

Demonstrator 2: Multi-Materials Sensors (MMS)

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

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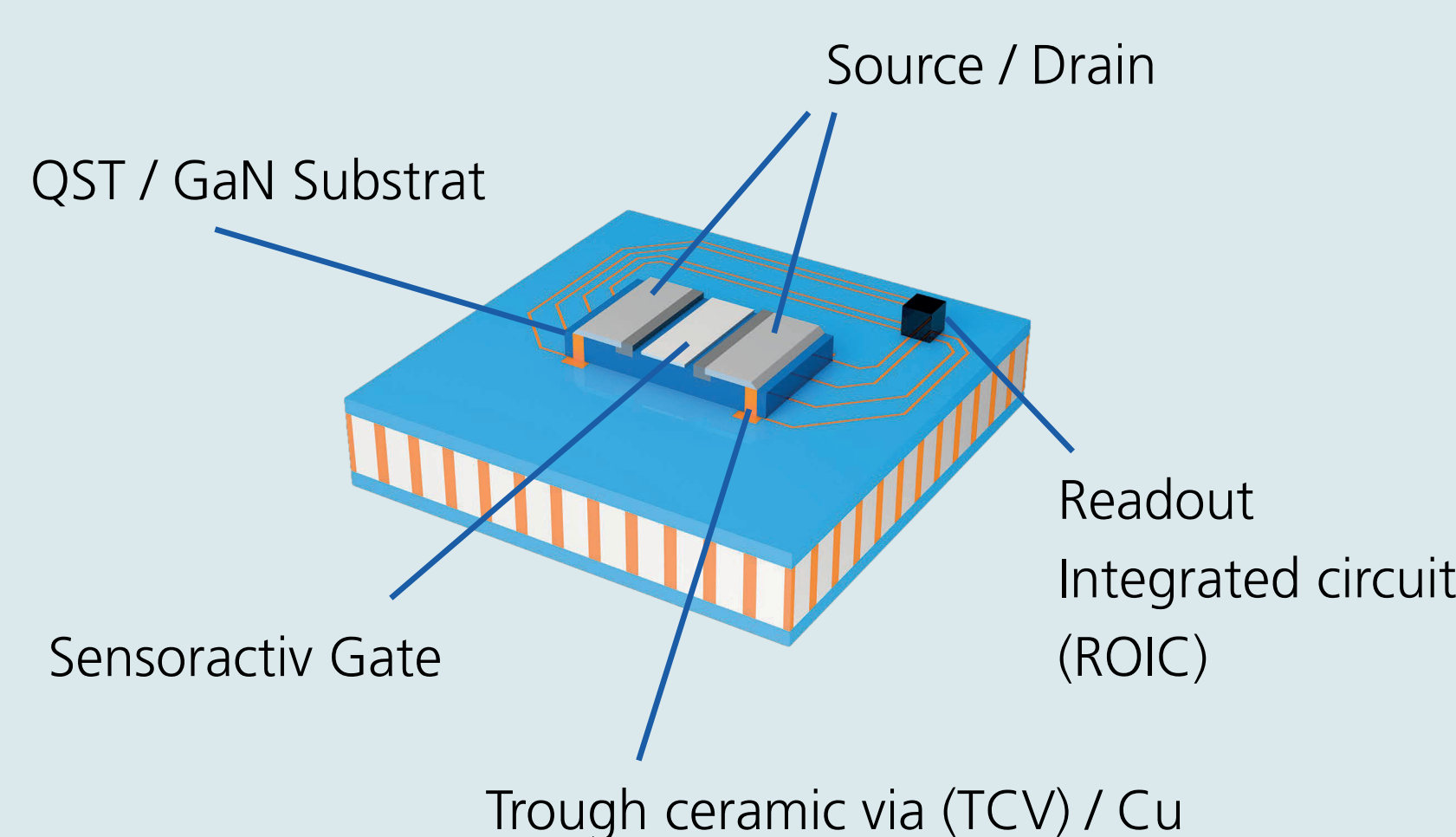
Within the APECS pilot line, four demonstrators, focusing each on one key technological field, are realized to give a comprehensive overview of the capabilities, possibilities, and portfolio of the APECS pilot line. One of these representative demonstrators is the MMS, which addresses the packaging and 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 QML and 2&3D of multi material. The range of envisaged sensor components covers acoustic-, electro-optical-, and III-V (Galliumnitrid)-sensor chiplets, a Silicon Hall-Array High-Resolution Platform (SHARP) Chiplet, 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, SHARP, electro-optical, and MEMS-mirror sensor chiplets.

