Functional Packaging for MEMS
from fast prototyping towards massproduction

Tomorrow’s electronics
Utrecht, 1 Oct. 2014

protecting your technology with ours

sencio functional packaging center
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Sencio

Development and manufacturing of functional semiconductor assembly solutions.

- Focus on (MEM’s) sensors.
- Development and volume Production
- Meeting quality demand of Automotive industry.
A young company with a long history

1987  Foundation of eurasem as an independent assembly subcontractor for plastic packaging in Nijmegen.
2001  Acquisition by Elmos Semiconductor AG.
2011  Sencio has taken over all advanced packaging activities from Elmos AG.

- Located in Nijmegen.
- Number of employees 51.
- TS16949 & ISO 14001 certified.
- 1200 m² clean room facility; 10K & 100K.
- Over 300 million assemblies supplied to the Automotive Industry.
Sencio, Proposition

• Core business:
  – Development of functional plastic encapsulation solutions for semiconductors.

• Services:
  – Ceramic / Plastic fast turn prototyping.
  – Wafer processing.
Plastic Package

Since the early 1970’s proven encapsulation for semiconductor chips.

Why?
- protection of the silicon chip
- interface between the chip and the pcb.
MEMS, => Micro Electro Mechanical Systems.

Voice / Sound
- Silicon microphones
- Gyroscopes
- Accelerometers
- Magnetometers

Motion / position
- Pressure monitoring
- Pressure-sensors
- TPMS modules

Projecting / receiving Light
- Micro-mirrors
- Micro-bolometers

Courtesy of Yole
MEMS Functional Package

Adding tasks to the plastic package;

Communication channel in the package.

Low stress packages (pre-moulded and gel)

SiP, System in Package.
Overmolding Technology; passive components

- Capacitors, resistors and diodes directly attached to the leadframe.
- Complex leadframe design possible.
- Overmoulded with standard semiconductor molding compound.

4000 cycles Temp.shock (Air to Air) -65C ↔ +165C
Pre-molded Technology;

Principle:
- Package created prior to assembly.
  - Thermoset (‘duroplast’).
  - Thermoplast.
- MEMS can be mounted ‘stress free’ using soft attach material.
- Die and wires are not encapsulated. => protection by gel.
- Package is optionally closed with a lid (glass, metal, plastic) or nozzle for tube access.
Pre-molded Technology; Pressure sensor package

Standard Jede outline:
- SOIC 16
- Special nozzle.

Advanced Technologies:
- Premoulded package

Mission Profile notes:
- Differential pressure sensor.
- Temperature – 40 to 125°C
- Dry air application
Globtop overmolding Technology;

Principle:

- Sensor die is covered with a silicone gel to prevent it from contact with moulding compound.
- Airgap prevents stress from moulding compound on the sensor surface.
Exposed sensor cavity molding Technology;

Principal:
- Overmolding with duroplast leaving only the sensor area free of molding compound.
- Gold wires encapsulated, sensor area exposed.

Technologies:
- Patented insert technology.
- FAM molding technology.
Exposed Sensor overmolding Technology;

Highlights:
- Interconnection reliability similar to standard plastic packaging.
- Ideal solution for harsh environments.
- Applicable for a wide range of plastic packages
  - Leadframe packages QFP, PLCC, SOP
  - BGA and CSP-packages (e.g. QFN)
  - Special customised packages
- Cavity format & size can be tuned to the application.
- Multi Chip (sensor(s) + ASIC + passives).
- Automotive qualified.
Exposed Sensor; MICROCAVITY by SOFT TOUCH

**NEW**

**Soft touch & FAM**
- Cavity Ø 400µm
- Cavity Ø 200µm (in development)

**Insert or FAM technology**
- Cavity Ø 900 µm.

**QFN package 4x4mm.**

**Soft-touch technology**

400 µm
Exposed Sensor; MICROCAVITY for MEMS

- Interconnections (Wires) fully encapsulated in thermoset compound.
- Soft-touch Small MEMS need a small cavity
- Soft-touch moulding avoids membrane cracking.
Glass on die technology; color sensor package

Standard Jedeck outline:
- QFN 4x4.

Advanced Technologies:
- Glass on die technology.

Mission Profile notes:
- Optical color sensor.
- Temperature – 40 to 125°C.
- Various application.
- Co-operation with MAZeT.
nCapsulate™

Additional functionality to the functional package.

Why?
- Combine 1\textsuperscript{st} and 2\textsuperscript{th} level assembly.
- Adding an extra dimension to the encapsulation of your device /system.

How?
- Functional shapes
- Combine mechanics with electronics.
nCapsulate™ ➔ functional shapes

Encapsulation shape adapted to the application.

• Accurate dimensional shape, stable over temperature.

• Applications:
  – Alignment features
  – Mounting support
  – Custom specific shape
nCapsulate™ ➔ embedded mechanics

Adding mechanical elements to encapsulated electronics:

- Alignment features
- Mounting features
- ...other...

Advantages:

- Improved alignment (measurement accuracy)
- Improved thermal contact
- Simplified design
- Improved efficiency
nCapsulate™ ➔ embedded mechanics bearing or guiding bush

Guiding element through hole or suspended version.

Accurate alignment between rotating axis and semiconductor sensor.
Application example: Magnetic sensors, HALL or MR.
- In case of high precision angle measurement.
- Magnet size reduction.

**nCapsulate™** → embedded mechanics bearing or guiding bush

**shaft circumference** by magnetic pole ring applications

**shaft end applications** by dipole magnet applications
nCapsulate™
Integration of screw-thread

- Harsh vibratory environments.
- Robust fixation of other elements on a package.
- Accurate alignment between nut & sensor.
nCapsulate™
Integration of nut applications

Direct mounting of heatsink (e.g. power & RF applications)

Mounting of tube access for MEMS applications (e.g. pressure)

Fixation of optical elements (e.g. lens, fiber..)
Pressure sensing MCM
Integration & overmolding of;
- Absolute MEMS Pressure sensors.
- Signal processing ASIC & Passive components.
- Embedding suspended nuts for solidly mounting a tube access.

Optionally Membrane protection by;
- silicone gel in the cavity.
- noble metallization (by MEMS supplier).
Fixation

e.g. welded connection between the Duroplast chip package & Thermoplastic sub-module (green).
# Functional encapsulation technologies

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<tr>
<th>Technologies</th>
<th>Pressure</th>
<th>Gas/chemical / fluid</th>
<th>Optical</th>
<th>Acceleration gyro</th>
<th>Magnetic</th>
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<tbody>
<tr>
<td>Over-molding</td>
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<td>Pre-molded</td>
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<td>Glass on die</td>
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Technologies can be combined!
Summary

- Functional Packaging is key to solve the challenges of MEMS assembly.

- nCapsulate™ creates an extra dimension to a package (freeform).

- nCapsulate™ creates additional value as the MEMS device is integrated into a system (next level assembly).

- Combined with other available technologies, Sencio offers a perfect packaging solution for your (sensor) system.
Thank you

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