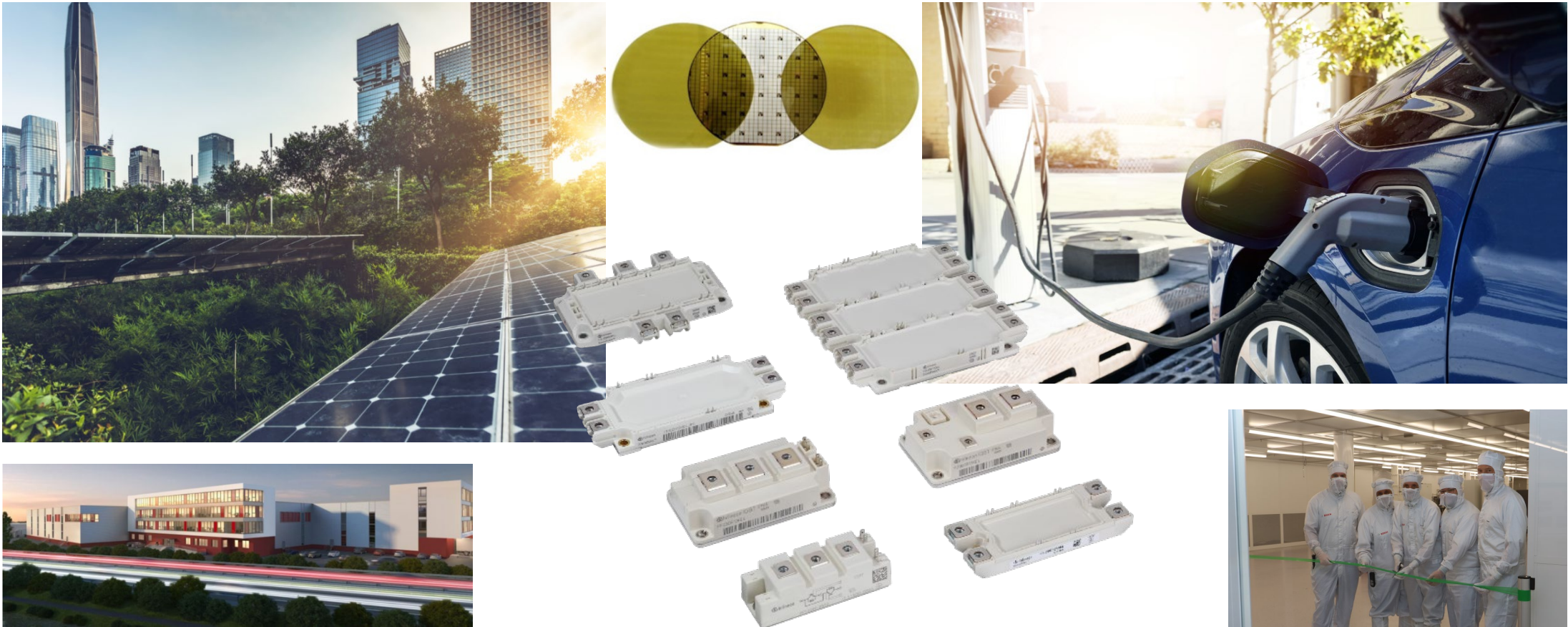


Technology Field 2: Power Semiconductors



 Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

 Federal Ministry
Republic of Austria
Digital and
Economic Affairs



Gefördert durch
 Bundesministerium
für Wirtschaft
und Energie
aufgrund eines Beschlusses
des Deutschen Bundestages

Technology Field 2: Power Semiconductors

PARTICIPANTS



BOSCH

elmos[®]



