Abstract title	Open-cavity moulding technique for fluid sensor applications
Author(s) name	T. Eggers, H. Dobrinski, I. van Dommelen, O. Lüdtke, A. Nebeling, J. Raben, D. Wüllner
Job title	Manager

Abstract

In cooperation with its partners Campus Micro Technologies developed a low cost microsensor for measurements of various electrical and other physical parameters of fluids. The microchip is mounted onto a standard leadframe with JEDEC SOIC-8 outline and encapsulated by a special open-cavity plastic moulding technique, patented by Eurasem B.V., whereas the sensitive electrode structure is protected against particle contamination during moulding. This open-cavity package concept meets the automotive AEC Q-100 quality & reliability requirements and is suitable in a temperature range of -65 °C to 160 °C.

Open-cavity moulding technique for fluid sensor applications

T. Eggers[1], H. Dobrinski[1], I. van Dommelen[2], O. Lüdtke[3], A. Nebeling[2], J. Raben[2], D. Wüllner[3]
[1]Campus Micro Technologies GmbH, Universitätsallee 29, 28359 Bremen, Germany,
Tel.: +49 421 20 20 783, Fax: +49 421 20 20 900, email: info@campus-micro-technologies.de
[2]Eurasem B.V., Microweg 1, 6500 AN Nijmegen, The Netherlands,
Tel.: +31 24 371 4499, Fax.: +31 24 377 0406, email: info@eurasem.com
[3]HELLA KG Hueck & Co, 59552 Lippstadt, Germany

Keywords

microsystem technology, fluid sensor, MEMS packaging, open-cavity moulding, high-volume

1. Introduction

In many applications microsensors and MEMS are becoming widely accepted. Thus there is a growing need for sensors of all different kind, such as:

- pressure,
- chemical properties of gases and liquids,
- optical
- fluid flow etc.

Most of these chemical and physical sensors necessitate a direct interface to the outer world for accessing the medium which has to be analyzed. Due to protection of the overall die surface standard plastic packaging techniques can not be applied for these kind of devices and new encapsulation methods have to be introduced.

2. Sensor design

In cooperation with its partners Campus Micro Technologies GmbH developed a low cost microsensor for the analysis of various electrical and other physical parameters of fluids. The measurement principle is based on the detection of changes in the sensors stray field capacitance induced by a modulation of the dielectric constant ε_r of fluids in contact with the sensors surface.

The chip is composed of a completely CMOS-compatible material combination (Fig. 1). In a first step a thin metallic interdigitated electrode structure (IDS) is fabricated by sputter deposition and patterning of a tungsten titanium alloy on a amorphous quartz glass substrate. For media compatibility and electrical insulation the sensing electrodes are conformally coated by an ultra thin dielectric layer of silicon nitride. Finally, in preparation for mounting and assembly a standard aluminium bondpad metallization is generated.

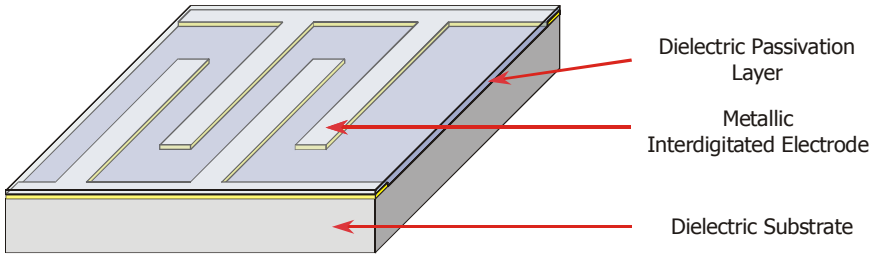

Fig. 1. Detailed view of the microsensor

3. Packaging

The manufacturing concept used for encapsulation of the microsensor is similar to a standard plastic IC packaging process with a special unique moulding step. It was developed and patented by Eurasem B. V. (US Patent 5,897,338).

