Leistungszentrum
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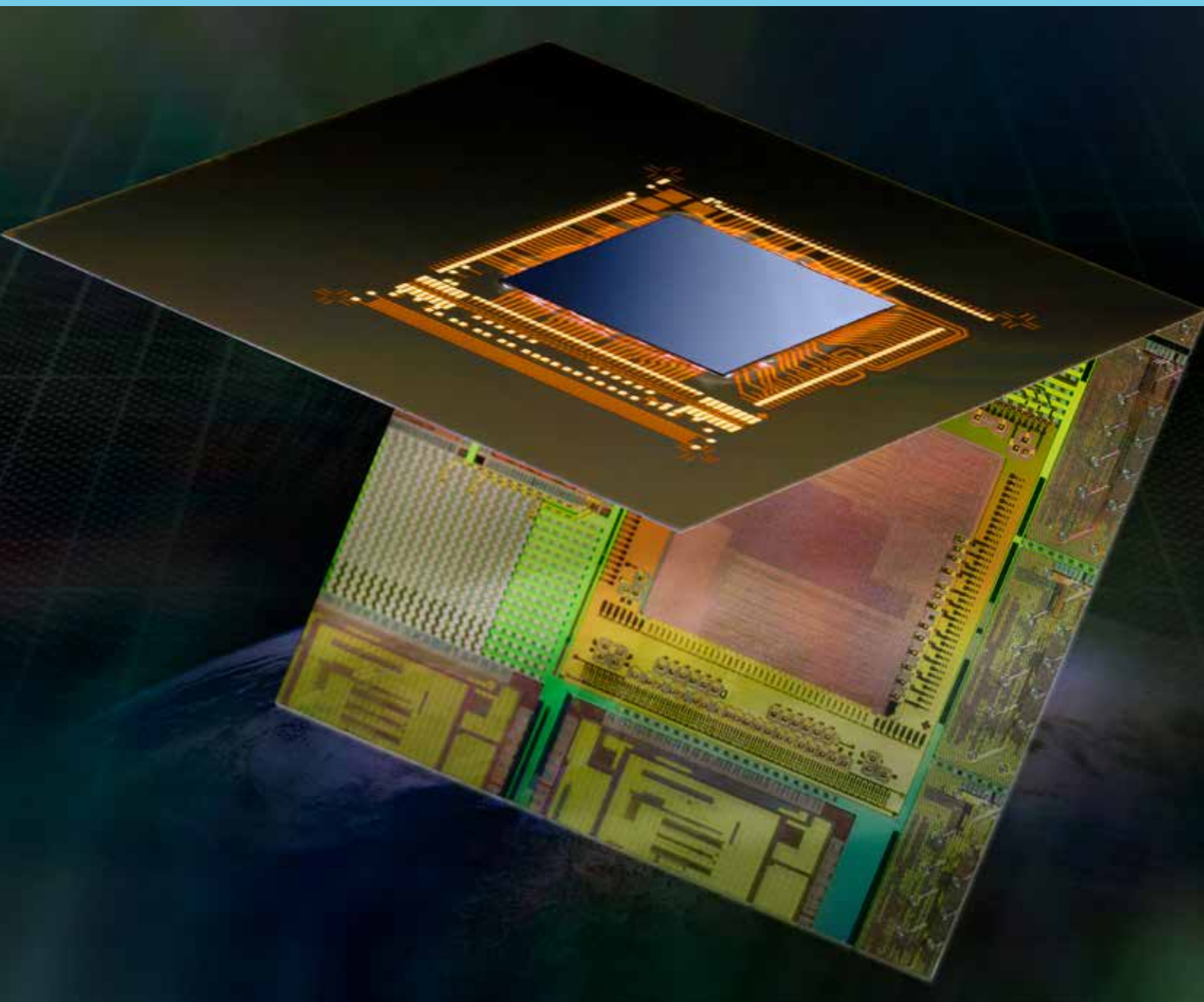
HIGH PERFORMANCE CENTER FUNCTIONAL INTEGRATION IN MICRO- AND NANOELECTRONICS PROJECTS



ENABLING NEW FUNCTIONALITIES IN MICRO- AND NANOELECTRONICS

High Performance Centers were established as a joint effort of Fraunhofer institutes, universities and other non-university research institutes targeting efficient transfer of excellent applied research to industry partners. These centers have clear topical as well as geographical focus, i.e. the participating research partners are located within the same region of Germany.