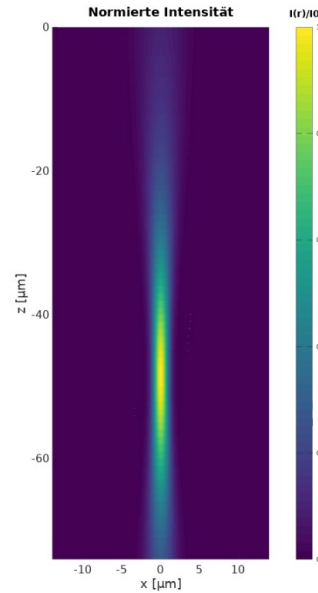
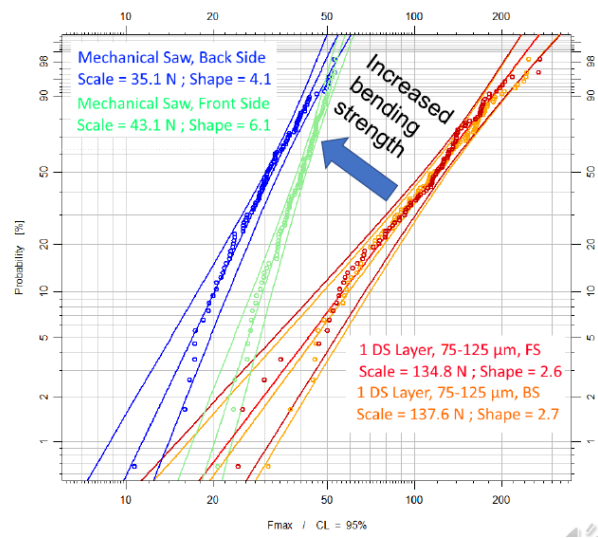
muRata
INNOVATOR IN ELECTRONICS

SEMIKRON
innovation+service



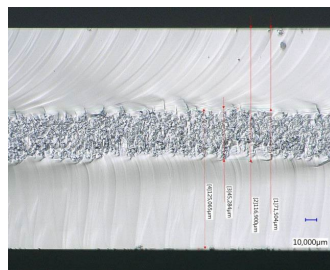
Technology Field 2: Power Semiconductors

DEVELOPMENT & COOPERATION



3D-Micromac – Selected Highlights in Power Semiconductors

- Design of a new optic setup for TLS-Dicing™ of Si wafers
- Simulation studies of the new optic
- Experimental investigations and comparison to simulation
- New setup leads to higher breaking strength of the separated dies resulting in higher reliability of devices in integrated systems and packages
- New optic kit available in the microDICE™ tool platform
- Currently, TLS technology is experiencing strong growth impulses due to the great success in the PV market.
- This should also convince even more decision makers in the semiconductor market of the potential of this excellent technology.
- Strong growth of activities in overall semiconductor market. Therefore tool platforms were enlarged with additional process steps.



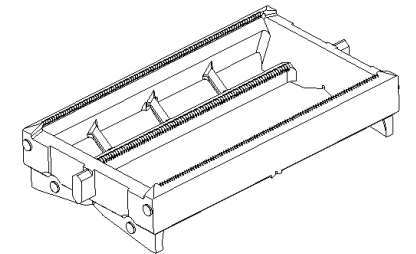
Technology Field 2: Power Semiconductors



DEVELOPMENT & COOPERATION

AP&S – Selected highlights in Power Semiconductors

- Development of a new 300mm platform responding to the current needs of the semiconductor industry (wide wafer thickness range & multi process solvent and acids in combination)
- Development of an automation concept for the stacking and handling of FOUP / carriers / boxes as well as the interfaces to the highly automated FABs
- Expansion of a clean room and a UHPW system for measurement and qualification of the wet process systems prior delivery -> data & statistics generation for the cleanliness of the systems before and after delivery as well as about the efficiency of the clean room + UHPW during the machine production
- Concept and development of a new process carrier with optimized surface conditions and pre conditioning procedure
- Implementation of "artificial intelligence" in the semiconductor machines to improve predictive maintenance, to reduce unscheduled down time and to increase the uptime



Technology Field 2: Power Semiconductors

AT&S

DEVELOPMENT & COOPERATION

AT&S – Selected Highlights in Power Semiconductors



Sputtering Tool, Left Copper PVD module / Right Titanium PVD module



Copper recycling, pilot phase

- Functional cores for power efficient substrates and packages:
Development of a concept to integrate magnetic materials in cores was carried out; prototypes were manufactured and reliability tests were done; various equipment for FID phase for power cores are installed according to our plan
- Installation of a sputtering tool:
Equipment installed and still in evaluation; format size on glass carrier up to 625 x 625 mm; used for metallic seed layer for non-copper terminated components and ultra-fine line structures, in addition for deep reactive ion etching for desmear and/or via formation
- Air cavities for high data transmission rates & low signal loss:
Development of dedicated air cavity concepts to substitute SotA dielectric waveguides by using air cavities (e.g. for feeding lines); environment friendly integration concept for 5G telecommunication applications; reduce signal transmission losses and power consumption.
- Improved sustainable Copper recycling:
The pilot phase for the copper recycling system is almost completed. The installation of the industrial scale unit is scheduled in 2022 leading to a copper recovery over 80%

