【Grant-in-Aid for Scientific Research (S)】

Broad Section C

Title of Project：Ultra High Sensitive Electric Nose for Medical Engineering Applications

TABATA Hitoshi
(The University of Tokyo, Graduate School of Engineering, Professor)

Research Project Number: 20H05651 Researcher Number：00263319
Keyword：Electric nose, Body gas, Tandem type gas sensor, Olfactory diagnosis, Stochastic resonance

【Purpose and Background of the Research】

In the olden days, the relationship between body gas and health condition was called olfactory diagnosis, which depended on the senses and experience of medical doctors, and it was difficult to quantify and objectively evaluate.

Currently, medical institutions and the like collect biological samples such as blood, lymph, and cerebrospinal fluid to confirm their health condition and diagnose their illness. However, since the collection of these biological samples involves the risk of invasion to the human body, the risk of infection, and the mental burden, the realization of simple and easy non-invasive measurement is an urgent issue. On the other hand, body gas (breathing, skin gas) is easy to collect, non-invasive, and can be measured sequentially, and contains real-time health condition, biochemistry, and pathological condition information of the individual. In particular, skin gas (including information derived from blood) is unconsciously constantly released from the skin surface, so there is no need to spray it like exhaled breath. However, the device does not exist which has an ultra-sensitive measurement mechanism on the order of ppb (pert per billion) and ppt (pert per trillion) required for skin gas measurement, and is wearable and can measure skin gas repeatedly.

In this research, we aim to "establish an academic concept for health status / pathology and body gas correlation". As a key technology for that, we will establish the basic technology of ultra-high sensitive electronic nose as a skin gas sensor which is a compact and wearable for realizing continuous monitoring the skin gas of our physical condition.

【Research Methods】

In this study, (1) skin gas is selectively concentrated using a functional porous material (zeolite). (2) measure the concentrated skin gas with an oxide semiconductor gas sensor with nanostructural control. By using a multi-functional (tandem type) gas sensor, we try to achieve ultra-high sensitivity at the level of ppb (pert per billion). In addition, for further performance improvement (ppt: pert per trillion), oxide semiconductor core / shell type nanorods having a two-layered structure (adsorption layer / detection layer) will be used. And moreover, genetically reorganized mosaic virus will be used for utilizing a scaffold for self-assembled nanowires as a template of bio mineralization.

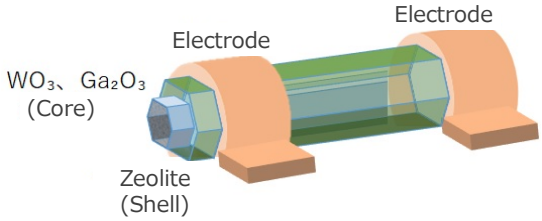

Figure 1 Core-Shell structured gas sensor

【Expected Research Achievements and Scientific Significance】

From early detection to non-illness, it is the key to extending healthy life expectancy in an aging society.

(1) Support for watching over the elderly, support for diabetics and preliminary patients

More appropriate care can be achieved by sharing the dietary intake status of dementia patients with their families & caregivers. It is also effective in diagnosing diabetes, following up, and preventing ketoacidosis.

(2) Prevention of various diseases and pathological management

Nonanal (lung cancer), methyl mercaptan (colon cancer), acetaldehyde (esophageal cancer), nitrogen monoxide (asthma, respiratory tract infection), ammonia (hepatitis), hydrogen (intestinal flora) as skin gases closely related to the disease Etc. are known. The ultra-sensitive skin gas sensor technology developed by this application research is considered to be extremely effective for measuring these pathological conditions.

【Publications Relevant to the Project】

・ Y. Yamada, S. Hiyama, T. Toyooka, S. Takeuchi, K. Itabashi, T. Okubo and H. Tabata, Ultratrace Measurement of Acetone from Skin Using Zeolite: Toward Development of a Wearable Monitor of Fat Metabolism, Anal. Chem., 87(15), 7588-7594 (2015)
・ H. Tabata、Fusion of bio inspired Yuragi and electronics,
・ Oyobutsuri, 86(1), 12-24 (2017)

【Term of Project】 FY2020-2024

【Budget Allocation】 151,200 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.bioxide.t.u-tokyo.ac.jp/
tabata@bioeng.t.u-tokyo.ac.jp