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Portable e-nose to classify different kinds of wine

M. Aleixandre*, J. Lozano, J. Gutiérrez, I. Sayago, M.J. Fernández, M.C. Horrillo

Laboratorio de Sensores, Instituto de Física Aplicada, IFA-CSIC, Serrano 144, 28006 Madrid, Spain

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Abstract

To address the problem of the wine quality measurement a portable electronic nose (e-nose) has been developed. Two different micromachined resistive sensor arrays are developed for this portable e-nose, one with a polysilicon integrated heater and the other with a platinum one. The nose is tested with four different wines coming of Madrid region (Malvar, Airén, Garnacha, and Tempranillo). The principal component analysis (PCA) plots show a slight overlapping of the responses for the sensor array with Platinum heater and an 88% of classification result is obtained with a probabilistic neural network (PNN). With the sensor array with polysilicon heater a good separation is achieved by the PCA and the PNN classification success is 100%.

Keywords: Electronic nose; Microsensors; Wine discrimination; Multivariate analysis

1. Introduction

In the last years the wine industry has improved the quality of wines produced and the customers are also raising their demand on that quality. Tools to handle and address the chemical analysis of these wines start to be necessity in wine industry in order to automate the production of wine and stabilize its quality. But the wine is characterized by a rich spectrum of different organoleptic features that is given by the around of 800 aromatic chemical compounds that give the scent to the wine. This complexity makes chemical analysis a difficult task. Tools that allow classifying the wine depending on the region of origin, kind of grapes used in the elaboration or the process that the wine has followed can help to this industry. These tools should be able to perform objective and abundant measurements of the wine properties. The e-noses with their high sensitivity, fast response, easy operation and capability to recognize different volatile compounds are a good approach to this kind of application [1].

In this work a portable e-nose has been developed to measure wine in different wine cellars. We have test two different micromachined array sensors that have several advantages such as low power consumption and small size so they are well suited to a large number of applications. While the classical analysis methods to measure volatile organic compounds are often big, non-portable, require complex preparation of the sample, have expensive fluidic circuits and their suitability for field test is reduced, this e-nose designed is cheap and can be used easily. We show the viability of this small and portable e-nose to measure different wines made with different grape types.

2. Experimental

This e-nose is formed by different parts: (1) Volatile compounds extraction method. (2) Control system. (3) Sensor arrays and (4) Recognition pattern techniques used to identify the wine types. A picture of total system can be seen in the Fig. 1 and the Fig. 2 shows a scheme with the parts of the e-nose.

2.1. Extraction technique: static headspace followed by dynamic injection

To create the headspace the wine is kept in a glass vial closed by a septum. To increase the stability of the system, the reproducibility and the amount of volatile compounds in the headspace of the samples, a thermal magnetic agitator was used. To extract the volatile compounds the carrier gas enters by a needle in the septum and exits by another needle. The carrier gas used was nitrogen with a flux of 200 ml/min. In the Fig. 3 is shown a picture of the system used. The device was prepared to work with headspace extraction but an external portable concentrator can be couple with it as well [2].

* Corresponding author.
E-mail address: manuel@ifa.cetef.csic.es (M. Aleixandre).

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Fig. 1. Image of the portable e-nose and the computer.

The samples measured in this work were four wines elaborated in the Madrid region with the four most common grape varieties of this region, two reds (Garnacha and Tempranillo) and two whites (Airén and Malvar). They correspond to the 2003 harvest. Wine samples (10 ml) were kept at 38 °C for 30 min in a 50 ml flask. After that time the headspace was injected in the measurement chamber for 10 min.