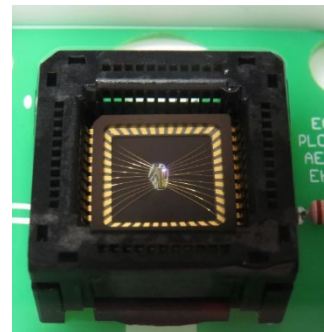
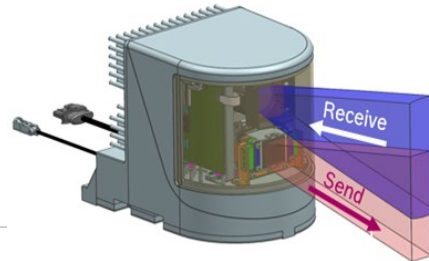
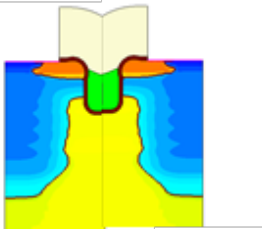
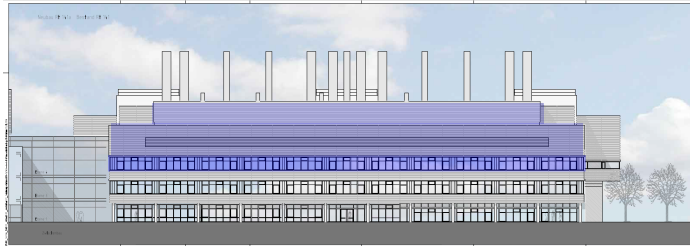
Technology Field 2: Power Semiconductors



DEVELOPMENT & COOPERATION

Bosch – Selected Highlights in Power Semiconductors (as of end of 2020, no further update due to project completion)

- Upgrade and extension of the clean-room infrastructure in Reutlingen for a 150 mm SiC Pilot line completed
- Joint development and installation of specific SiC process equipment for the pilot-line to be completed in 2020
- Development of a new SiC technology for highly robust automotive power electronics applications, first evaluation samples to be expected shortly
- Joint development and installation of 300mm mixed-signal processing equipment at the new fab in Dresden to be completed by end of 2020
- Development of highly innovative components for autonomous driving functions and eMobility applications, first evaluation samples expected in 2021





Technology Field 2: Power Semiconductors

DEVELOPMENT & COOPERATION

Elmos – Selected Highlights in Power Semiconductors

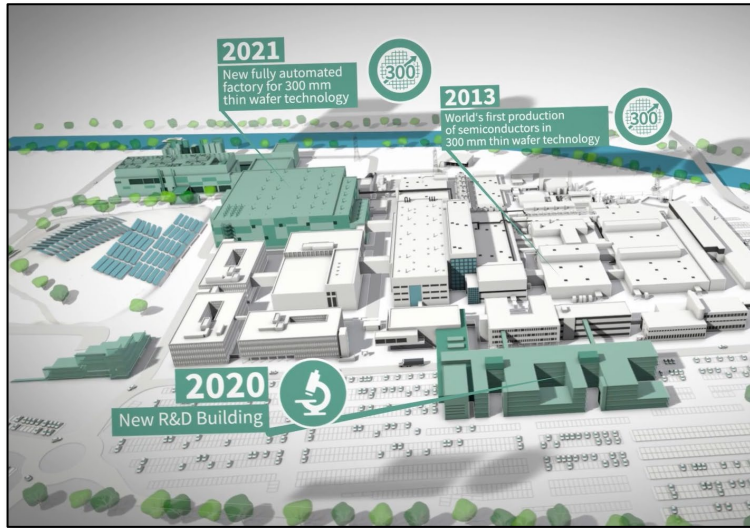


- First samples of advanced intelligent motor control available and verified
- Start of FID in 2022
- Ongoing R&D for failure analysis in synergy with TF 3
- Due to the good cooperation with an external development partner (Germany) to perform R&D on intelligent motor control software, Elmos has taken over Online Engineering beginning of 2021
- Elmos will finalize the project in TF2 by end of 2021

