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FRAUNHOFER RESEARCH INSTITUTION FOR MICROSYSTEMS AND SOLID STATE TECHNOLOGIES EMFT

1 *Chip stack on bottom wafer*

HETEROGENEOUS 3D INTEGRATION

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Applications

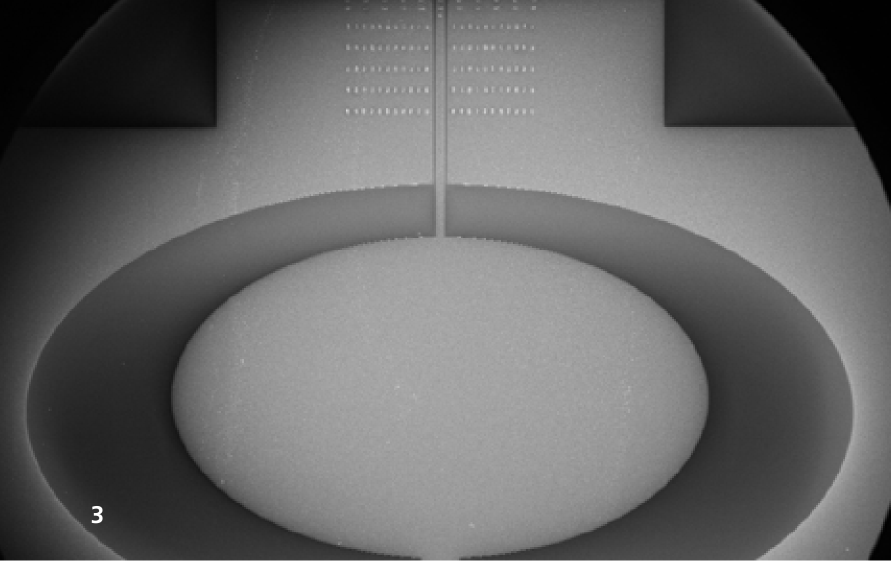
Heterogeneous 3D integration is a key technology for the development of miniaturized, multifunctional, high-performance devices and sensor systems. Potential applications comprise all fields of ambient assisted living, smart buildings (e.g. wireless gas sensors for air quality systems), safety and security (e.g. IR imagers), biosensors and smart medical systems (e.g. active medical implants).

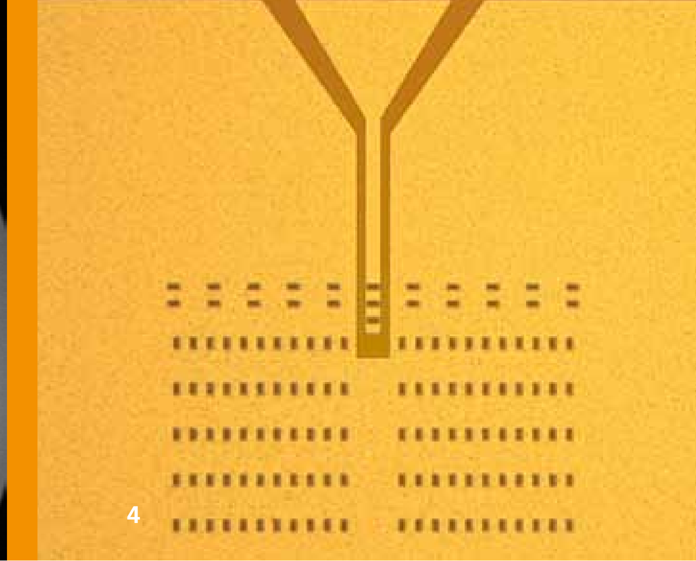
Fraunhofer EMFT has a long-standing experience in vertical integration of subsystems, especially in the field of inter-chip interconnections. This allows for highly integrated devices and systems for diverse applications, e.g.

- Miniaturized sensor systems for medical applications such as pacemakers
- Wireless sensor systems for near field communication (e.g. 60 GHz)

Technical innovation

- Flexible solutions for diverse components supplied by the customer
- Depending on individual requirements specific process modules are available, e.g. inter-chip interconnections, deep etching of Through-Silicon Vias (TSV), low temperature processes, solid-liquid-interdiffusion bonding
- Implementation of highly reliable heterogeneous sensor/ IC systems
- 3D TSV based high frequency components for RF-MEMS and RFIC-applications (e.g. high-Q inductors and 60 GHz antennas, see picture 5)





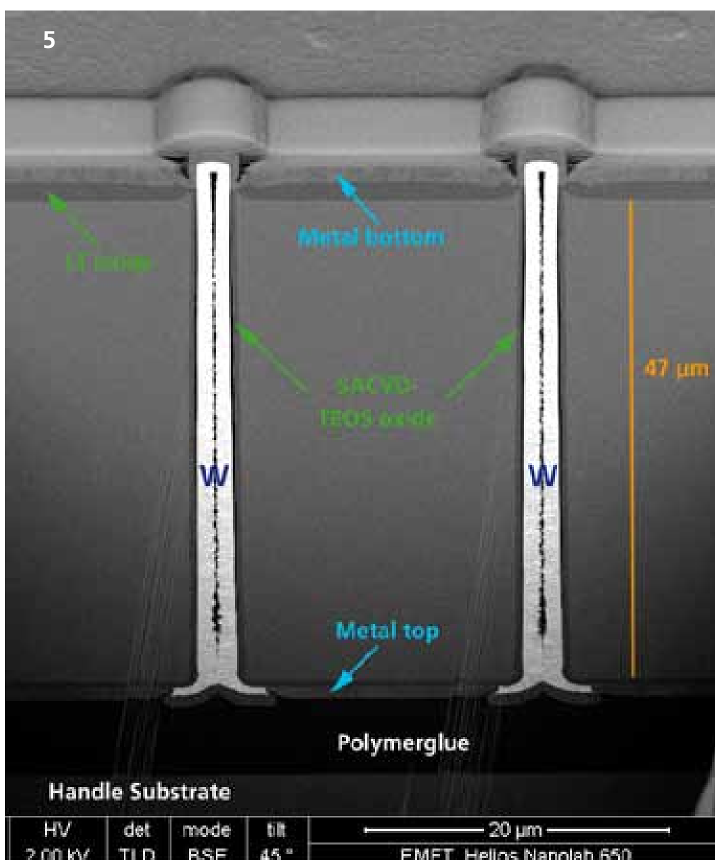
Technical data

Fraunhofer EMFT competences in the field of 3D integration comprise:

- Physical design and layout for system integration
- Ultra thin silicon devices
- Wafer level technologies for embedding thin chips
- Integration of silicon devices in/ on foil substrates and foil packages
- TSV-processes (deep etching, isolation, CVD-TiN, W)
- Backend process integration, substrate processing, assembly and connecting technology
- Low temperature wafer bonding
- Electroplating (Cu, Sn) for IMC bonding, SMD soldering, passive devices
- Wire bonding (Au, Al)
- Analytics
- Specific performance and reliability tests (e.g. Highly Accelerated Stress Test)

Outlook

Sensor integration can be considered as the main driver for heterogeneous 3D integration. The integration of sensors with ICs and passive components, such as energy harvesters, actuators and batteries, is becoming more and more important. This knowhow is becoming increasingly important especially for the high growth market area of distributed wireless sensor systems – which will constitute the key connected hardware infrastructure of the Internet of Things.



3 *SEM picture of a 3D TSV integrated antenna*

4 *High resolution microscope image of a 3D TSV integrated antenna*

5 *Through-Silicon Vias of an RF module*