The High Performance Center »Functional Integration in Micro- and Nanoelectronics« combines the capabilities of the Fraunhofer Institutes IPMS, ENAS, IIS-EAS and IZM-ASSIS, which are well aligned along the value chain of microelectronics and microsystems R&D. Additionally, these competences are complemented by the expertise available at the Technische Universität Dresden (Dresden University of Technology), Technische Universität Chemnitz (Chemnitz University of Technology), and the Hochschule für Technik und Wirtschaft Dresden (Dresden University of Applied Sciences). This portfolio of competences is employed to address R&D segments of high relevance for our industry partners, such as:

- Novel materials to enable new functionalities
- Modular heterogeneous wafer systems
- Technology platform for ultrasonic sensors
- Integrated spectrometers and other optical systems employing nanostructured materials
- Sensors and actuators for integration into machine tools.

The close cooperation between the Fraunhofer institutes and research groups at the said universities ensures a fast transfer of technologies from a research context to the development phase and the final demonstrator.

This High Performance Center offers application- and customer-specific development as well as small series production of components, integrated circuits and system-in-package (SiP-) solutions for sensors and actuators. Cross-institutional use of R&D-expertise and –infrastructure enables systems solutions and demonstrators for sensors and actuators targeted at e.g. “Industry 4.0” applications, or more generally speaking, the internet of things (IoT).

EXPANDING THE JOINT TECHNOLOGY PLATFORM

The High Performance Center »Functional Integration in Micro- and Nanoelectronics« constitutes a unique platform across the participating institutes for the core competences

- Systems design & integration
- New functional materials
- Components and related fabrication technologies
- Assessment of reliability.

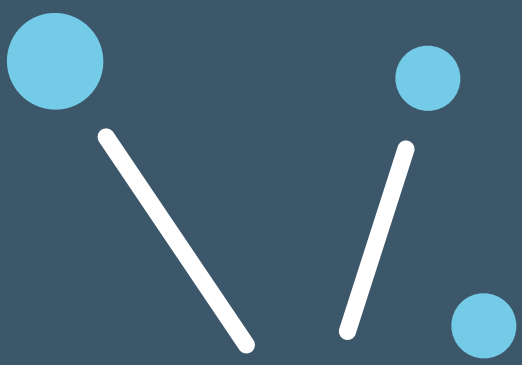
These capabilities will be expanded further in 2019/2020 through the below listed platform R&D projects, funded by the Free State of Saxony and the Fraunhofer Society:

- Structure-integrated wireless sensors for machine tools
- Platform for micromechanical ultrasonic transducers (MUT)
- Modular integration of thin heterogeneous sensor systems
- Test wafer hub – platform offering 300 mm test wafers for wafer-based technologies and products.

The recent advances in micro- and nanoelectronics as well as microsystems technology drive new approaches in the field of structure-integrated sensors and actuators for machine tools and manufacturing systems for industrial applications.

Non-contact ultrasound-based sensing gains importance in particular for sensors needed in the context of "Industry 4.0". Here, silicon MEMS-based (MEMS – microelectromechanical systems) ultrasonic transducers (MUT) offer significant advantages and open up new ways to build complex multi-element sensor systems, which will allow e.g. a 3D room survey.

For the cost-effective medium to large scale production of such microelectronics and MEMS based sensor systems, wafer-based fabrication and modular integration technologies are required for wafer sizes up to 300 mm. The last two of the above listed platform projects address exactly these topics and thus, rounding out the portfolio of core competences available at the High Performance Center.