Technology Field 2: Power Semiconductors



IPCEI location: New Fab in Villach



DEVELOPMENT & COOPERATION

Infineon Austria – Selected Highlights in Power Semiconductors

- BeforeFID phase for all relevant subtasks on track and close to transfer to withinFID phase according to plan
- Clear progress of subtask 3 at advanced GaN-on-Si high-voltage epi stack with superior leakage current performance
- Improved performance of subtask 2 SiC technology on 150mm wafers achieved
- Process window fine tuning and technology stabilization of IPCEI ME relevant MOSFET technologies in subtask 1
- First results to understand physical and chemical failure modes for Subtask 4 Smart rectifier
- Equipment installation of relevant IPCEI ME inno tools in new Fab on track
- Spill Over activities in full progress, networking with new partners successfully initiated
- First collaboration projects started

Technology Field 2: Power Semiconductors

DEVELOPMENT & COOPERATION



➤ CEA-LETI – Selected Highlights in Power Semiconductors

- In collaboration with ST
 - Development of GaN/Si 200mm process for 650V diodes and transistors
 - Development of power interconnections with low parasitic impedance
- In collaboration with MURATA
 - Evaluation of novel polymer dielectrics for high FoM capacitors

Technology Field 2: Power Semiconductors

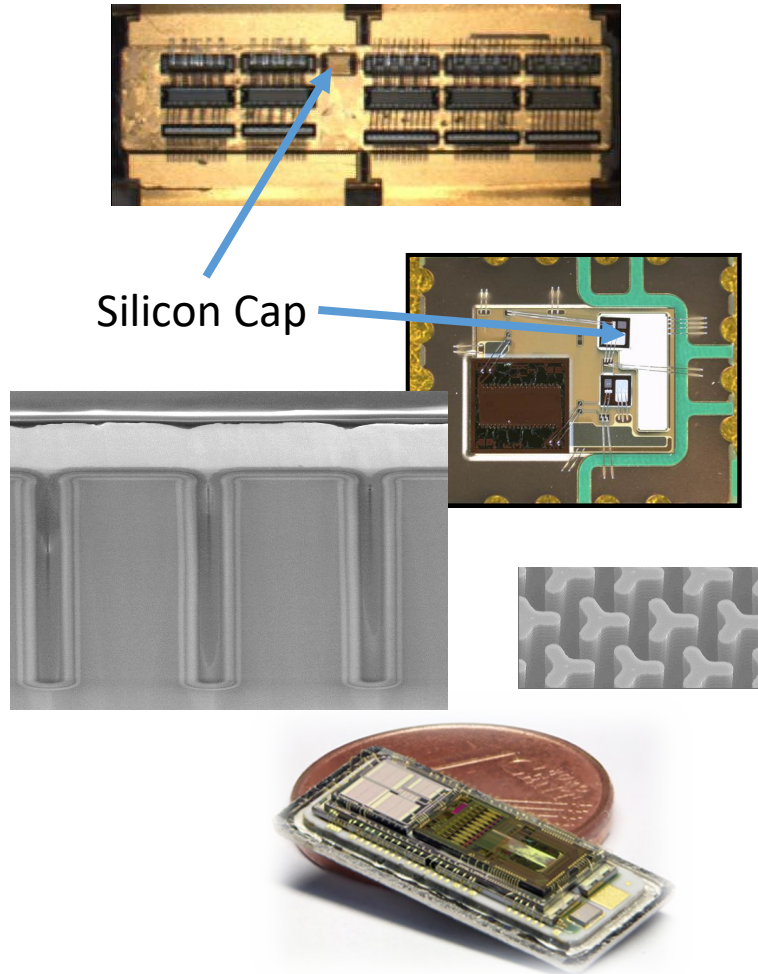


DEVELOPMENT & COOPERATION

➤ Murata – Selected Highlights in Power Semiconductors

- Development of new 3D structures for high density Silicon capacitors targeting more than $1.5 \mu\text{F}/\text{mm}^2$, industrialization starting in 2021!
- Ultra thin components down to $30\mu\text{m}$ with first samples shared with adopters in 2021
- Development of 3D Silicon capacitors with breakdown voltages above 1000V to be integrated into high power electronic modules
- Optimization of structures with very low parasitics for power applications in X-EV applications
- Optimization of components structures to increase reliability,

- Collaboration with labs : CEA-Leti, Ampere, LTM...
and companies : Valeo, APSI3D, Schlumberger, Air Liquide...



