IPCEI on Advanced Semiconductor Technologies - Technology Fields

AI Chips and Accelerators

The development of AI chips and accelerators “Made in Europe” boasts a tremendous potential to differentiate the local semiconductor and downstream industries from competitors worldwide as well as being beneficial to society at the same time. Addressing novel technologies for AI within an IPCEI AST reduces existing dependencies on third countries. The goal is not to compete with standard GPU architectures at small technology nodes but to further develop various other chip architectures with potential applications in AI, including (but not limited to) the edge, and to bring them into first industrial deployment. It is imperative to foster co-design of hard- and software in close cooperation with end-users of AI chips, to promote free and open standard instruction set architectures (ISA) and to foster the integration and usage of RISC-V technologies.

Within the scope of the IPCEI AST, novel AI-chip technologies, e.g., ASICs, logic chips, in-memory computing, memory chips and memristors or neuromorphic chips encompassing energy-efficient and secure solutions creating new market applications (e.g. in data centres and automation) are addressed.

Chiplets and Heterogenous Integration / Advanced Packaging

Chiplet technology, in combination with heterogenous integration and other advanced packaging technologies, generate a great opportunity to fundamentally increase the security of Europe’s supply and resilience. Including this field within IPCEI AST is aimed to reduce existing dependencies on third countries and to de-fragmentize current developments and bring them into first industrial deployment in Europe. The combination of these technologies can reduce reliance on chips produced on leading edge technology nodes and yield a unique selling point of the European semiconductor ecosystem by focusing on European strengths like collaborative approaches and expertise in mature technology nodes ≥ 22nm. However, it is necessary to follow a holistic approach and strengthen the capabilities of all relevant actors in Europe, from EDA, chip-design to manufacturing and beyond. Only by developing a broad and deep technology platform and strong standardization efforts can this be achieved.

The focus should lie on novel integration and packaging technologies incl. design addressing ASICs, DAO, logic chips, MCU, memory chips, interposers, and system-on-chip approaches. Reaching these objectives requires strong collaboration efforts. These efforts should not be limited to the development of fabrication technologies but should also encompass advancements in modularity, standardization processes, in automation and testing, which are prerequisites for the establishment of stable and versatile production capacities.

Disruptive Sensors for Autonomy

Europe has a strong position in the field of developing and producing sensors for a vast number of applications. Thus, this situation can be used to create within the IPCEI AST a unique selling point for Europe by developing the next generation of disruptive sensor technologies. Among others, bio-, quantum- or image sensors and sensor fusion systems acting more and more autonomously or contributing to needs for more autonomy in applications can be used to strengthen European assets and drive innovation in industrial, automotive and medical applications but also in the internet of things and beyond. This encompasses advancements of further technologies, e.g. DSP/DPU, LIDAR chips, IR sensors, MEMS,

chemical and bio sensors, quantum sensors as well as radar sensors. Thereby, co-development and integration of AI technologies and addressing energy efficiency, low latency as well as high security and trustworthiness should play a major role.

Photonic Integrated Circuits

Currently, Photonic Integrated Circuits (PIC) are at an early stage of industrialization and Europe holds a strong technologic pioneering position. The field boasts tremendous potential to accelerate data transfer and computation speed but lacks industry-wide standardization, integration/combination with standard CMOS solutions and suffers from overseas supply chain vulnerabilities.

The aim of the IPCEI AST is to de-fragmentize this technology field and to unfold the full potential of the latest disruptive innovations including: compound semiconductor photonic devices, coherent photonic transceivers, optical interconnects, co-packaged photonics and electronics, sensors, quantum photonics, and optical processing units (OPU). Thereby, the focus should lie on strengthening the ecosystem with conception, packaging and system integration following a holistic approach along the entire value chain to establish a competitive position, while reducing critical supply chain dependencies.

Power Electronics and Disruptive Energy Saving Solutions

For power electronics, the focus should be on disruptive developments of wide band gap devices such as GaN/SiC-based chips, addressing new device architectures and processes, full stack design for new product development (from transistor to system design), and 300 mm wafer production for GaN and SiC. In this regard, a clear distinction from activities in the IPCEI ME/CT is required. In addition, ultra-wide band gap-based devices are also addressed, so long as they will be ready for first industrial deployment within the timeframe of the IPCEI AST.

In the context of the increasing uptake of AI technologies, the boom of renewable energy production, and progressive electrification of mobility, the development in (ultra) wide bandgap power electronics will contribute to achieving greater energy efficiency in the management of energy production, conversion, and storage.

Secure Communication

In the IPCEI AST, developments of specifically secure and trustworthy communication chip technologies are addressed. They are crucial for critical infrastructure, data reliability, and safety as well as public safety. Addressed technologies encompass, among others, 6G integration, quantum-safe and free space optical communication as well as advanced photonics but also disruptive RF/microwave developments that are decidedly different from developments in previous and ongoing IPCEIs.

These technologies lay the foundation for hardware/software co-design which must occur in parallel to the IPCEI AST in order to achieve maximum impact for the European economy. Involvement of the entire value chain is necessary to accelerate innovation and ensure European leadership in this critical area.

Enabling Technologies

The semiconductor value chain encompasses much more than just the design and front-and-back-end manufacturing of the chips themselves. In this context, Europe has especially pioneered investment initiatives aiming at making Europe's chip industry more sustainable and positioning itself as a leader in green semiconductor manufacturing, creating a unique selling point. To successfully strengthen the European economy in the fields the IPCEI AST addresses, further steps in the value chain must be strengthened with view to their sustainability and beyond.

Essential steps such as EDA, core-IP, testing procedures and equipment, manufacturing equipment, and processes, as well as inputs (e.g. materials, chemicals, wafers...) are just as important within the semiconductor supply chain. Europe should focus its efforts on fields where it can become indispensable within global supply chains. To enable aforementioned technologies, it is necessary to reinforce and accelerate innovation in areas such as equipment, materials, processes, and design software (EDA).