STRUCTURE-INTEGRATED WIRELESS SENSORS FOR MACHINE TOOLS

For a self-organizing, user-oriented and demand-driven automated production (Industry 4.0), smart functionalities have to be integrated into mechanical engineering systems. To implement such functionalities, a large variety of connected, structure-integrates sensors and actuators will be required. These devices have to be robust combined with a small form factor and should be able to communicate via wireless data links.

A promising approach towards that goal is the functional and structural integration of microelectronic and micromechanical devices and subsystems into machine tools and components of manufacturing systems.

It is often challenging to achieve a process-controlled condition monitoring at hardly accessible positions inside the machines and constructions. Therefore, miniaturized, networked and energy-efficient information and communication technologies (ICT) have to be integrated into machine tool parts.

A joint research team from the High Performance Center »Functional Integration in Micro- and Nanoelectronics« and Fraunhofer IWU works together on the conception, engineering and test of structure-integrated sensor and actuator systems in machine parts. Here, exemplarily shown for a ball screw drive, a structure-integrated wireless sensor technology is implemented into a manufacturing system for advanced process control and status monitoring.

PROJECT DETAILS:

Concept:

- Providing a technology development platform to enable smart "Industry 4.0" functionalities in mechanical engineering systems implementing sensors and actuators
- Functional integration of microelectronic and micromechanical devices and subsystems into components of manufacturing systems
- Exemplary use case: "intelligent" ball screw drive with built-in sensor ring

R&D objectives:

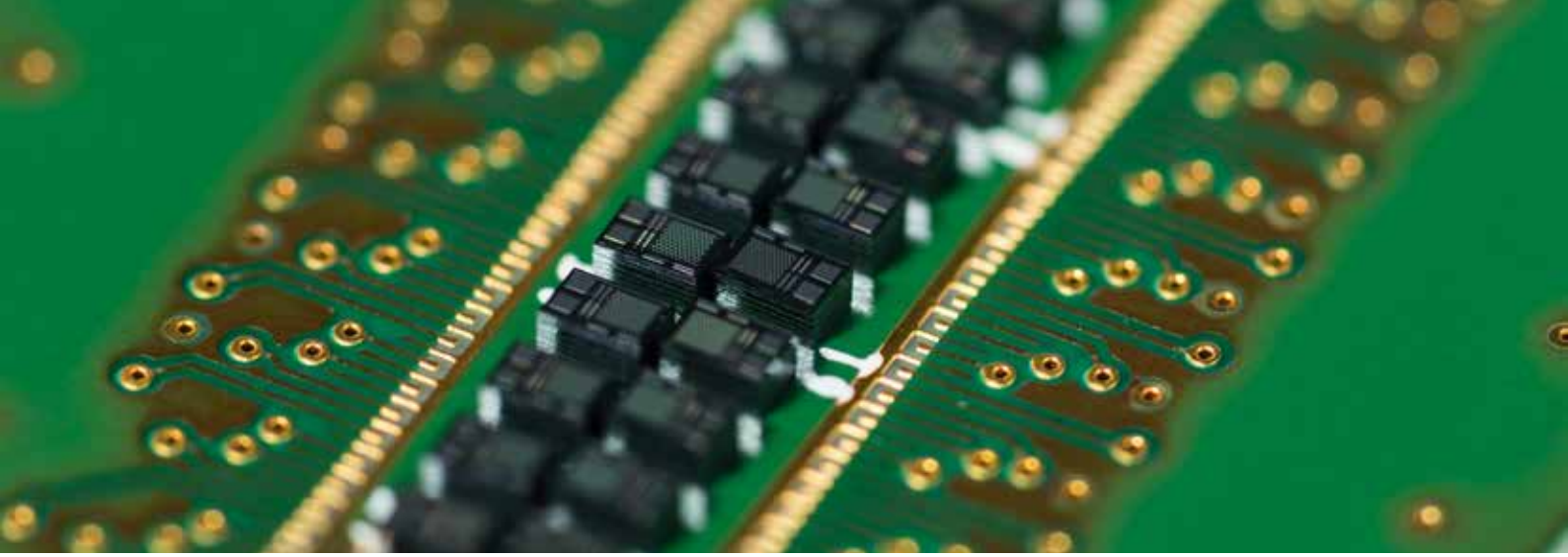
- Complete structural integration of all key electronic components through rigorous miniaturization
- Wireless data transmission out of a metal shielded environment
- Power supply and management for wireless IoT solutions
- Improved functionality, robustness and reliability

