# 6채널 압전소자를 이용한 냄새인식에 관한 연구

°박 옥순*, 최 용성**, 장 상목*, 권 영수**
* 동아대학교 화학공학과, ** 동아대학교 전기공학과

# A Study on the Analysis of Odorants using Six Channel Piezoelectric Crystals

Ok-Soon Park*, Yong-Sung Choi**, Sang-Mok Chang*, Young-Soo Kwon**
* Dept. of Chemical Engineering, Dong-A University
840 Hadan-dong, Saha-ku, Pusan 604-714 Korea
** Dept. of Electrical Engineering, Dong-A University
840 Hadan-dong, Saha-ku, Pusan 604-714 Korea

## Abstract

At-cut quartz crystal has been applied as chemical vapour sensors. The responses of quartz crystal at 9 MHz coated with various lipids were determined for organic gases which showed different affinities for each lipid. The identification of odorants depending on the species of lipid used for coating is discussed in terms of the normalized resonant frequency shift pattern.

## 1. Introduction

Since Sauerbrey[1)] reported the empirical equation for the relationship between the frequency shift of quartz resonator and the mass of substance deposited on its surface, much attention has been paid to piezoelectric crystal detectors as simple, sensitive and reliable detectors[2~3)].

$$\Delta F = -2.3 \times 10^6 F^2 \Delta m A^{-1} \qquad (1)$$

where $\Delta F$ is the frequency change due to deposited mass( Hz ), F is the original resonant frequency of the piezoelectric crystal( MHz ), m is the mass of the substance deposited on the surface( g ), and A is the area coated( $cm^2$ ).

The olfactory reception of odorants is not very well understood. Nomura et al.[4)] emphasized the importance of lipid in olfactory cells for odorant detection. They hypothesized that lipid layers act in the detection of odorant in olfactory cell even if lipid itself does not have a specificity to odorants.

In this paper, we investigated the responses of six types of lipid-coated quatrz crystal resonators as chemical vapour sensors. The identification of odorants is discussed by comparing the behaviors of their normalized resonance frequency shift patterns, which are dependent on the phospholipid used.

## 2. Experimental Method

(1) Materials

Phosphatidylglycerol( PG ), phosphatidylserine( PS ), posphatidylinositol( PI ), phosphatidylethanolamine( PE ), and lipid A( LA ) were used as sensitive films. The odorants, amyl acetate, acetoin and menthone as well as methanol, ethanol, propanol and butanol were measured. Lipids were obtained from Sigma Chemical Company. Others were obtained from Wako pure chemical industries Ltd.. All chemicals used in this study were of analytical grade.

(2) Apparatus

The schematic diagram of the experimental system is shown in Fig. 1. The lipid-coated AT-cut quartz crystal resonators were placed in a vessel which has two valves for nitrogen gas inlet and outlet. The volume of the vessel is 10 ml. The electrodes were deposited with the thickness of 200 Å of chromium, and 2000 Å of gold in turn by vacuum vapour deposition( ULVAL EBH-6 ) on the both sides of quartz crystal, using self-made mask. The surface area of electrode was 0.5 $cm^2$. The resonant frequency was measured using six channel frequency counter combined line with micro-computer( NEC PC-9800 ). Standard gases of odorants were generated by putting a

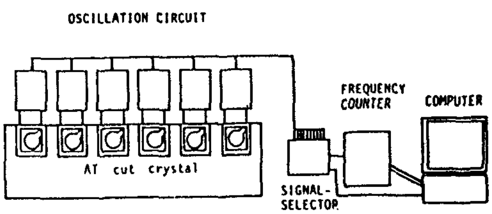


Fig. 1. Schematic diagram of experimental system

sampling tube in the tube holder and flowing nitrogen as a carrier gas. The concentration of a standard gas was controlled by changing the diameter and length of a sampling tube, flow rate of nitrogen, and temperature. The resonant frequency was measured at an interval of about 30 second.

## 3. Results and Discussion

The correlations between resonant frequency shift and concentration of seven odorants for six lipid-coated AT-cut quartz crystal were investigated. The responses were different from each other. Therefore, the frequency shift for each odorant of the different lipids was represented in the pattern. The patterns cannot be compared directly with each other due to the different vapour concentrations. Normalization is necessary for comparison. Therefore, we normalized the response so that the sum of each response is one[5].

$$P(i,j) = \Delta F(i,j) / \sum_{j} \Delta F(i,j) \qquad (2)$$

where P is the pattern factor, i is the kind of odorant, j is the kind of lipid.

The results after normalization procedure were shown in Fig. 2. The pattern itself is specific and represents a pronounced pattern for each odorant. The normalized pattern can be used for the identification of odorants.

From these results, it follows that a multichannel lipid-coated AT-cut quartz crystal can monitor different odorants. Using a number of different lipids for coating of surfaces of quartz crystals, odorants can be identified by a computerized pattern recognition algorithm. This approach can open a wide field for the detection of odorants.

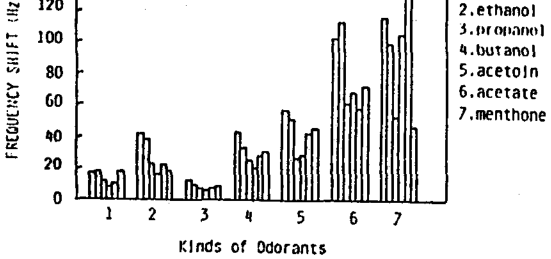


Fig. 2. The normalized patterns of resonant frequency shifts to respective
PG : phosphatidylglycerol
PI : phosphatidylinositol
PE : phosphatidylethanolamine
PS : phosphatidylserine
LA : lipid A

## References


(1) G. Sauerbrey, " Use of a quartz vibrator from weighing thin film on a microbalance ", Z. Phys., 155, pp. 206~210( 1959 ).

(2) W. H. King, " Analytical uses of the piezoelectric crystal ", J. Anal. Chem, 36, pp. 1535~1539( 1964 ).

(3) G. Guilbault, " Piezoelectric crystal detectors in analytical chemistry ", Anal. Proc., 19, pp. 68~79( 1982 ).

(4) T. Nomura and K. Kurihara, " Liposomes as a model for olfactory cells : Changes in membrane potential in response to various odorants ", Biochemistry, 26, pp. 6135~6140( 1987 ).

(5) S. M. Chang, B. Ebert, E. Tamiya and I. Karube, " Detection of chemical vapor using a lipid-coated SAW resonator oscillator ", J. Biotechnology, 16, pp. 211~220( 1990 ).