

原著論文

臭いセンサーを活用した室内空気質 (Indoor Air Quality; IAQ) の簡易計測法

山口 一¹, 岡田 博¹, 布施幸則¹, 富岡一之¹, 鈴木道哉¹

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The Application of Semiconductor-based Odor Sensors Capable of Measuring and Evaluating Indoor Air Quality

Makoto YAMAGUCHI¹, Hiroshi OKADA¹, Yukinori HUSE¹, Kazunori TOMIOKA¹ and Michiya SUZUKI¹

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Abstract

In general, the Japanese spend some eighty percent of their day working in thermally-insulated, air-tight residential or office buildings. Lack of proper ventilation in these buildings give rise to a number of problems including concentration of hazardous chemical substances emitted from building materials and open type heaters, and a rise in room humidity and condensation. Furthermore, lack of proper ventilation promotes increased growth of room bio-pollutants (allergens), such as mites, mold and house dust, and studies of allergic diseases traceable to these substances have shown a marked tendency to increase over the years. Currently, one-third of all Japanese suffer from some form of allergic diseases, while about one-tenth are hypersensitive to chemical substances.

Now believed to be responsible for anaphylaxis to chemical substances, concentrations of formaldehyde (HCHO) and volatile organic compounds (VOCs) given off by interior finishing materials and furniture is very low in residential spaces. To accurately measure these concentrations, it is necessary to concentrate the air sample during sampling and to employ high-precision analyzers such as a gas chromatographic (GC) analyzer to obtain the results. Since these complicated sampling and analytical operations require a high-level of expertise, the development of an on-the-spot precise measuring instrument has long been awaited. This study examines the application of three semiconductor-based odor sensors each capable of measuring and evaluating HCHO and VOCs levels in low concentrations quickly and in a timed sequence. HCHO and VOCs in a variety of concentrations were measured both in the field and in a special laboratory chamber. To evaluate the characteristics of each sensors, the results of the measurements were compared with results obtained from high-precision analyzers, such as a GC Analyzer, a Gas Chromatography Mass Spectrometer and a Liquid Chromatographic Analyzer. A relatively good correlation was obtained between the results, indicating the sensors can be used to develop an effective complementary system to enhance the analyzers. Furthermore, the effects of moisture and chemicals which could interfere with the proper operation of the sensors were studied under various conditions to clarify the characteristics of the interference.

In conclusion, this study proposes some the essential technology required to accurately and quickly measure HCHO and VOCs levels in low concentrations in residential spaces.

Key word: IAQ, formaldehyde, VOC, odor sensor, semiconductor sensor

要 旨

日本人は、1日の約80%を住宅やオフィスビル等で過ごしており、現在のような断熱・気密化された住宅で、適切な換気がされない場合、建材・開放型の暖房機器等から発生する有害化学物質の濃縮、また室内湿度の上昇、結露等の問題が生じ、ダニ・カビ・ハウスダスト等の、室内生物汚染粒子(アレルゲン)の増加が顕著となる。これら由来のアレルギー疾患や有害化学物質による化学物質過敏症も年々増加する傾向にあるという。

化学物質過敏症の原因と考えられる、住宅の内装材・家具等から発生するホルムアルデヒド(HCHO)や揮発性有機化合物(VOC)等の有害化学物質の居住空間での存在濃度は低い。そのため、濃度測定のためには、対象空気のサンプリング時に濃縮したり、ガスクロマトグラフ(GC)等の精密分析機器による測定が必要になってくる。しかし、これらの操作は非常に煩雑且つ専門的であるため、現場サイドの簡易な測定法の開発が望まれている。そこで本研究では、半導体センサーを利用した「臭いセンサー」の適用を検討し、室内の低濃度のHCHO、VOCを迅速かつ時系列に測定・評価できる3種の臭いセンサーを選出した。これら3種の臭いセンサーを使用し、現場計測、ラボにおけるチェンバー試験にて、種々のHCHO・VOC濃度で測定し、GC、ガスクロマトグラフ・マススペクトロメトリー、液体クロマトグラフ等の機器分析と比較し、その特性を評価した。概して、両者の相関の結果は善く、機器分析の補完システムとして有用であることが示された。

また、臭いセンサーの干渉物質として考えられる湿気や化学物質等の影響を、種々の条件で調査し、その特性を把握した。本研究の成果は、居住空間におけるHCHO・VOC対策の必須技術であると考えられる。

1 清水建設株式会社 技術研究所, 東京都江東区越中島3丁目4-17

Institute of Technology, Shimizu Corporation, 4-17, Etchujima 3-Chome, Koto-ku, Tokyo, Japan