Added value:

- Increase in overall equipment effectiveness (OEE)
- Condition-dependent scheduling of maintenance intervals
- Better monitoring of production processes

Targeted applications:

- Condition monitoring
- Predictive maintenance
- Adaptive process control



PLATFORM FOR MICROMECHANICAL ULTRASONIC TRANSDUCERS

MEMS-based micromechanical ultrasonic transducers (MUT) offer significant advantages over conventional transducers based on established piezo-ceramics or composite materials. MUT-devices can be realized with a small footprint at low cost. They allow the convenient fabrication of multi-channel arrays as well as flexibility in the choice of the operating frequency for an optimal trade-off between detection range and sensitivity.

With the setup of a technology platform for MUT ultrasonic transducers the High Performance Center »Functional Integration in Micro- and Nanoelectronics« helps to further advance the development and the market introduction of MEMS-based ultrasonic transducers. Its offering extends from the realization of compact sensor systems based on this technology to the development of related fabrication technologies up to marketing support for different target applications.

Potential application areas are factory automation, automotive sensors, and medical diagnostics. Image generating MUT sensor systems are applicable to endoscopic high-resolution imaging or tamper-proof fingerprint sensors. Industrial robots and autonomous vehicles can be enabled to gather information of their surroundings including gestures of people, and hence to interact appropriately with its environment. The small form factor of MUT transducers further allows their integration into smartphones and wearables.

PROJECT DETAILS:

CONCEPT:

- Establish a technology platform for miniaturized and integrated MEMS ultrasonic transducers to open up new fields of application

R&D OBJECTIVES:

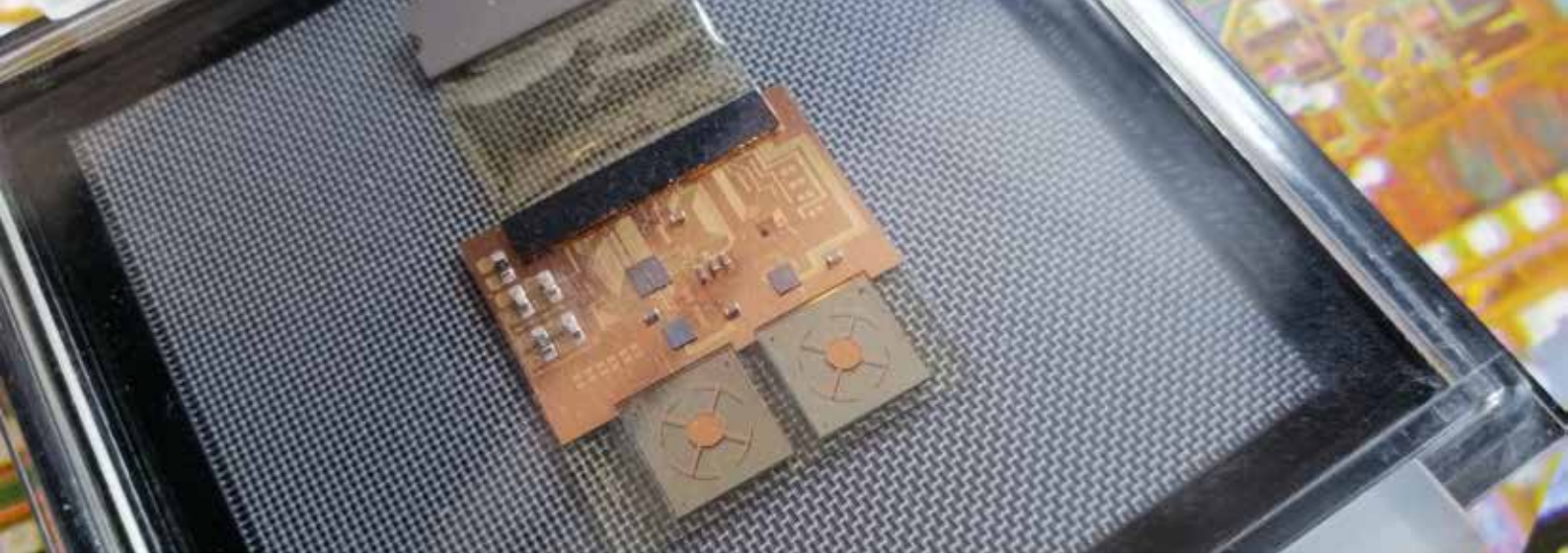
- Provision of technologies for the realization of MEMS ultrasonic transducer arrays with high channel count
- Design tools for application specific modifications and developments