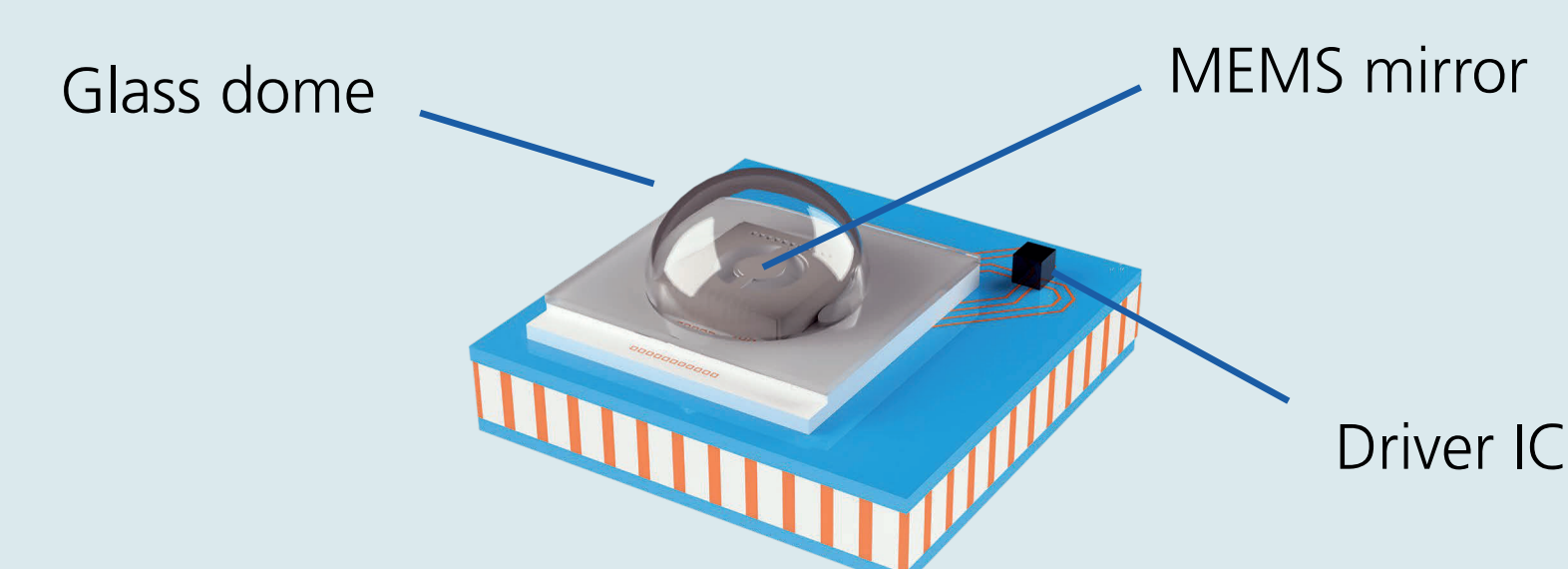
HEMT GaN-Sensor Chiplet

- 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)



