

Demonstrator 2: Multi-Materials Sensors (MMS)

Integration of components with differing material properties, covering III-V, electro-optical, and acoustic sensor chiplets

Authors: Wölk, Martin; Wunsch, Dirk; Stefani, Alessio; Kappert, Holger; Wysocki, Lena; Gu-Stoppel, Shanshan; Fankhänel, Johannes; Burger, Alexandra

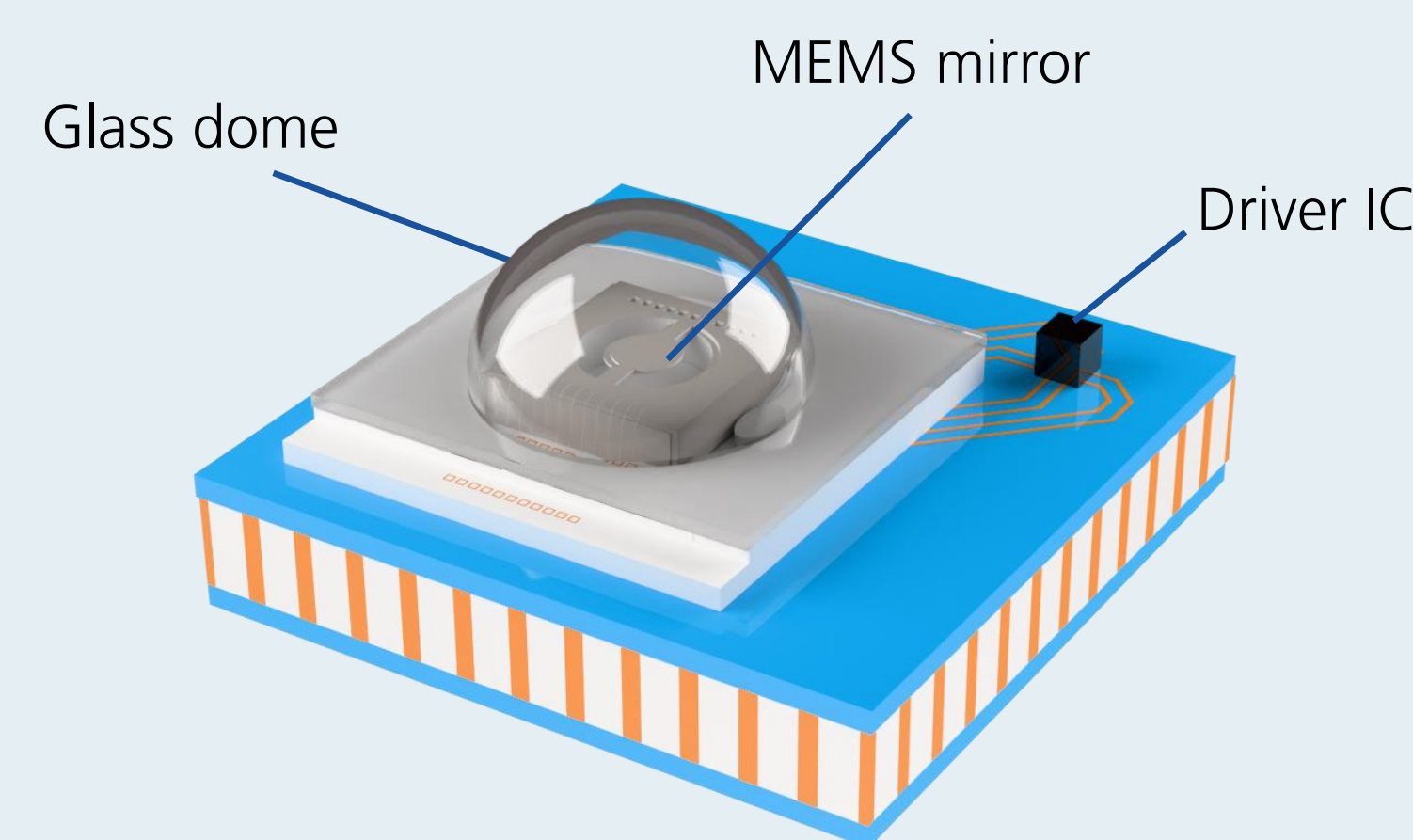
Within the APECS pilot line, four demonstrators, focusing each on one key technological field, are realized to give a comprehensive overview of the capabilities, possibilities, and portfolio of the APECS pilot line. One of these representative demonstrators is the MMS, which addresses the packaging and integration of multi-material sensor components, ranging from CMOS via Post-CMOS to III-V. The sensor interfaces are to be aligned in co-design with their heterogeneous system interposers and sensor frontends. The planned integration includes QMI and 2&3D of multi material. The range of envisaged sensor components covers acoustic-, electro-optical-, and III-V (Galliumnitrid)-sensor chiplets as well as a MEMS-mirror chiplet.