ADDED VALUE:

- Providing access to next generation miniaturized MEMS-based integrated ultrasonic systems
- Coverage of the complete value chain from design to pilot production

TARGETED APPLICATIONS:

- Medical imaging for diagnostics and therapy
- High-resolution fingerprint sensors
- Gesture control



MODULAR INTEGRATION OF THIN HETEROGENEOUS SENSOR SYSTEMS

The objective of this project is the development of technologies for the realisation of heterogeneous systems for applications that require very small assembly heights (< 500 µm). The requirement for such a small thickness arises from applications such as portable in-cloth-integrated electronics (so called wearables) as well as fibre-plastic composites with integrated electronics.

One major challenge for the realisation of heterogeneous sensor systems with small assembly heights is given by the integration of devices with different manufacturing technologies such as: MEMS, MOEMS, integrated passive devices, electronics, and batteries. This project comprises research work on different concepts for the modular assembly of very thin, complex sensor systems as well as the technological implementation of these concepts.

Based on the project results, different applications such as smart cards, foldable electronics, fibre compound lightweight construction and wearables are addressed by customer-specific projects.

PROJECT DETAILS

CONCEPT:

- Thin, encapsulated systems
- Modular technology for
  - Wafer level packaging for rigid systems
  - Flexible assembly

R&D OBJECTIVES:

