Journal of The Gujarat Research Society
ISSN: 0374-8588
Volume 21 Issue 10, October 2019

A REVIEW ON APPLICATION AND SENSORS OF ARTIFICIAL OLFACTION

Basavaraj H
Faculty of Engineering and Technology
Jain (Deemed-to-be University), Ramnagar District, Karnataka – 562112
Email Id- h.basavaraj@jainuniversity.ac.in

Abstract

Artificial scent, based on automated systems (electronic noses), involves three simple odorant-based functions: a sample handler, an array of gas sensors and a form of signal processing. The artificial nose is a bio-inspired mechanism that imitates the sense of smell. With traditional analytical methods, like gas chromatography, the complexity of most odorants makes characterisation impossible. The electronic noses are simple to create, provides fast examination periods, both online and in real time, and demonstrate high specificity and sensitivity to the odorants being evaluated. These methods are non-destructive tools used to characterise odorants in a range of quality-of-life applications, like nutritional control, environmental quality, public safety or clinical diagnostics. Much science, however, remains to be done, especially with regard to new technologies for materials and sensors, data analysis, understanding and confirmation of findings. This thesis explores the key characteristics of new electronic noses and their most relevant environmental and safety implementations. The major elements of an electronic nose listed above are defined. Finally, some interesting remarks are also listed in the numerous applications about the strengths and disadvantages of electronic noses.

Keywords: *Artificial Olfaction, Electronic Nose, Environment, Security, Sensors.*

I. INTRODUCTION

The human nose, at least with respect to the processes responsible for the primary response to an external stimuli, is much more complex than other human senses, such as the ear and the ears. Therefore, mimicking the hearing and visual senses was much better. Hundreds of distinct types of biochemical receptors are implicated in olfaction. While there have been some fascinating advances about so-called artificial noses, their efficiency is far from that of our sense of smell. They are not as susceptible to certain odorous compounds as our nose is. In the olfactory epithelium, the human nose comprises nearly 50 million cells that function as primary receptors for smelly substances. These primary receptors are correlated with around 10,000 primary neurons that bind to a single secondary neuron that feeds the brain's olfactory cortex in turn. This concurrent structure indicates an arrangement designed to mimic the biological mechanism that might contribute to an equivalent instrument. Given this discrepancy, chemical sensor arrays are quite helpful in many real world applications, like monotonous environmental activities and food quality control and protection, together with pattern recognition techniques. Thus, electronic noses are evolving as a new form of instrumentation that can be used to assess the consistency of a compound or to detect a scent. They function in a collaborative manner and have a great resemblance to the human nose in that regard[1][2].

The electronic nose is an electrical component that aims to mimic the configuration of the human nose, so the first step is to communicate with the necessary receptors between the volatile compounds (usually a complex mixture): the olfactory receptors in the biological nose, and the sensor array in the case of the electronic nose that complies with the law. "One odorant receptor is susceptible to multiple smells and multiple odorant receptors detect one smell." The next stage is the storing in the brains or in a pattern recognition repository (learning stage) of the signal produced by the receptor and later the identification of one stored odour (classification stage).

With high precision, vertebrate olfactory systems can recognise and differentiate vola- tile compounds (odorants) from different molecular structures. At amounts as low from a few parts per trillion, the mammalian nose can identify such substances. These findings are due to various olfactory receptors (ORs) and their corresponding neural processing expressed by olfactory sensory neurons.

While certain receptors are comparatively restricted to a collection of several chemically associated compounds in the mechanism of scent sensing, the attachment of particular odorants to the OR proteins is the initiation stage in the detection of odour and the initiating of signaling pathways in a cell. Each of the ORs may attach to various odorants with specific affinities. It says that' It is intriguing to tether them to certain generic electronic instruments that could be endowed with some of the most popular properties of animal smell: discrimination, precision and adaptation, considering the fantastic odour space sensed by the olfactory receptors.' Latest experiments have led to a more refined understanding of olfactory nerves and of odorant recognition pathways[3].

The combined efforts of biologists and biochemists have shown that, by using molecular components, olfactory receptors accomplish odorant recognition and signal transduction. In detecting food and understanding environmental factors, the olfactory system plays a very important function. For the identification of human pathogens, food poisoning or toxic agents, olfactory sensing can be used. Olfactory study is primarily concentrated on the improvement of possible commercial applications.

In order to improve selectivity and sensitivity for different trace level odorant detection systems, the biomimetic architecture of an artificial nose on the principle of the mammalian olfactory system can benefit. For the development of sensors, various parts of the biological olfactory system are used. This paper discusses the state of art in the use of electronic noses in: control of environmental conditions, and protection and security for people[4].

II. DISCUSSION

A. **Detection system: sensors: -**
Several types of gas sensors have been developed over the past decades, based on various sensing materials and different transduction platforms that form integrated multisensors (electronic noses), making them the most sophisticated tools for global tracking.
Metal-oxide semiconductors, conducting and plastic polymers, and other novel materials can be considered as gas-sensing materials.

