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研究成果報告書

研究課題名

分子を認識する二次元プラズモニックガスセンサアレイによる匂いの痕跡識別システム

Odor trace discrimination system using two dimensional plasmonic sensor array with molecular recognizing ability

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研究代表者

九州大学　大学院システム情報科学研究院 情報エレクトロニクス部門　教授

林　健司

Graduate school of information science and electrical engineering, Kyushu University

Professor

Kenshi Hayashi

Abstract

Odor, the composition information of many volatile chemical substances, has extremely rich information. If the traces of invisible odors can be visualized, it will be possible to identify human, objects, and situations and track movement routes. The visualized odor information can be completely new information; where it is difficult to erase or disguise traces of odor information due to adhesion, enormous number of target chemicals, and invisibility. In addition, it is possible to acquire hidden information that cannot be detected by the camera, and it gives abundant multidimensional information that is completely different from visual information. The basic technology developed by the group to realize such new odor visualization information sensing, (1) high-speed two-dimensional plasmonic gas sensor, (2) surface modification technology and molecularly imprint technology for gas selectivity, (3) chemical information identification technology like olfactory information processing. The aim of this research is constructing odor trace identification system using a two-dimensional odor image sensor which provides a new and huge information.

Based on the above research background and purpose, we conducted research and development and obtained the following results. First, we developed a device that can visualize odor traces and flows by making a plasmonic gas sensor that detects volatile chemical substances at high speed and two-dimensional. A plasmonic gas sensor based on LSPR (localized plasmon resonance) is a deposit of metal nanoparticles whose optical characteristics change depending on the atmosphere on a glass substrate. In this study, gold nanoparticles (AuNPs) on the order of 10 nm were densely spread by sputtering. This plasmonic gas sensor can control the gas responsiveness by the composition of the Au/Ag metal material, where gas discrimination ability was obtained by changing the Au/Ag composition of core-shell nanoparticles.

Next, to visualize the flow and traces of multiple gases, it is necessary to create a sensor device in which Au/Ag core-shell nanoparticles with different response characteristics. Thus, we have controlled the Ag growth rate for each position of the sensor device by pixel-patterned light irradiation, and created a two-dimensional odor image sensor for four types of Au/Ag core shells. As a result, we succeeded in visualizing the flow of odors, and analyzed the difference in the response pattern of the sub-pixels by the non-negative matrix decomposition technique, and identified the type of odor as each element gas.

Regarding the identification of odor molecules, information was also acquired by dye modification of the surface of metal nanoparticles by using the hyper-spectrum information. It analyzes and detects huge amounts of information obtained from two-dimensional gas sensor devices by machine learning. The target odorant could be identified with high accuracy.

We have developed a system that can identify traces of odors in real time by mounting the last developed sensor on the robot. This robot system is equipped with an 18-channel plasmonic gas sensor configured by dye modification, and can detect multiple odors remaining on the floor while traveling, and can identify odors by machine learning.