'Electronic Nose' - New Condition Monitoring Devices for Environmental Applications

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'Electronic Nose'—New Condition Monitoring Devices for Environmental Applications

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Introduction

The responses of individual odour sensors combined into an array, where each sensor possesses slightly different response selectivity and sensitivity towards the sample odours, when combined by suitable mathematical methods, can provide information to discriminate between many sample odours (Pearce *et al.*, 2002). Arrays of gas and odour sensors, made using different technologies, are finding their way into a variety of specialized applications (Persaud, 2001). Software techniques and material science are important aspects of the development of the systems. These devices have become known as 'electronic noses' and consist of three elements: a sensor array which is exposed to the volatiles; conversion of the sensor signals to a readable format; and software analysis of the data to produce characteristic outputs related to the odour encountered. The output from the sensor array may be interpreted via a variety of methods—such as pattern recognition algorithms, principal component analysis, discriminant function analysis, cluster analysis and artificial neural networks—to discriminate between samples.

We describe three different environmental applications for such technology and illustrate how the problems were resolved.

Detection of dry rot infections in buildings

We aimed to develop a portable sensing instrument that could be used by property surveyors in the field for detection of volatiles at very low concentrations that are emitted from fungal infections of *Serpula lacrymans* in buildings. The volatiles are emitted at very low concentrations and a GC/MS analysis indicated that key marker compounds included 3-octanone, 3-octanol and 1,3-octen-3-ol. We developed an automated system for sampling and preconcentration of these volatiles that was incorporated into a probe that could be inserted into crevices or cracks and be used to probe wall cavities or under-floor spaces. This was based on solid phase microextraction fibres (SPME) (Figure 1a) and allowed rapid sampling of odour at very low concentrations from previously inaccessible locations.

The measurement system was based on a array of metal oxide sensors, incorporated into a suitable header (Figure 1b)so that when a SPME fibre was inserted, thermal desorption of trapped volatiles occurred and dynamic responses of the sensors could be recorded (Figure 1c).

Monitoring of waste water volatiles

The requirements were for a device for monitoring the odour of waste water at the inlet of a sewage plant, where continuous measurement of the organic load can be measured. The requirements are stringent—the device has to operate continuously in real-time transmitting odour concentration data so that abnormal organic or industrial loads are detected in time. Because this device needed to be operated in a very harsh outdoor environment, the packaging requirements were also stringent. We utilized in this case an array of metal oxide sensors sensitive to sulphurous compounds that are

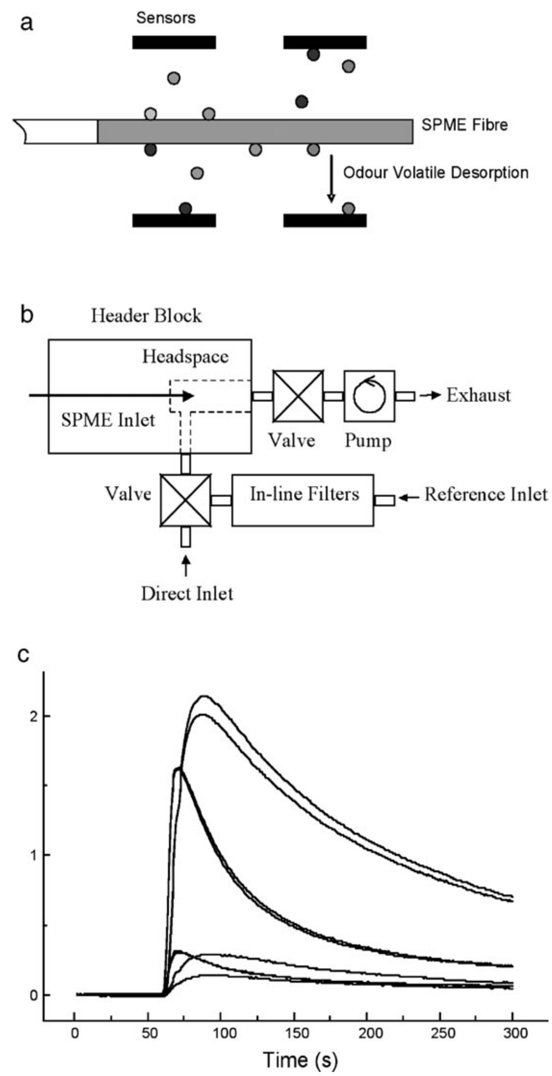

Figure 1 (a) Solid phase microextraction fibre: thermal desorption of adsorbed volatiles onto a heated sensor array. (b) Design of the measurement system. The sensors are mounted in a symmetrical three-dimensional array within a stainless-steel header block. The array encloses a small headspace volume that is rapidly heated to elevated temperatures by the sensors themselves. The header block allows the introduction of the SPME fibre. The sample volatiles are thus desorbed directly into the enclosed region between the sensors as shown. (c) The desorbed volatiles are sensed and the resulting response profile is dependent on the selectivity and sensitivity of the sensors to the mixture of volatiles.

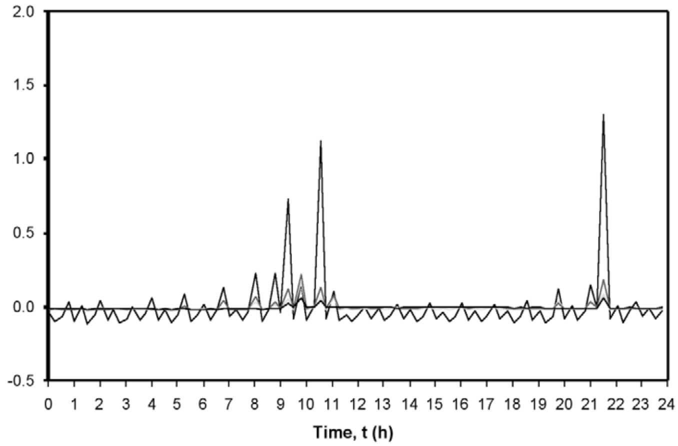

Figure 2 Continuous monitoring of odour at the inlet of a sewage plant. The trace shows a 24 h recording using an array of four sensors sensitive to sulphurous odours. Odour events are recorded in real time and can be seen between 0800–1100 and 2100–2200 h.

characteristic of organic decay and these have proven to be robust in monitoring changes in odour level over time (see Figure 2).

Smart fire detection systems

A big problem in fire detection is that of false alarms and many optical detectors do not discriminate between different types of smokes. We have been developing an array of conducting polymer sensors that are capable of carrying out the rapid discrimination of volatiles from different types of fires. GC/MS analysis would indicate that the odorous volatile profiles emitted from different type of standard fires can be characterized. We have developed a conducting polymer sensor array that allows discrimination of these profiles (Figure 3).

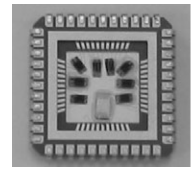

Figure 3 Conducting polymer sensor array developed for the fire detection application.

Conclusion

We show that odour sensor array based technology has improved. When coupled to suitable sampling systems and pattern recognition software odour sensor array technology can produce instruments that fulfil a variety of sensing needs, where a change of condition needs to be monitored.

Acknowledgements

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