These instruments can be used on various transduction units, including chemo-resistive, acoustic surface wave (SAW), quartz crystal microbalance (QCM), optical transducers and MOSFET (metal-oxide-semiconductor field-effect transistor) transducers[5].

B. **Metal-oxide sensors: -**
Semiconductor metal-oxide based gas sensors have been stu-died for several years, primarily to boost their sensitivity, selectivity and stability, despite further studies. PEN-3 for Airsense Analytics and Fox 4000 from Alpha Mos are also available as many commercially available e-noses based on this technology.

The most commonly used deposition methods for the growth of delicate layers are sputtering, thermal vacuum deposition, chemical vapour deposition (CVD) and the sol-gel method. They are distributed either as a thin or thick film, primarily ceramic or silicon, on various types of substrates.

C. **Conducting polymer sensors: -**
There are fascinating characteristics of gas sensors based on conducting polymers that make them suitable for gas sensors: room temperature operation, simple to prepare and fast reaction times, among others. When exposed to various volatile species, different conducting polymers such as metalloporphyrins, poly-pyrrole, poly-N-methylpyrrole, polyaniline exhibit major sensitivities such as: metha-nol, ethanol, acetone, toluene, ether and aldehydes that alter their electrical resistance . Utilizing multi-walled carbon nanotubes (MWCNTs) reinforced electrically by conducting polymer composites adopting the solvent casting process, gas sensors have currently been produced. Sensors lack accuracy, exhibit minimal reproducibility

and display a pronounced cross-sensitivity to water vapour, despite some positive perspectives[6].

D. **Optical sensors: -**
In many applications, they have been commonly used as chemical sensors because their reaction can be well described and accurately measured. Although optical sensors are more complex than other sensors, they have alternate possibilities for measurement. If the sensor light source excites volatile molecules, the absorbance, reflectance, fluorescence, refractive index, colorimetric and chemoluminescence can be measured as a signal. Photo diodes, CCD and CMOS cameras were able to track the output signals from these sensors. The most conventional technique is the calculation of the analyte's absorbance in a given frequency band. The colour adjustment using metalloporphyrine markers in an LED and photodetector device is another choice as the easiest calculation. Most optical sensors typically use optical fibres coated with particular dyes that, when exposed to different gases, produce different properties (VOCs, H2, CH4)[7].

E. **Gravimetric/acoustic sensors: -**
In sensing applications, as in environmental fields and protection, arrays of acoustic wave (AW) instruments are commonly utilized. Some types of acoustic wave sensors are: microbalances of quartz crystals, acoustic plated modes of systems based on Rayleigh waves, transverse surface waves and Love waves. Due to increased sensitivity, rapid response, real time detection, reliability and low cost, Love wave sensors are ideal for detecting CWAs.

F. **Applications of Artificial Olfaction: -**

1. Environment: For most chemical pollutants, traditional screening technologies are costly, time-intensive, and require small sampling and sophisticated analytical techniques. There is a growing need today for inexpensive, better and efficient methods for the quick, precise identification and quantification of chemical contaminants in the atmosphere[1][8].
2. Security: Early detection and identification of explosive and chemical warfare agents (CWAs) is becoming a social concern attributable to growing need for homeland security in the face of the avoidance of terrorism attacks, and also the remediation of high-risk areas like: removing minefields or avoiding toxic gases like: Sarin (GB), Soman (GD) or Purified Mustar. Awareness of processes influencing the nature and transportation of CWAs in the atmosphere will lead to forecasts of environmental persistence, hazard projections, and the creation of techniques for disinfection and dispose[9][10].

III. CONCLUSION

The present review aims to include details on recent developments in electronic smell, analysing the latest innovations experimented on the three fundamental structural steps: techniques of sensing, sample processing and pattern detection that customise the e-Noses and also their most relevant environmental and citizen protection applications. The results and prospects are seen individually, taking into consideration the two major problems regarded: latest devices and specialised applications.

In the context of MOS sensors, sensing devices with increased sensitivity, selectivity and stability added to various transduction units have been used in chemo-resistive detectors by choosing characteristics like surface area, donor density, agglomeration, porosity, and acid-base properties of the sensing material. For sensing applications, nano-structured materials, carbon nanotubes, nanoparticles and nanoporous structures have also been developed. Any of these materials have well-defined chemical composition mono crystalline structures, surface terminations, safe from displacement and other prolonged defect. Surface effects are widespread because of the increase in their particular surface area, contributing to the improvement of surface-related characteristics, like catalytic activity or surface adsorption, which are essential properties for the development of superior chemical sensors.

As far as environmental emissions control is concerned, this is a modern area for the production of electronic nose (E-nose) applications which offers many new monitoring technologies required to overcome the shortcomings of traditional spectrometers. Using these comparatively inexpensive instruments, a huge variety of control activities may also be carried out, raising the number of sensors that create large and cheaper networks. In such a manner, relatively reliable information processing for certain complex urban emissions issues could be done in real-time and would help to mitigate pollution harm by decision-making.

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