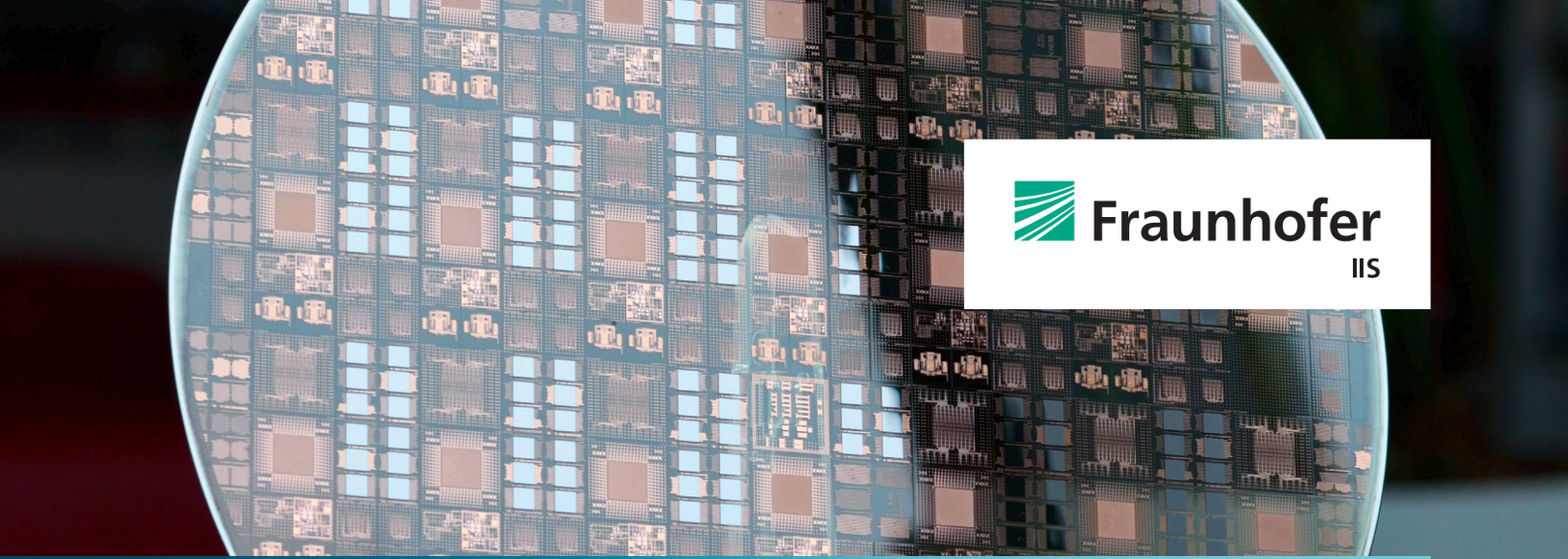


Fraunhofer IIS

Division Engineering of Adaptive Systems

Robust Chiplet Solutions for the Automotive and Industrial Sectors

Chiplet integration – systems, architectures, design (support)

Systems destined for use in the automotive and industrial sectors need to be powerful and especially robust, as they are exposed to extreme environmental conditions. In particular, the challenges posed by thermal cycling and mechanical stresses such as vibrations and oscillations place high demands on the materials and technologies used. In addition to the high performance and reliability requirements, these applications often face the challenge that they are only needed in comparatively small quantities.

Against this background the innovative chiplet approach offers great potential for the automotive and industrial sectors. The modular principle behind chiplets enables efficient design and production: individual components have to be produced only once and can then be flexibly combined to create tailored solutions.

By integrating various functional units, chiplet technology enhances performance through the opportunity to involve mixed processing nodes from major nodes down to 5nm, as well as more specific technologies such as SiGe and GaN. This offers major advantages when it comes to the cost-effective production of high-performance specialized chips.

