Advances in dairy Research

Extended Abstract

Dairy Industry: Innovative sensor system and evaluation procedure for monitoring of food processing

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Abstract

There is a broad field of economic online and in-situ field analysis applications like the online monitoring of volatile components for quality monitoring in food processing. Looking to beer production, for example, the quality of the raw materials like grain, hops and yeast have to be investigated because these items could be the source of a contamination with 2,4,6-Trichloranisol (TCA). TCA is a chloric aromatic hydrocarbon with intensive mildewed and moldy smell and, therefore, leads to immense damage of the product not only limited to beer production. Another field of application is the monitoring of food transport and store chains to guarantee the quality of food and to avoid harm for the consumers. Typically, Volatile Organic Compounds (VOCs) are often evaporated, which can be measured by sophisticated gas sensor systems and therefore used for investigations of the mentioned problems. The purpose of this paper is to introduce a sophisticated sensor system which was developed to measure VOCs. The principal sensing element is a four-fold sensor array on a 4x4 mm2 alumina chip (Figure 1), which comprises four micro-dispensed thickfilm sensing layers of different SnO2/additive-composites. Operating MOG sensors thermo-cyclically and simultaneous sampling of the conductance yields gas specific Conductance-over-Time-Profile (CTP) features. Further-more, an innovative calibration and evaluation procedure ProSens will be introduced, which enables substance identification and concentration determination even in the case of varying environmental conditions from the characteristic CTP shapes. Many field analysis problems like those mentioned above are looking for innovative solutions. The above described sensor chip in combination with the numerical procedure ProSens is a powerful tool to solve existing problems in the area of food monitoring and food processing.

Aroma substances are volatile compounds, which are perceived by the odor receptor sites of the sensory organ—the olfactory tissue of the nasal cavity. More than 10,000 compounds are believed to be detectable in foods, of which no more than 230 play a role in the perceivable aroma of a given food. These odorants are referred to as key food odorants. However, many more may play a role as useful indicators in food processes or for the presence of malodors as a result of suboptimal processing parameters.

Due to the complexity of the task, such electronic nose applications can be used only for very specific applications with clearly defined target profiles, such as the detection of a malodor in the monitoring of continuous production lines. Moreover, and in contrast to the analytical approach of a gas chromatographic system, a sensor system is confronted with all volatiles of a sample at a single moment. So either the sensor system must have a high specificity or only a few volatiles at the same time can be introduced to the system. Implementation of the sensor system requires special efforts in the qualification of the applied sensing elements and their calibration.

The major advantage of bioelectronic noses is their high specificity, as physiological, environmental odorant-binding molecules (e.g., mammalian or insect odorant receptors) are activated only by highly specific interactions with their cognate volatile ligands. The challenges for bioelectronic noses are to maintain specificity when employed in nonphysiological environments and to retain durability of the biotech fusion elements and the reversibility of the detection event for repeated usage. For example, the complex biochemical detection system in insect antennae can be used as a selective detection system for volatile compounds in the parts per billion range. Many prototypes have already been designed that work sufficiently in the lab. As mentioned above, the main challenges will be the robustness and stability of such devices as a control system in a food processing environment.

Another current trend is the usage of conductive nanomaterials as field-effect transistors using single-walled carbon nanotubes and carboxylated polypyrrole nanotubes as carriers for odorant-binding molecules. In this fusion technology of semiconductor and biomolecular sciences, the receptors are expressed in large amounts in a biotechnological system, such as Escherichia coli strains purified and assembled on these sensing transistors. Cases have been shown in which these sensors responded to odorants in a concentration-dependent manner and with good sensitivity. However, no industry-relevant applications have yet been reported

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