

半導体原理に基づくアレルギー診断デバイスの創製

Development of a novel device for allergy test based on semiconductor principle

東京大学大学院工学系研究科¹、広島大学大学院医歯薬保健学研究院²

杨皓月¹、齋藤暁子¹、加治佐平¹、柳瀬雄輝²、坂田利弥¹

¹School of Engineering, Univ. of Tokyo

²Graduate School of Biomedical and Health Sciences, Hiroshima Univ.

Haoyue Yang¹, Akiko Saito¹, Taira Kajisa¹, Yuki Yanase², Toshiya Sakata¹

sakata@biofet.t.u-tokyo.ac.jp

Introduction

Allergy is one of the closest diseases at the present day. Almost half of the population are affected with some types of allergy in Japan, and the number of patients are increasing throughout the world. There are still a lot of questions on its mechanism that remain unexplained and strong demands for approach to treatment. However, its precise diagnosis requires not only a lot of time but also collection of large amounts of blood from patients. Therefore, easy-to-use evaluation approaches are expected in clinical test and drug discovery. Diagnostic test kit lacks precision because it assesses only the presence of antibody using enzyme. In this study, we focused on type I reaction, the immediate allergic reaction such as food allergy and pollen allergy. We investigated the cellular activities based on antigen-antibody reaction at mast cells in an easy, quantitative, and label-free way by use of semiconductor-based biosensor.

Experiment methods and Results

In the electrical measurement, we used N channel depression field effect transistor (FET) with Ta₂O₅/Si₃N₄/SiO₂ as the insulation membrane. Mast cell that we used in this study was Rat basophilic leukemia (RBL), which has been commonly used in allergy studies. Firstly, RBL cells of 1*10⁵/mL were incubated on the gate insulator of FET in the culture medium overnight, where anti-DNP IgE antibody (RPMI+10%FBS+1%PS/SM+IgE0.5μL) was included. Then, IgE is adhered at RBL cell membrane. On the next day, the cell culture medium was exchanged before measurement. After keeping the device in the CO₂ incubator for the electrical stability, we added antigen, Ag(DNP-HAS) solution(RPMI+10%FBS+1%PS/SM+Ag5μL) of 10μL on the IgE-RBL-based FET. Moreover, β-hexosaminidase, which is widely used for evaluating histamine, was fluorescently labeled in the medium to investigate quantitatively histamine secretion from RBL following the antigen-antibody reaction at the cell membrane.

As a result of that, the gate surface potential of IgE-RBL-based FET decreased continuously and specifically after introduction of antigen. This result indicates that the electrical activity of RBL was monitored on the basis of pH changes at the cell/gate interface using the IgE-RBL-based FET, because histamine is basic compound. From this research, it became clear that the allergy reaction could be evaluated by principle of semiconductor.