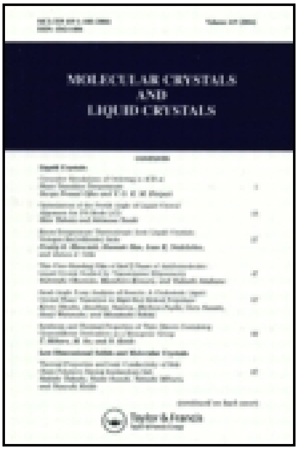

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Preparations of Lipid LB Films and their Applications to Olfactory Sensor

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Preparations of Lipid LB Films and their Applications to Olfactory Sensor

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Nine different kinds of chemical vapors were identified by the response characteristics of quartz crystal microbalance(QCM) coated with lipid Langmuir-Blodgett(LB) films to the chemical vapors as the basic olfactory sensing system.

Keywords : Quartz Crystal Microbalance(QCM); Langmuir-Blodgett(LB) films; Olfactory Sensing System; Neural network

INTRODUCTION

Odorant molecules are mostly lypophilic and therefore have an affinity to lipids. These properties may provide the selective affinities for different odorants, but there is no common explanation for specific reception[1]. Recent studies about olfactory sensor system have been focused on intelligent sensors with good selectivity. Output patterns of many receptors with slightly different characteristics are recognized by an olfactory neural network for odor identification[2]. In this paper, the response characteristics of QCM coated with lipid LB films were investigated with nine kinds of chemical vapors and analyzed using neural network pattern recognition method.

EXPERIMENTAL

The lipids used in this study were dipalmitoylphosphatidic acid (DPPA), dipalmitoylphosphatidylcholine(DPPC), cholesterol, dipalmitoylphosphatidylethanolamin(DPPE), sphingomyelin, and dipalmitoylphosphatidylserine (DPPS). All lipids were purchased from Sigma Co. and used without further purification. After spreading molecules on the water surface, monolayers were compressed with 12 *mm/min* up to 30 *mN/m*, and then deposited onto QCM. The dipping speed was fixed at 5 *mm/min*. The odorant chemicals were methanol, ethanol, propanol, butanol, ethanolamin, ethylenediamin, acetic acid, dimethylether, and triethylamin, and they were in HPLC grade. Standard gases were generated by bubbling the odorant chemicals with pure N_2. We designed a test sensor cell of having two inlet lines to have a good contact with target gases[3].

RESULTS AND DISCUSSION

Deposition of phospholipid films

Fig. 1 shows the surface pressure-surface area isotherms of phospholipids. The monolayers of lipids at 30 *mN/m* were the condensed state, but sphingomyelin was near the expanded.

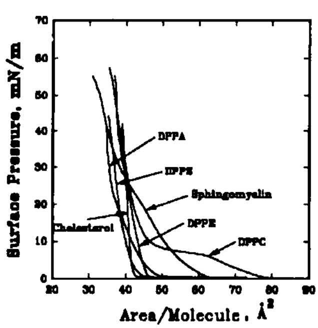

FIGURE 1 The surface pressure-surface area isotherms of materials used in this study.

In the case of film deposition, we transferred the mixed monolayers of phospholipids with octadecylamin(ODA) or DPPA at high subphase pH(nearby 9.0) with divalent metal salt(such as $BaCl_2$, $CaCl_2$). The minimum molar portion of ODA or DPPA to form a stable multilayer was about 70 %.

Characteristic points

We defined three parameters $\Delta f(t_s)$, A_1, and A_2 to characterize the adsorption-desorption response of odorants on the sensor. $\Delta f(t_s)$ is a frequency change at t_s after the onset of response, A_1 is the fraction of adsorbed sites after t_s, and A_2 is the fraction of vacant sites t_b after the onset of desorption. The detailed explanation of these parameters has been reported in elsewhere[3].

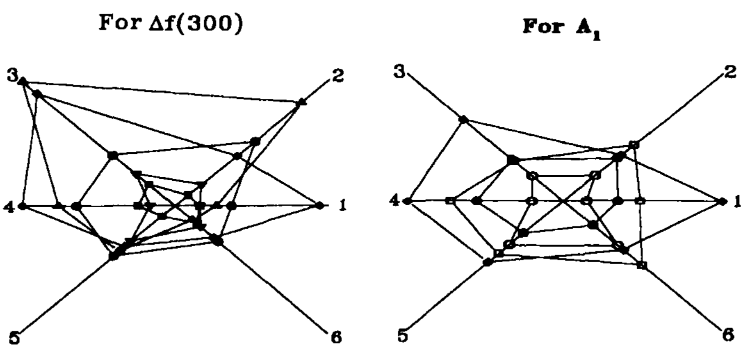

FIGURE 2 Circular profile patterns for each odorant by $\Delta f(300)$ and A_1 from six channels. ● ; methanol, ■ ; triethylamin, ◆ ; acetic acid, ○ ; dimethylether, □ ; propanol, Δ ; ethylendiamin, ∇ ; ethanolamin, 1 ; ODA, 2 ; DPPS/ODA, 3 ; DPPA/DPPS/ODA, 4 ; DPPE/ODA, 5 ; DPPA/ODA, 6 ; Sphingomyelin/ODA

Circular profile pattern and material identification

A six-channel sensor cell which contains six different lipid film coated QCM was constructed. Fig. 2 shows the circular profiles of $\Delta f(300)$ and A_1 for the six channel system. Those circular profiles gave the possibility to construct an olfactory sensing system using the pattern recognition method.

Fig. 3 shows the identification result of nine different chemical vapors from a self organizing feature maps(SOFM) neural network[4]. The frequency shift Δf(300) provided correct identification with a 100 % confidence for 5 compounds, and 70-90 % for the other compounds, while the average moment A_1 identified three compounds with a 100 % confidence and 80-90 % for the others.

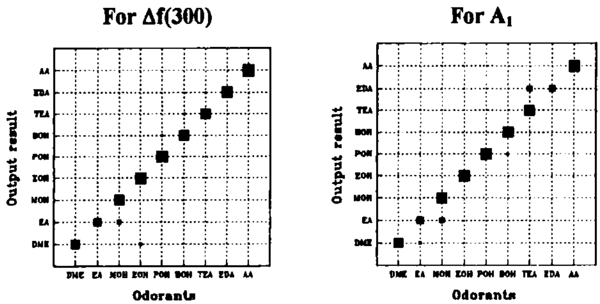

FIGURE 3 The identification result of 9 kinds of chemical vapors
AA ; acetic acid, EDA ; ethylenediamin, TEA ; triethylamin, BOH ; butanol, POH ; propanol, EOH ; ethanolamin, MOH ; methanol, EA ; ethanolamin, DME ; dimethylether

CONCLUSION

Multilayers of lipids with film deposition promoters(ODA or DPPA) were deposited(using a $BaCl_2$ salt at high pH) onto QCM as a sensing membrane. Using the SOFM neural network system, nine kinds of different chemical vapors were identified with a probability of 80-95 %.

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