Following the distributed pilot line and a common STCO approach among all application areas, discrete processing and integration value chains are realized within APECS. The resulting IP portfolio shall offer design flexibility and fast development times for different applications.

Here, the individual components of the MMS-Demonstrator are displayed, giving further insights into the build-up of the envisaged HEMT GaN-, acoustic, electro-optical, and MEMS-mirror sensor chiplets.

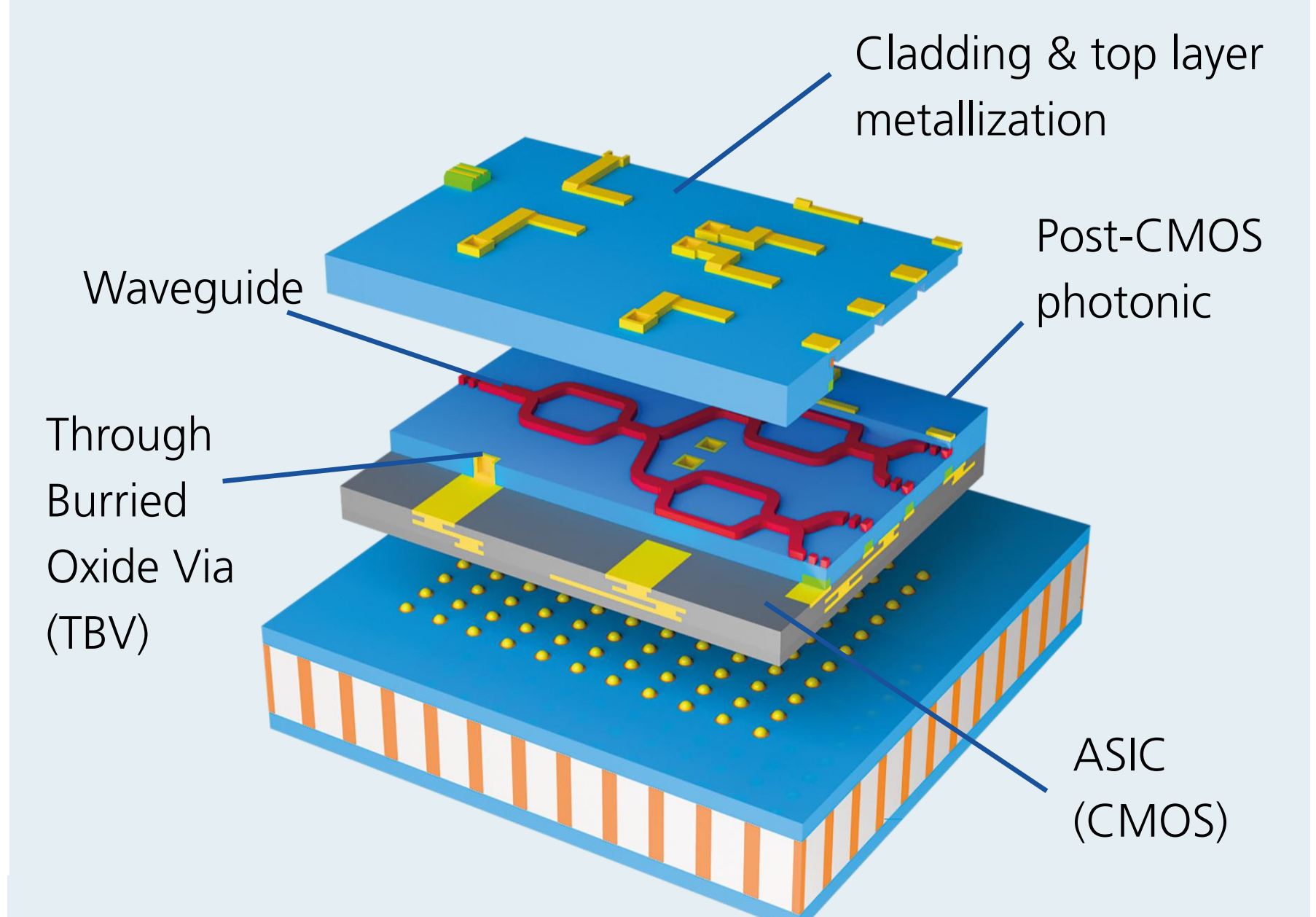
Opto Sensor Chiplets: MEMS-Mirror Chiplet