2.2. Control system

This control system is composed by two parts, a laptop and a central unit to control the fluidic and electronic systems. The fluidic system includes an electrovalve, a pump and a humidity filter. The electrovalve is used to select the circuit of carrier gas and to switch it over the sample. The humidity filter eliminates the humidity that could affect to the measurements. The pump produces a constant flow of gas that goes toward the measurement chamber where the sensors are placed. The electronic system is used to amplify the control signals, to provide electric current to heat the sensors at the desired temperature, to the measurement bridges, electrovalve and pump. The connection between the computer and the control system is made with two PCMCIA cards, one to convert the digital signal of the computer into a analogic signal (D/A) that allows to control the heaters and fluidic system and other one that converts the analogic signal from the measurement brigdes to a digital signal (A/D) that is used to measure the sensor resistance. The computer has a software that controls the fluidic and electronic systems and stores

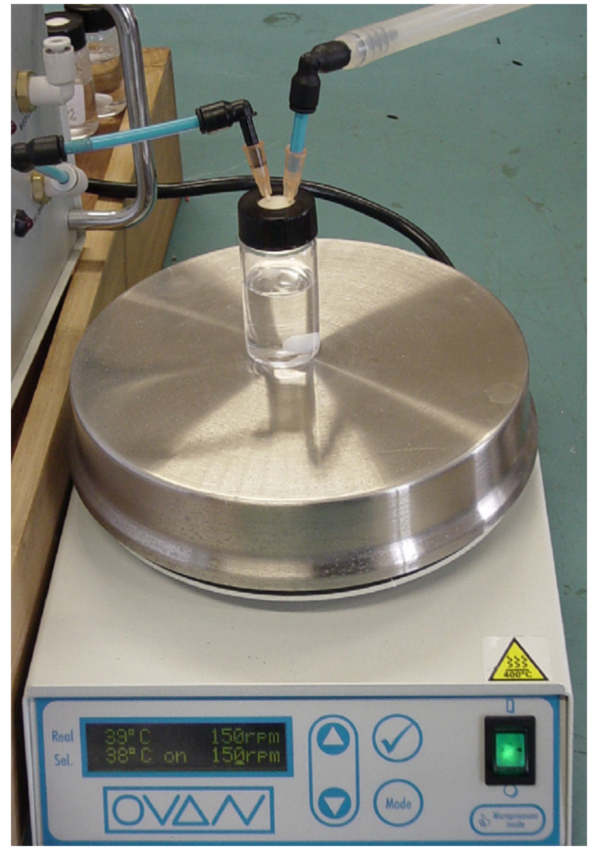

Fig. 3. System of extraction of headspace with vials.

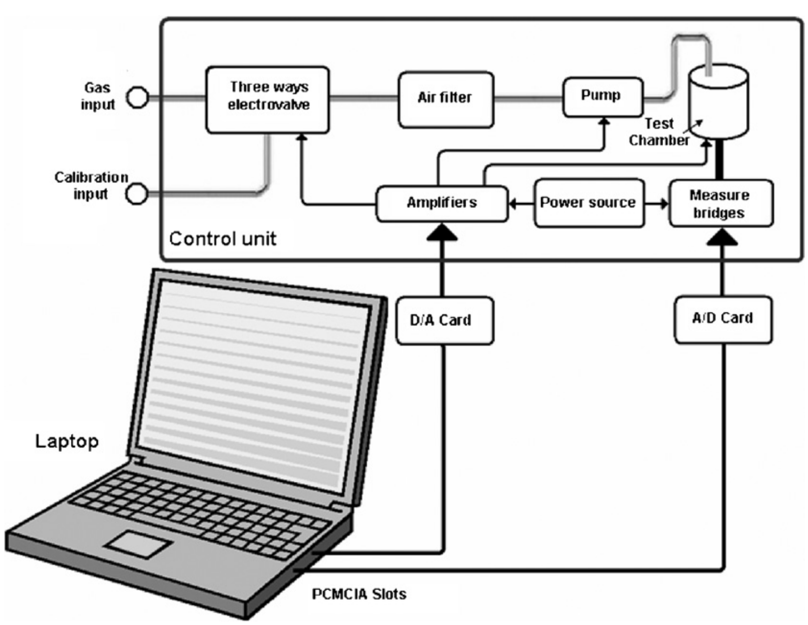

Fig. 2. Scheme of the system.