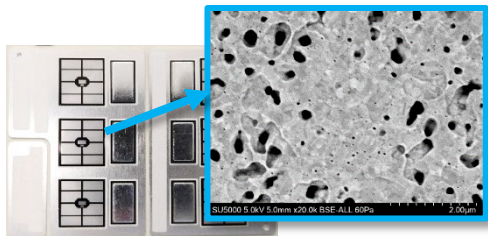
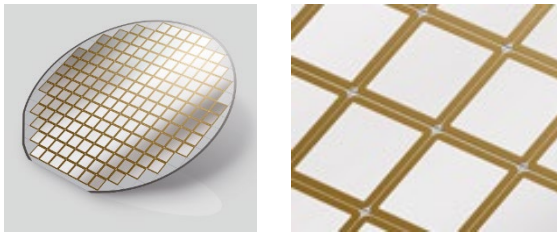
Technology Field 2: Power Semiconductors



DEVELOPMENT & COOPERATION

➤ SEMIKRON – Selected Highlights in Power Semiconductors

- Ongoing R&D work for power module assembly with double sided sintered Si and SiC chips; focus on the implementation of new process routes, material and process optimization
- Cooperation among several TF2, RTO and university partners towards more efficient and reliable power semiconductor technologies based on novel process technologies and materials.
- R&D activity towards a Si thin wafer freewheeling diode; Clean room preparation finished and equipment installation ongoing; first 1200V samples show promising electrical and reliability results



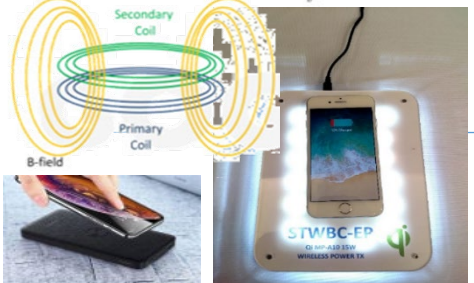
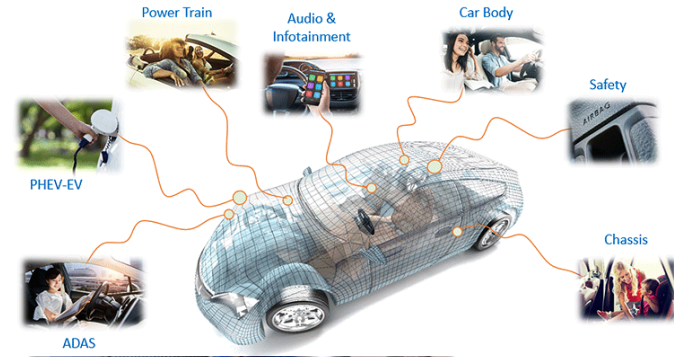
Technology Field 2: Power Semiconductor



DEVELOPMENT & COOPERATION

➤ STMicroelectronics – Selected Highlights

- Development of the new products based on BCD technology platform: wireless battery charger, power management solutions for data storage and computers, products based on galvanic isolation, gate drivers; product designed for safety relevant application (Braking EPS and steering), ADAS applications, BMS and motor control.
- New technology perimeters and IPs to extend application field and improve competitiveness (e.g. 18V PMOS high performance in BCD9s, Top Power Metal for embedded Die in BCD9s using SiN interposer solution).
- Feasibility study for next generation of BCD technology with new HV components. Started the development of BCD technology at 40nm with new HV components.
- Building and facilities in the new 300mm Fab in Agrate Brianza; smart manufacturing (i.e. Industry 4.0 concepts) and process robustness in the other fabs.
- Passive technologies: 4 copper metallization option has been introduced.
- Power GaN technologies: Epitaxy reactor and its peripherals have been installed in Tours site. First tests have demonstrated encouraging preliminary results.
- RF GaN: design optimization, technology development based on new enabling process step and equipment availability
- Development of new Si-based power technology and devices for automotive and industrial applications: low voltage MOSFET with double gate, IGBT Narrow MESA, devices in MDMESH technology
- Yield improvement and enabling tools on SiC MOSFET Gen3 and Silver Generation 1200V SiC diode. Technology development for a new generation of SiC PMOS (Gen.4) based on new enabling processes.
- R&D activities and preparatory work for 6-inch new pilot line for SiC substrate
- New package development for Power Module and Intelligent Power Module

