ABSTRACT SUBMISSION TO THE SPIE CONFERENCE ON

SMART ELECTRONICS, MEMS, BIOMEMS, AND NANOTECHNOLOGY

14–18 March 2004, San Diego, California, USA

SUBJECT: **SS07**

1. Paper title:

   Smart ASIC chip for vapour detection based upon carbon black/polymer composite nanomaterials

2. Authors:

Julian Gardner

Affiliation:	School of Engineering, University of Warwick, England
Mailing address:	School of Engineering, University of Warwick Coventry, CV4 7AL, UK
Telephone:	+44 24 7652 3695
Fax:	+44 24 7641 8922
Email address:	J.W.Gardner@warwick.ac.uk

Jesús García-Guzmán

Affiliation:	School of Engineering, University of Warwick, England
Mailing address:	School of Engineering, University of Warwick Coventry, CV4 7AL, UK
Telephone:	+44 24 7652 8168
Fax:	+44 24 7641 8922
Email address:	J.Garcia-Guzman@warwick.ac.uk

Marina Cole

Affiliation:	School of Engineering, University of Warwick, England
Mailing address:	School of Engineering, University of Warwick Coventry, CV4 7AL, UK
Telephone:	+44 24 7652 3546
Fax:	+44 24 7641 8922
Email address:	Marina.Cole@warwick.ac.uk

3. Presentation preference:

   Oral presentation

4. Principal author's biography (maximum 50 words):

Julian W. Gardner (BSc, PhD, DSc, CEng, FIEE, SMIEEE). Professor Gardner joined the School of Engineering at Warwick in 1987. His research interests are microsensors, microsystems technology, electronic noses, intelligent sensors and multivariate data processing methods. He has previously spent 5 years in industry working first at AEA Technology Ltd. and later at Molins Advanced Technology Unit on Instrumentation. At Molins he developed a novel opto-electronic sensor that has been packaged in the UK and US for implementation on high speed packaging machinery. In 1989 he received the Esso Centenary Education Award sponsored by the Royal Society and Fellowship of Engineering to pursue his research interests. He has published over 300 technical papers and is an author of six books in Nanotechnology (1991), Electronic Noses (1992), Microsensors (1994), Electronic Noses (1999) and MEMS (2001), Handbook of Machine Olfaction (2003). He was an Alexander von Humboldt Fellowship in Germany in 1994. He currently heads the Sensors Research Laboratory in the Centre for Nanotechnology & Microengineering at Warwick University, where he is Professor of Electronic Engineering.

5. Abstract text:

Summary

In this paper we report on the characterisation of a smart ASIC chip based around a pair of room temperature resistive vapour sensors in a ratiometric configuration. This novel design enables the elimination of undesirable baseline effects, such as long-term drift, ageing, temperature and humidity dependence; it also incorporates an automatic offset of the output signal. The ASIC response has been modelled and simulated prior to fabrication as reported elsewhere[1, 2]. Two different carbon black/polymer composite materials have been spray coated on to our ASIC chips, in order to illustrate their functionality. The novel ASIC chip has been designed[1, 3] and fabricated through a standard 0.7 μm CMOS process. Responses to ethanol and toluene vapours are presented. Its smart capabilities of drift rejection and self-calibration demonstrate its potential application in a micro-power palm-top unit for the monitoring of volatile organic compounds (VOCs) or gases.

There are two main stages in the circuit: one for the processing and conditioning of the sensor signals and the other, if required, for temperature control[1]. Two sets of sensor electrodes are positioned in two corners of the chip and are connected in a non-inverting operational amplifier configuration. Chemoresistors were created through a post-fabrication stage via in-house spray coating of carbon black/polymer composite nanomaterials across the metal electrodes. Poly(ethylene-co-vinyl acetate) and Poly(caprolactone) polymers have been deposited and during tests one of the sensors was exposed to the vapours whilst the second one was kept passive using an inert material.

Following deposition, the responses of ASIC devices to ethanol and toluene have been characterised in an automated mass flow system. Temperature and humidity dependence, sensitivity and linearity have been determined.

6. Keywords:

Smart sensor; ASIC; Resistive gas sensor; Ratiometric sensor array

---

[1] J. García-Guzmán, N. Ulivieri, M. Cole, J. W. Gardner, "Design and simulation of a smart ratiometric ASIC chip for VOC monitoring", Sensors and Actuators B, at press.

[2] M. Cole, N. Ulivieri, J. García-Guzmán, J.W. Gardner, "Parametric model of a polymeric chemoresistor for use in smart sensor design and simulation", Microelectronics Journal, at press.

[3] M. Cole, J. García-Guzmán, J.W. Gardner, "Smart ratiometric ASIC chip for a palm-top VOC monitor", 16th European Conference on Solid-State Transducers, Prague, Czech Republic, 2002, p. 509-512.