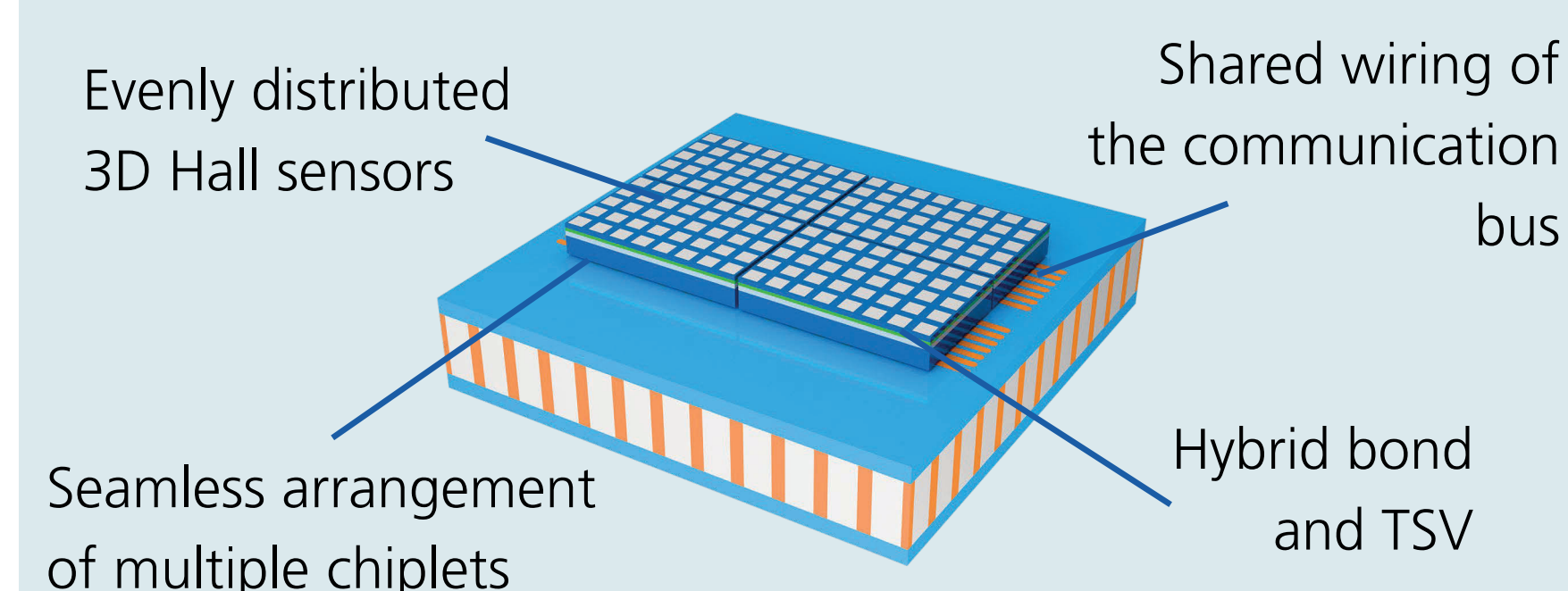
Opto Chiplets: MEMS-Mirror Chiplet

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



Silicon Hall-Array High-Resolution Platform Chiplet

- Monolithic high resolution ($500 \mu m$) 3D magnetic field sensor array (5×8 pixels)
- Seamless stacking of multiple chiplets for full-area, scalable Hall array module (chiplet size 3.9×2.4 mm)



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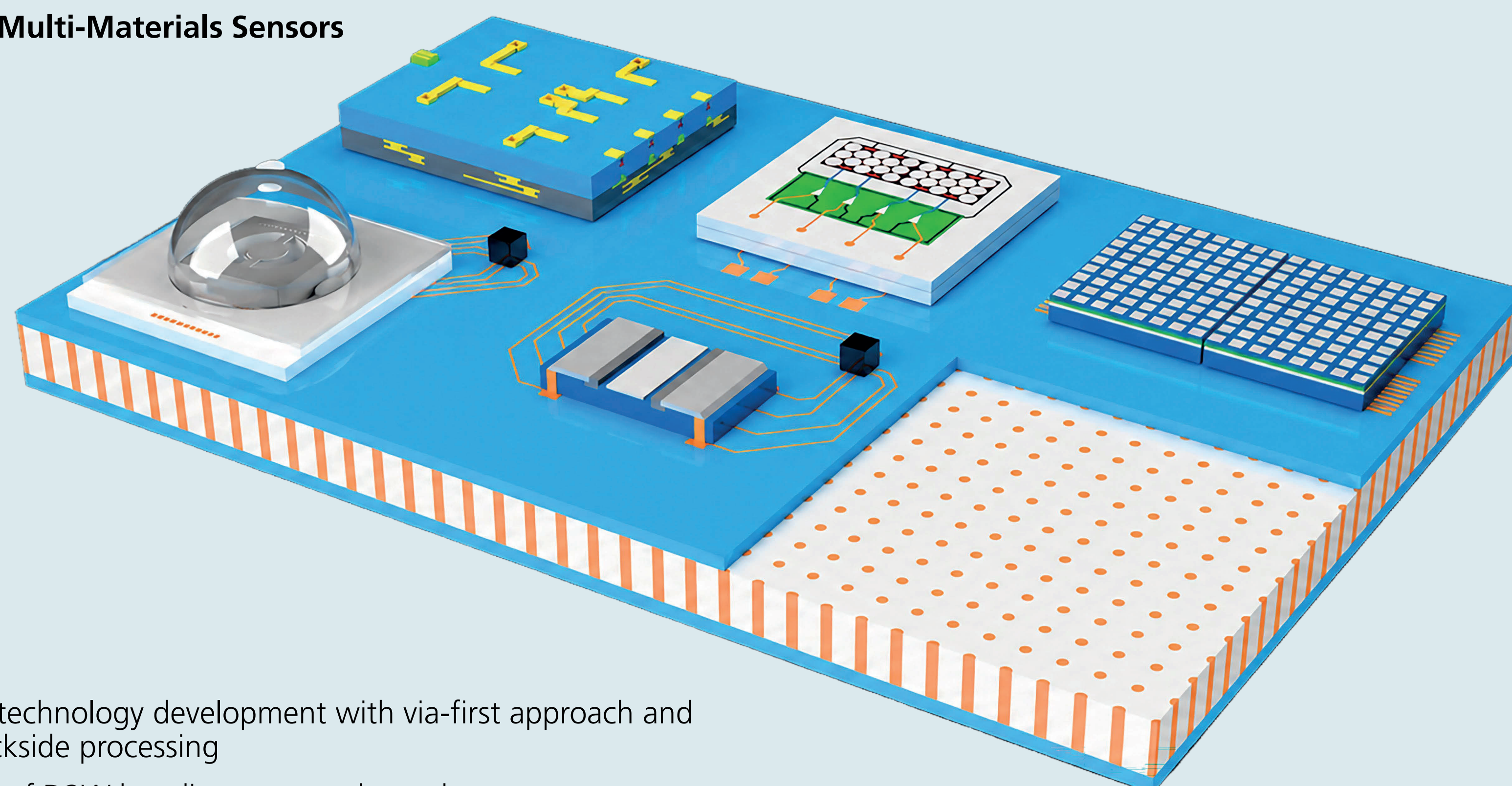
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Additional information

