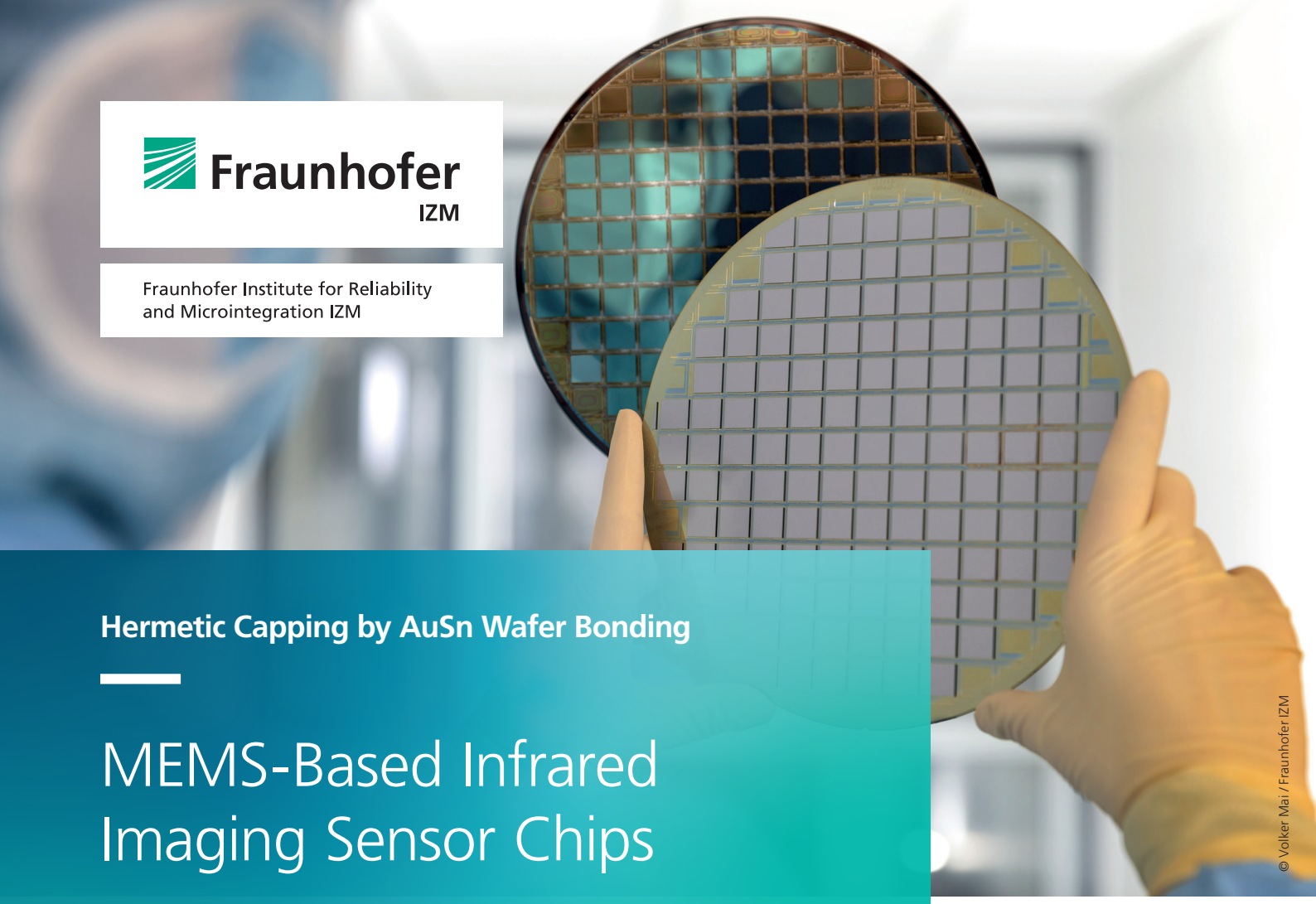
Fraunhofer IZM

Fraunhofer Institute for Reliability and Microintegration IZM



© Volker Mai / Fraunhofer IZM

Hermetic Capping by AuSn Wafer Bonding

MEMS-Based Infrared Imaging Sensor Chips

Research Project APPLAUSE

A consortium consisting of 31 key European players from the electronic packaging, optics, and photonics sectors, leading equipment suppliers, and testing experts were involved in the EU-project »Advanced packaging for photonics, optics and electronics for low-cost manufacturing in Europe« (APPLAUSE).

Wafer-level packaging processes for the cost-efficient production of infrared cameras

The project was set up to bolster the European semiconductor value chain by developing new tools, methods, and processes for high-volume manufacturing.

Its proposed use cases included the construction of a low-cost, but high-performance thermal infrared sensor.