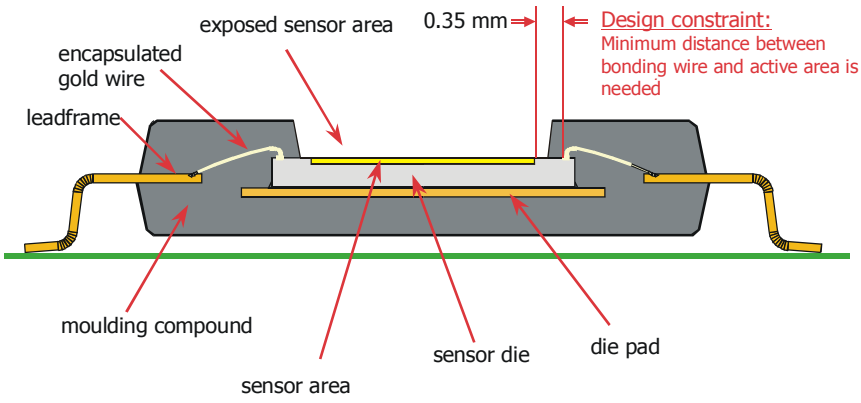

Fig. 2. Cross section of a moulded open-cavity package

After several electrical tests on wafer level the diced microchip is mounted onto a standard leadframe with JEDEC SOIC-8 outline and electrically connected to this by gold wires (Fig. 2). Due to a metal insert with a soft preform the active sensor area of the chip surface is kept open during transfer moulding and saved against damaging and particle contamination. When the fluid compound is pressed into the mould cavity a special nipple pressed onto the chip surface prevents the moulding compound from reaching the sensor active area. Therefore, only the gold wires are covered with moulding compound. This gives a mechanical protection both in the further processing as well as a high reliability, which is identical to a standard plastic package. In temperature cycling tests (1000 cycles, -65 to 160 °C) no failures were determined.

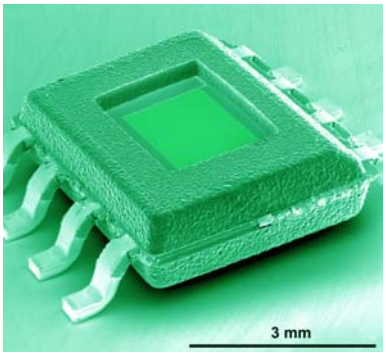

Fig. 3: SEM picture of the fluid sensor in open-cavity SOIC-8 package

By this packaging concept a minimum distance between bonding wires and active area of 350 µm was reached. The overal covering of the active sensor area by mould compound particles was lower than 1 %, and therefore, no significant deterioration of sensitivity and spreading of offset capacitance was observed.

4. Conclusions

The presented open-cavity moulding technology has several general advantages for packaging of microsensors that must be interfaced to the outer world:

- interconnection reliability similar to standard plastic IC packaging processes
- based on a standard flow for plastic packages
- applicable for a wide range of plastic packages (e.g. SOIC, QFP, PLCC, SSOP, BGA, CSP)
- can be applied with multi-chip concepts (sensor(s) + ASIC)
- package cost for medium to high volumes

Furthermore, using decametric and conductometric analysis methods the developed fluid microsensor gives an information about mixing ratios, contaminations and aging effects in various fluids and suspensions. A commercially available IC converts the quasi static capacitance and conductance, respectively, of the sensor to a pulse-width modulated output signal that is read out by a microcontroller set-up.

Due to its internal multi-phase conversion concept this sensor system is highly accurate without any further calibration and therefore it meets in combination with the package technology cost targets for high-volume applications.

Brief biography of principal author

Torsten Eggers was born on August 27th, 1968 in Bremen, Germany. He received his diploma in electrical engineering (microsystem technology/ microelectronics) from University of Bremen in 1995. From 1995 to 2000, he was a scientific research fellow at the Institute for Microsensors, -Actuators and -Systems (IMSAS) at University of Bremen.
In April 2000, he joined Campus Micro Technologies GmbH as a manager.
Currently he is finishing his Ph.D. thesis "Biomedical sensor implants in health care markets".