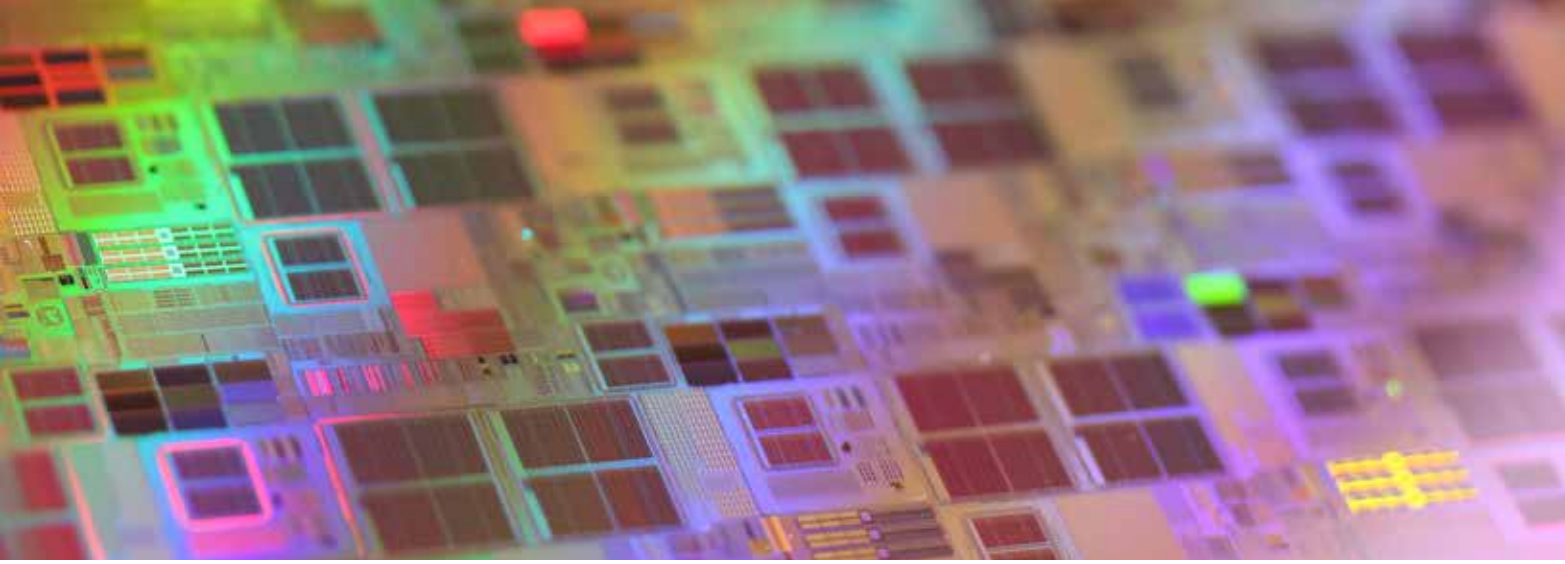
- Technologies for system integration
- Miniaturization of the assembly
- Reliability study

ADDED VALUE:

- Creation of a technology platform for thin and heterogeneous wafer level packages
- Scalability of assembly technology depending on system complexity
- Broad field of applications

TARGETED APPLICATIONS:

- Wearables, smart cards
- Fibre compound lightweight construction
- High performance, e.g. augmented- / virtual- / mixed-reality



TEST WAFER HUB

Creating new products based on 300 mm semiconductor technologies requires significant process development effort and therefore represents a costly and time-consuming challenge. Thus, the availability of 300 mm test wafers and process modules is essential for the development of new critical technology steps and components. Likewise, the supplier industry which provides tools, raw materials and consumables for the production of silicon microelectronics can benefit from access to a test environment close to manufacturing conditions in order to qualify new products.

The objective of the Test Wafer Hub project is to provide such a 300 mm test and evaluation platform. The spectrum ranges from suitable test wafers that can be adapted to customer-specific requirements to entire technology modules on established manufacturing equipment including subsequent leading edge characterizations and evaluations.

Based on their complementary resources in the areas of process technology development, application-specific know-how and analytics, Fraunhofer IPMS and Fraunhofer IZM-ASSID jointly offer sophisticated structured test vehicles and test substrates for 300 mm CMOS or advanced packaging development. The offering comprises on the one hand front-end-of-line (FEoL) technologies, such as high-k dielectrics and epitaxial Si(Ge) layers, and on the other hand back-end-of-line (BEoL) processes as well as advanced packaging where the metallization, especially by means of copper and its embedding, plays a role.

PROJECT DETAILS:

CONCEPT:

- Supporting customers in process and product development by providing test wafers
- Sharing complementary skills and resources at IZM-ASSID and IPMS

R&D OBJECTIVES:

- Expanding the portfolio of current test vehicles
- Improved connection of hardware and logistic resources
- Creation of a common marketing platform

ADDED VALUE:

- Joint offer for process development
- Offering both front-end and back-end technologies through a single point of contact
- Mutual tool backup between partners to improve delivery reliability of products and services

TARGETED APPLICATIONS:

- Test wafers for the development of materials and processes for 300 mm silicon fabs
- Material / process screening and development on 300 mm wafers
- Combination of front-end and back-end technologies for reduced development times

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