- AlScN - driven, biaxial, resonant MEMS- mirror
- 90° x 90° FoV @ 2- 5 kHz / 60° x 60° FoV @ 15-25 kHz
- Glass interposer with Through-Glass Vias (TGVs)
- Hermetic packaging with a glass dome



Opto Sensor Chiplets: Electro-Optical Chiplet

- Universal photonic-electronic co-integration through Post-CMOS photonics
- Electro-optical switch matrix at visible wavelengths (@633nm)
- Control from CMOS and sensing using on chip photo diodes



Interposer

- Si-Interposer technology development with via-first approach and frontside/ backside processing
- Development of D2W bonding process dependent on contact density and CTE mismatch
- Key features: Universal core design adaptable RDL, very deep vias (300-400µm) to avoid temporary bonding processes

Contact

Martin Wölk

Technical Lead Demonstrator 2 (T6.2)
Fraunhofer Institute for Silicon Technology ISIT
Fraunhoferstrasse 1, 25524 Itzehoe, Germany
Email: martin.woelk@isit.fraunhofer.de

Dirk Wunsch

Deputy Technical Lead Demonstrator 2 (T6.2)
Fraunhofer Institute for Electronic Nano Systems ENAS
Technologie-Campus 3, 09126 Chemnitz, Germany
Email: dirk.wuensch@enas.fraunhofer.de

