INSTITUTE OF PHYSICS PUBLISHING JOURNAL OF PHYSICS D: APPLIED PHYSICS
J. Phys. D: Appl. Phys. **34** (2001) R125–R149 PII: S0022-3727(01)15069-2

## TOPICAL REVIEW

# Function and applications of gas sensors

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Received 3 April 2001
Published 18 September 2001
Online at stacks.iop.org/JPhysD/34/R125

**Abstract**
Gas sensors directed to high-volume applications are discussed. Mainly semiconductor sensors cover this sector, but the merits of competing devices are shown in comparison. Chemical and physical function is elucidated by spectroscopic results and molecular calculations. Important applications, e.g. monitoring of combustibles, especially methane, and the early detection of fires, are presented as illustrations. Progress in microelectronics has enhanced the development of electronic noses. An early example of such noses, the identification of solvents and also the present state of food aroma detection are described.

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## 1. Introduction

Periodic international sensor conferences are devoted predominantly to fundamental research, for example Transducers/Eurosensors (http://www.transducers01.de/) and SGS (semiconductor gas sensors, http://zeus.polsl.gliwice.pl/~zm/), PITTCON (electrochemical gas sensors, http://www.pittcon.org/exhibitor.htm). National conferences are usually more application oriented, e.g. 'Sensoren und Messsysteme' in Germany (www:http://www.vde.com/itg). A book series with yearly updates has covered the state of sensor chemistry, physics and technology to a large extent for a decade [1].

The following review focuses on gas sensors for high-volume applications. Semiconductor sensors are prevailing in this sector because they are cheap to produce. The basics of chemical and physical function are elucidated by spectroscopic results and molecular calculations. Important applications are presented as illustrations.

Within the last decade the availability of microcontroller chips with prices below US$1 have stimulated more complex gas sensor systems, usually tagged as electronic noses. One of the first successful applications, the identification of solvents by a set of electrochemical cells, is still available as an optional module of the 'Lennartz Moses II', electronic nose (http://www.lennartz-electronic.de), also featuring semiconductor and microgravimetric gas sensors [2]. Besides a description of this historical landmark, recent results from food aroma analysis by gas sensors are reported.

## 2. Function

First a short summary of gas sensor operating principles shall be given.

Microcalorimetric gas sensors (pellistors) burn combustible gases with the surrounding air on the surface of a small ball or film of a catalytically active metal [3]. The catalyst, e.g. Pt, Pd or Rh, is kept at 500–600 °C. The heat of combustion in

  