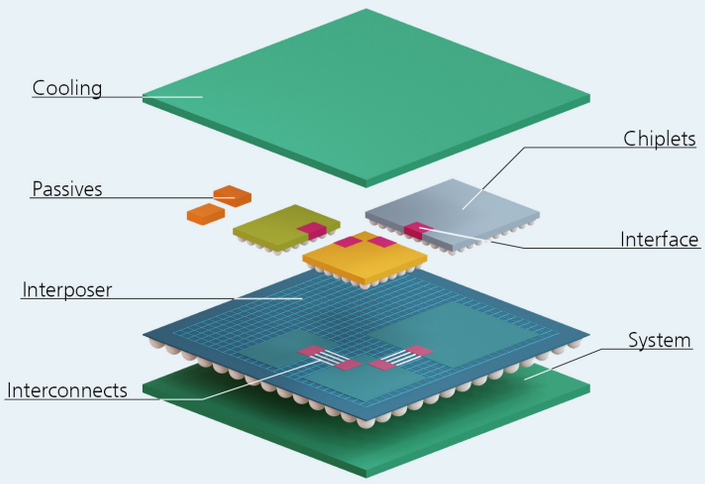
Fraunhofer IIS is researching specialized chiplet solutions that meet the requirements for long-term stability and reliability. Particularly with regard to chiplet architectures and design, Fraunhofer IIS supports you in utilizing the advantages of the chiplet approach from concept to prototype realization.

Your benefits

- Reduce development time and cost through (re-)use of available ICs
- Increase functionality with heterogeneous integration
- Open up new markets with lower volumes due to higher flexibility
- Overcome more-Moore limitations on semiconductor production level
- Get access to the European supply chain from package prototypes manufactured by Fraunhofer to small and midsize volumes produced by our partners
- Smaller packages with better ecological footprint and reduced resource usage

Our services – from concept to prototype realization

- System concepts and exploration
- Die-to-Die interface electronic development up to 5nm
- Power delivery concepts (e.g. in package regulators)
- Heat removal concepts (e.g. new materials)
- Robustness concepts
- Robustness tests (e.g. thermal cycling, mechanical stresses, vibrations, oscillations)
- Design support
- Bring-up and characterization



Circuit heterogeneity – key advantage and major challenge

Chiplets for automotive and industrial applications often call for several semiconductor technologies to meet different performance requirements. These can range from special CMOS variants that include high-voltage options to more advanced semiconductor materials such as GaN, SiC, or SiGe. This heterogeneity of the circuits used poses specific challenges in developing a robust chiplet solution.

Moreover, chiplet technologies often have a lower transistor density than advanced CMOS technologies, meaning a larger chip area is required for the same functionality – a particularly tough challenge for the protocol layer, which is required in addition to the purely electrical layer to ensure communication. Various protocols are currently under discussion, but these are often too complex or resource-intensive for specialized technologies with limited transistor density. That makes it necessary to develop greatly reduced protocols that are tailored to the requirements of these technologies and at the same time offer the required performance and efficiency.

Reliability tests under extreme conditions

Ensuring that the chiplet systems can withstand the extreme conditions in automotive and industrial manufacturing calls for extended load tests and other comprehensive testing. This includes thermal cycling and vibration tests, which may not have been carried out to this extent in the past. Modeling must also be refined with a view to simulating such systems precisely in advance and identifying potential weaknesses at an early stage. At our institute, this is achieved not only by further developing advanced simulation methods, but also by creating new material databases that take into account the special properties of the materials used.

Efficient design through ADK and ADF integration

To simplify the development of chiplets and ensure efficient design, we integrate all this data and the new methodologies into an assembly design kit (ADK) and into an assembly design flow (ADF). This guarantees that the systems meet the applications' requirements for both performance and robustness.

Chiplet Center of Excellence – shaping the future of electronics

Together with Fraunhofer IZM and Fraunhofer ENAS, Fraunhofer IIS has launched a groundbreaking research initiative in Dresden: the Chiplet Center of Excellence (CCoE). Its purpose is to partner with industry to drive forward the introduction of chiplet technology. The CCoE is dedicated to the future development of chiplet technology in Europe and spans an important bridge between chiplet research and its practical application in various industries, starting with the automotive sector.

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