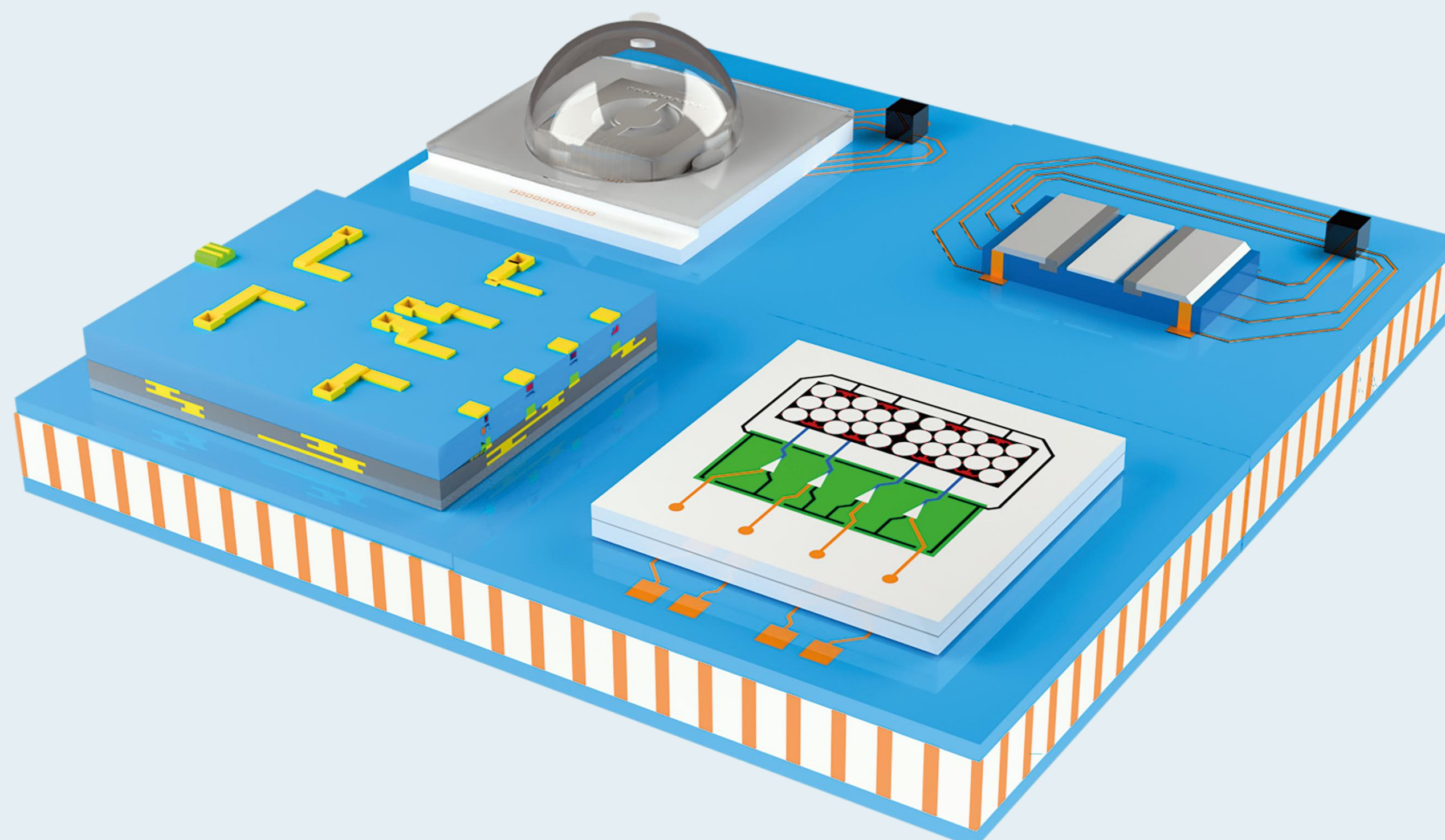
www.apecs.eu | info@apecs.eu

Additional information

The work presented was carried out in the framework of the APECS Pilot Line of the Chips Joint Undertaking, funded by Horizon Europe and Digital Europe Programmes and national funding authorities of Austria, Belgium, Finland, France, Germany, Greece, Portugal, Spain.

