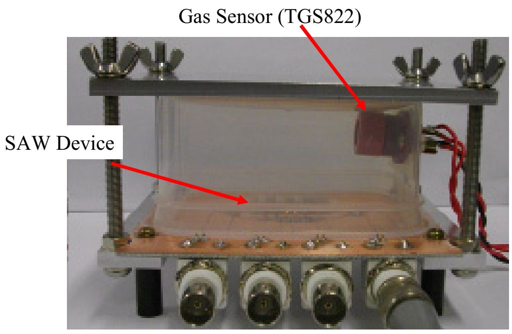
Corresponding author. E-mail address: saitoa@shibaura-it.ac.jp

4. Experimental Results

The experimental setup for the fundamental study on odor generator based on SAW streaming is shown in **Fig.3(a)**, **(b)**. As shown in Fig.3(a), RF burst signal amplified by an RF power amplifire was inputted to the IDT. The generator was set into the measurement chamber equipped with a metal oxide semiconductor gas sensor (TGS822 with sensitivity to ethanol gas purchased from Figaro Engineering Inc.) in order to measure the gas concentration generated by the generator in the chamber.



(a)



(b)

Fig.3. Experimental setup
(a) Electrical setup for driving of SAW device
(b) Gas concentration measurement setup

In this experiment, ethanol diluted to 20 times with triacetin was used as a liquid sample for atomization test of VOCs. And, the amplitude and the duty ratio of burst signal was varied to control the concentoration of atomized gas.

Fig.4 shows the gas sensor response, when the burst signal with the amplitude of 2.08V and the duty ratio of 70% is inputted to the IDT, repeatedly. The area with yellow color in Fig.4 shows the time which SAW is excited (about 5 seconds). From the result, it is found that the ethanol gas is generated synchronizing with excitation of SAW.

Fig.5 shows the relationship between gas sensor response and the amplitude of the burst signal. In this experiment, the duty ratio of the burst signal is 70%. The gas sensor response depends on the amplitude of the inputted signal.

And, The relationship between gas sensor responses and the duty ratio of the burst signal was also examined under the condition that the amplitude of the burst signal was 2.08V. The result is shown in Fig.6. From the figure, the sensor response also depends upon the duty ratio of the input for the excitation of SAW.

Those results show that the controllability of gas concentration is realized by the adjustment of the input signal for the excitation of SAW, easily.

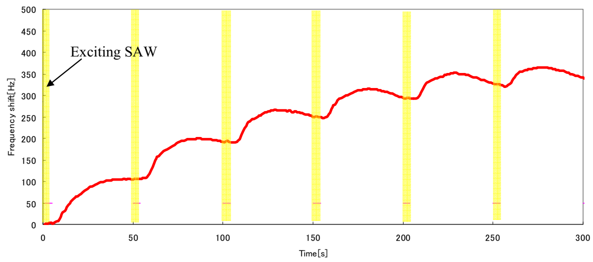


Fig.4. Change in gas sensor response by repeatedly driving of odor generator.

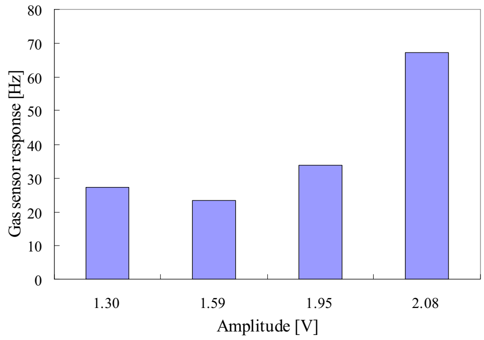


Fig.5. Relationship between amplitude of burst signal and gas sensor response.

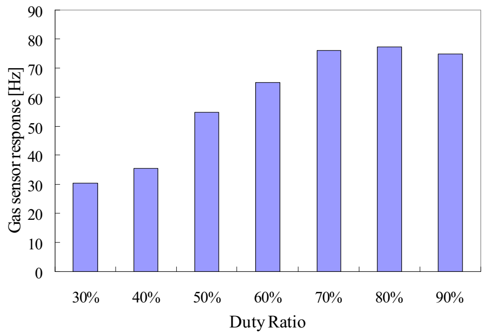


Fig.6. Relationship between duty ratio of Burst signal and gas sensor response.

References

1. T.Nakamoto, K.Yoshikawa: IEICE TRANS. FUNDAMENTALS. Vol.E89-A, NO.11(2006), 3327.
2. S.Shiokawa, Y.Matsui, T.Moriizumi: Jpn. J. Appl. Phys. **28** (1989) 125.
3. K.Chono, N.Shimizu, Y.Matsui, J.Kondo, and S.Shiokawa: Jpn. J. Appl. Phys. **43,** No.5B (2004) 2987.