For this use case, Fraunhofer IZM developed wafer-level packaging processes for the hermetic vacuum encapsulation of large MEMS pixel arrays for infrared thermal sensors for automotive safety applications.

Contributions from Fraunhofer IZM:

- Preparation of the MEMS device wafers (microbolometer, pirani)
- Fabrication/ micromachining of 8’ silicon substrates for silicon capping
- Silicon hybrid caps for maximum internal volume
- Processes and design for vacuum encapsulation with AuSn wafer bonding
- Hermetical vacuum sealing by AuSn wafer bonding

Realized innovation:

- MEMS-based IR imaging sensor chips encapsulated under vacuum at the wafer level (200 mm) with a sealing yield estimated at > 90 %

Project partners (selected)

- Integrated Detector Electronics AS
- University of South-Eastern Norway
- Fraunhofer IMS, Germany

Project volume

- € 9.98 million (Germany)

Duration

- 05/2019 - 10/2022

Funding code

- 16ESE0352

SPONSORED BY THE

Federal Ministry of Education and Research

ECSEL JU

Since a vacuum is required for the microbolometers (MEMS consisting of a multi-layered ultra-thin membrane with an infrared-sensitive absorber layer) to function properly, Fraunhofer IZM developed a wafer-level packaging process for robust hermetic encapsulation in a vacuum.

After adequate preparation of both device and cap wafers, the device wafer including the electronics (ROIC) and the fine MEMS microbolometer structures are sealed by wafer bonding with a cap wafer acting as a window for infrared transmission.

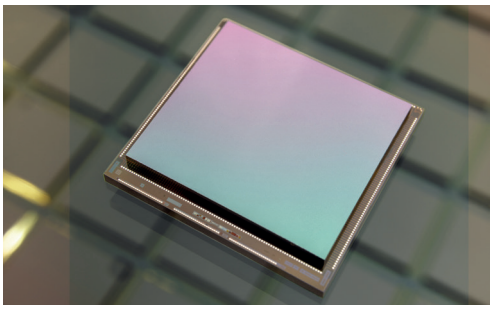
During bonding, the rings of electrodeposited AuSn solder melt and seal both parts together. This not only protects the highly sensitive MEMS sensor elements for later integration in the final camera sensor, but also provides a hermetic / gas-tight seal under vacuum for their proper functioning, including IR transmission onto the MEMS.

Advantages of the developed processes:

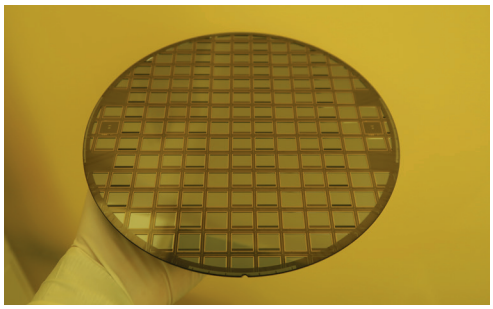
- parallel capping of entire device wafers with vacuum encapsulation (currently > 120 large devices)
- thermally robust sealing with AuSn bonding technology
- smaller footprint compared to standard housing
- cost reduction and high-volume manufacturing

Fraunhofer IZM was also involved in the development of two other industrial applications within the APPLAUSE project, namely new packaging processes for:

- a high-speed datacom transceiver, and
- a flexible patch for cardiac monitoring.



MEMS-based IR imaging sensor chip encapsulated at wafer level (200 mm) under vacuum



200 mm cap wafer prior sealing with deep-etched cavities and electrodeposited bond rings

You would like to get to know our developing packaging and interconnection technologies?

Contact us!

Fraunhofer IZM: Invisible - but indispensable. Nothing works anymore without highly integrated microelectronics and microsystems technology. The basis for their integration into products is the availability of reliable and cost-effective assembly and interconnection technologies.

Fraunhofer IZM, a world leader in the development and reliability assessment of electronic packaging technologies, provides its customers with customized system integration technologies at the wafer, chip, and board level. The research done at Fraunhofer IZM helps make electronics more reliable and provides customers with reliable data about the durability of electronics.

More information

Fraunhofer Institute for Reliability and Microintegration IZM

Kai Zoschke
Ph. +49 30 46403 – 221
kai.zoschke@izm.fraunhofer.de

Dr. Hermann Oppermann
Ph. +49 30 46403 – 163
hermann.oppermann@izm.fraunhofer.de

Dr. Charles-Alix Manier
Ph. +49 30 46403 – 612
charles-alix.manier@izm.fraunhofer.de

Fraunhofer IZM
Gustav-Meyer-Allee 25
13355 Berlin
Germany

www.izm.fraunhofer.de 03/2023