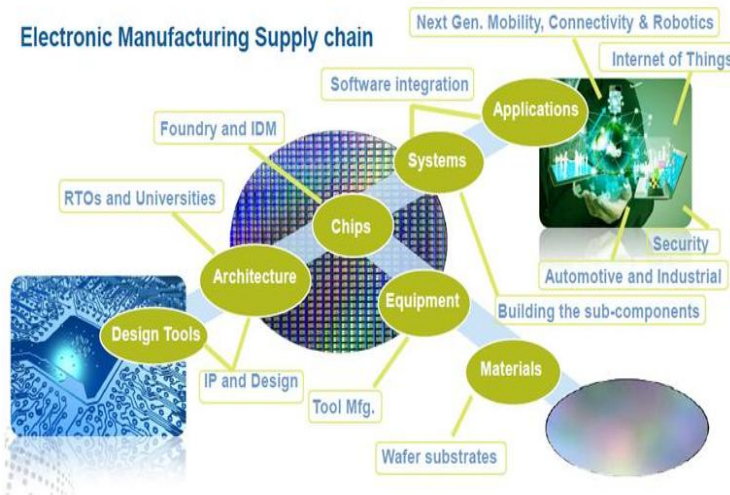


Status Technology Field 2: Power Semiconductors

➤ X-FAB Germany – Selected Highlights in Power Semiconductors



- Planned goals to topics like tool monitoring, quality assurance, advanced process control, yield assurance methods, and data analyzing systems are achieved to enable higher flexibility of highly diversified products in manufacturing.
- Development of production logistics methods progressed which help to expand existing processes of the logistic control and control system in order to meet the requirements of a highly diversified product and technology landscape.
- The process capabilities for the subject of tungsten metal deposition were examined. This required numerous investigations into the physical integrity of structures.
- Completion of a complex qualification of the inspection system, which provides testing of fault detection in various classes. In addition to successfully passing the qualification test, the submission of various proofs for the correct and complete administration of a production plant is a prerequisite for the plant to be approved for the production and development of technologies.



Technology Field 2: Power Semiconductors

SUMMARY DEVELOPMENT & COOPERATION

IPCEI created significant progress in the field of power semiconductors in Europe by

- Advancing new technologies and products based on wide bandgap materials, SiC and GaN, to state of market readiness
- Expanding leading edge manufacturing capabilities and capacities on 300mm for silicon based power semiconductors
- Creating synergies between semiconductor frontend and assembly & packaging (also called backend) technologies leading to unparalleled knowhow
- Increasing reliability of devices in integrated systems and packages
- Increasing sustainability of frontend and backend processes
- Implementing Artificial Intelligence in semiconductor equipment, manufacturing (Industry 4.0 concepts) and testing
- Fostering collaboration along the value chain

Technology Field 2: Power Semiconductors

COVID-19 impact

- Due to the continuing sharp rise in incidence, business travel will continue to be severely restricted. However, communication can take place well via the established digital options.
 - Conferences should first be attended virtually, if possible.
 - Only "business essential" trips should be made if there is no alternative.
 - On-site appointments must be taken over by local employees
 - When equipment is ready to be delivered to customers, a "pre-approval" by the end customer would be enormously important. However, pre-tests, training (together with the customer) etc. currently have to be completely omitted.
- No significant impact on CEA-LETI activities in 2021
- Moderate business growth in 2021 with strong reduced direct customer contact (mainly online meetings) as well as strong reduced trade fair activities. Enlarged delivery times due to shortage of material supply.
- Chip shortage: supply chain disruptions due to COVID-19 and additional natural disasters limit supply, while home office increases demand.