Synopsis of Original Research Paper

Development of sensor system for odor sensation measurements

Kiyoshi Toko

Graduate School of Information Science and Electrical Engineering, Kyushu University

An odor sensor was developed using a surface polarity controlling method. In this method, changes of electric potentials of the electrode show the different surface electrical polarity, and hence the interaction between odor substances and the electrode surface is different in each electric potential. Thus the response ability and information about chemicals can be obtained through controlling surface polarity. Pt electrode was adopted and the surface polarization of the Pt electrode was controlled by sweeping electrode potential from negative to positive values (e.g. -0.7V to 0.3V) through a potentiostat. Chemicals with electrical charge and high polarity interact with polarized surface, and nonpolarized and hydrophobic substances interact with nonpolarized surface. Thus various chemicals can be detected with one electrode. Electrochemical impedance was measured at each electrode surface potential to detect the interactions between the electrode surface and chemical substances. Frequency dependencies of the surface impedance of the electrode were measured by superimposing small amplitude sinusoidal signal. Equivalent circuit of the electrode impedance was based on a surface roughness model. The equivalent circuit was determined by curve fitting procedures.

The sensor can detect various chemical substances; both electrolytes and nonelectrolytes (hydrophobic and hydrophilic substances) with high sensitivity. As a result, various odor substances can be detected using this sensor, and much information can be obtained through surface polarity control. Electrode potential profiles of the surface impedance had various patterns according to the characters of chemicals. Adsorption of chemicals to the surface altered the surface resistance and capacitance. Hydrophobic substances affected the surface resistance in the negative region and the surface capacitance in the potential area where the neutral surface was attained. Furthermore, response patterns to odor substances, especially hydrophobic odorants, could be modified by replacing base solutions in which the electrode was immersed; used base solutions were KCl solution with additive of acetone and triton X-100. Principal component analysis was carried out to response patterns, and the principal component map was able to be categorized into some groups by the quality of used odorants. Thus the information from the electrode can be utilized to distinguish the odor quality. The present method was simple and bio or organic materials were not used. So the results denote that odor sensations are dominated by physicochemical characteristics of chemicals interacting with the electrochemical surface. These results suggest that the surface polarity controlling method can be utilized for the mechanism of sensor transducers for odor sensor.