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Demonstrator Multi-Materials Sensors

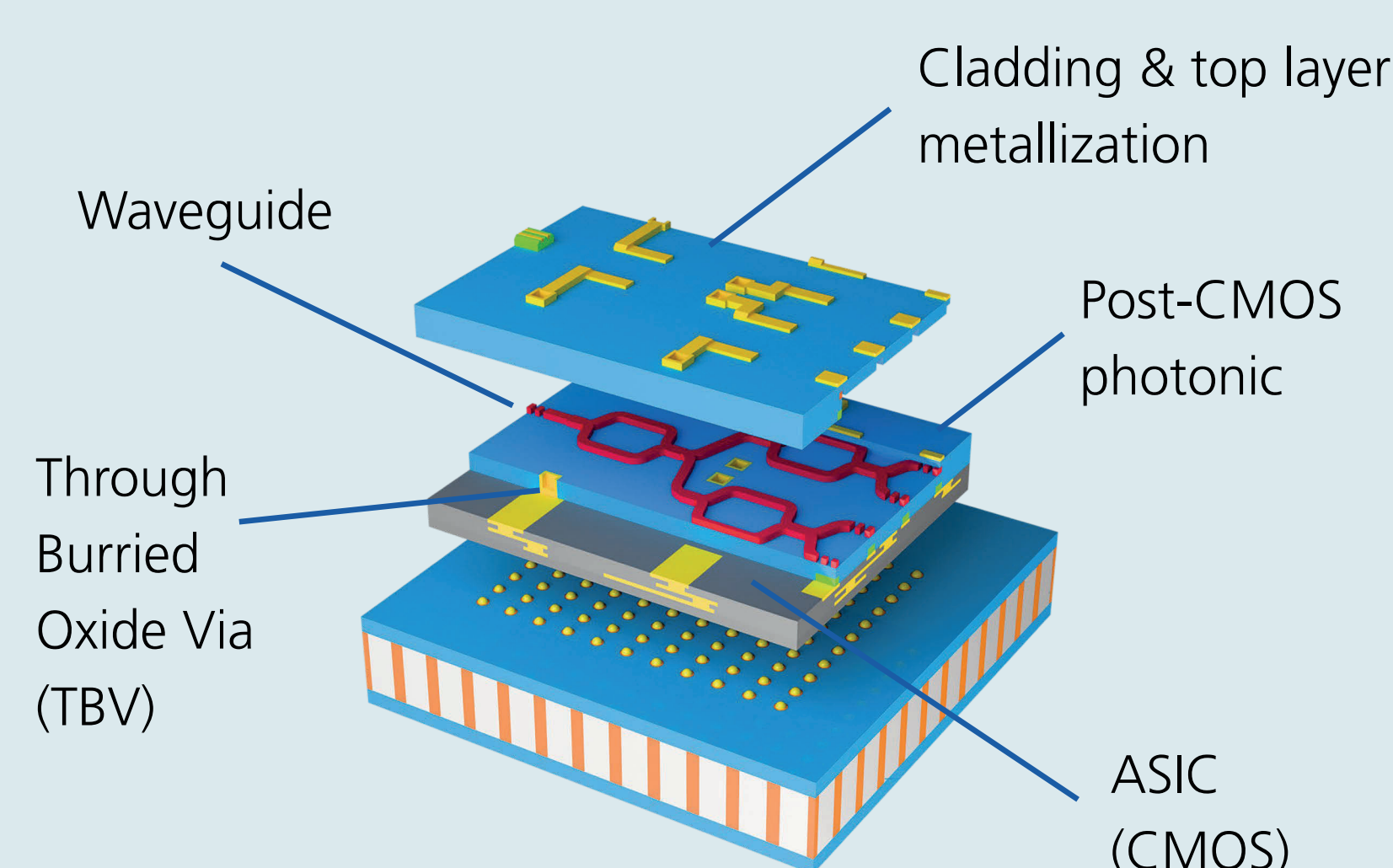


Interposer

- 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 ($300-400 \mu m$) to avoid temporary bonding processes

Opto 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



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)