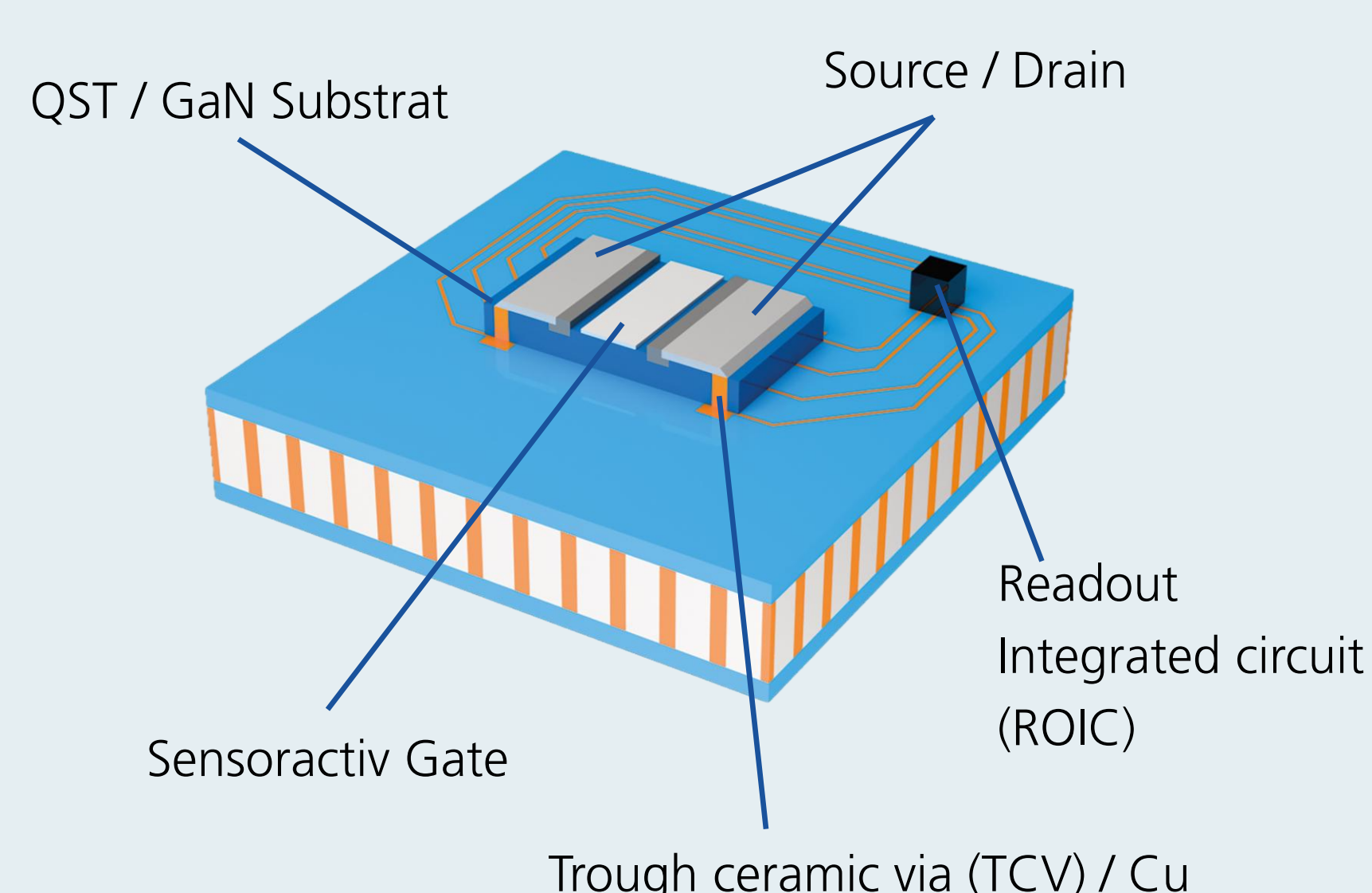
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Chips Joint Undertaking. Neither the European Union nor the granting authority can be held responsible for them.

Demonstrator Multi-Materials Sensors



HEMT GaN-Sensor Chiplet

- High-electron mobility transistor (HEMT) with $R_{DS(on)} \approx 20 \Omega$ based sensors with low to none cross sensitivity
- High sensitivity (ppm range) & high S/N ratio > 500/1 HEMT sensors with dedicated Readout Integrated circuit (ROIC)



Acoustic Sensor Chiplet

- Quasi-monolithically integrated CMUTs and ASIC as a gesture recognition demonstrator
- Based on a BSOI pocket wafer chiplet with TSVs
- Features airborne CMUTs (1 Tx and 4 Rx channels, Frequency ≈ 2 MHz, Bias < 50 V DC, BW > 15 %)
- Contains an ASIC as a collaboration of Fraunhofer IPMS and Fraunhofer EMFT (Tx + Rx Duplex, 8 channels, PC interface)

