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IMS

FRAUNHOFER INSTITUTE FOR MICROELECTRONIC CIRCUITS AND SYSTEMS

Programme Inter Carnot Fraunhofer

HOTMOS

High temperature SOI CMOS technology platform for applications up to 250°C

The challenge:
The operation temperature of microelectronic devices increases

The operation temperatures for microelectronic devices are steadily increasing due to challenging applications. Robust electronics for harsh environments are essential for the exploration and exploitation of new energy supplies, production processes to conserve natural resources or to improve energy efficiency in automotive and aerospace. While some years ago 125°C was considered the maximum required temperature in automotive application, today's customers ask for 150°C and even 175°C. The demand for energy efficiency pushes the microelectronic technology industry to develop high performance power electronics systems. Whether for niche or high volume markets, power electronic devices must deliver high performance in terms of compactness, reliability and efficiency.

The recent availability of power devices based on GaN and SiC offers the potential for making significant progress since they can be operated at temperatures beyond 200°C, increasing the overall system performance. However, in order to exploit the high temperature capability of these new power devices the CMOS (Complementary metal oxide semi-conductor) control electronics must also be able to operate at these high temperatures.

Our vision:
High-temperature, high performance microelectronic circuits

Within HOTMOS a highly integrated high-temperature Silicon-On-Insulator (SOI) CMOS process which enables highly integrated embedded systems for application temperatures up to 250°C will be developed.

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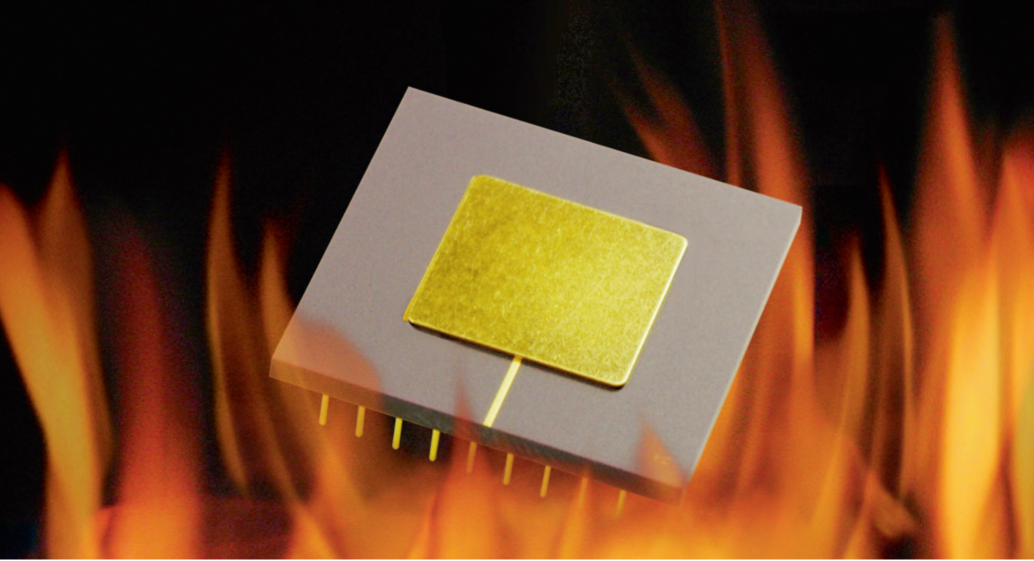

Our innovation:
High temperature gate drivers for GaN and SiC power devices

HOTMOS will provide a high temperature SOI-CMOS process with 0.35µm feature size for temperatures up to 250°C. The new process will allow a gate density of about 8500 gates/mm^2.
High reliability of the interconnections will be provided by employing Tungsten for the metal lines. Tungsten is not prone to electromigration because of high activation energies for material transport along the electron current.
To enable efficient and reliable circuit design for the extended temperature range improved device models will be developed that take the specific features of SOI, like reduced leakage currents and self heating aspects, into account. Such models today are only built for temperatures well below 200°C. A reliable model for the full temperature and voltage range will be available at the end of HOTMOS. Using 0.35µm high temperature technology will allow to develop high temperature gate drivers for GaN power devices. These drivers consider the specific drive requirements for GaN like reduced maximum gate voltage, small gate capacities, low threshold voltage. The high integration density of the 0.35µm SOI-CMOS process allows intelligent and compact drivers including on-chip control, power and fault management. The combination of SOI-CMOS and GaN power devices enables efficient and compact power modules.

In contrast to technologies available on the market today, the results of the HOTMOS project will provide:

- SOI-CMOS technology with reduced feature size (0.35µm design rules, which allow high integration)
- reprogrammable non volatile memories (EEPROM)
- one time programmable (OTP) devices
- Tungsten metallisation, for high reliability operation at high temperatures
- dedicated gate driver for GaN power devices

A complete Process Development Kit (PDK) including precise modelling of the devices over the whole temperature range from -40°C to 250°C will be available at the end of HOTMOS. The process will be open for foundry service for external design houses.

Our know-how:
High temperature technology and circuits

Fraunhofer IMS has long time experience with (SOI)-CMOS process and device development as well as mixed-signal circuit design for harsh environments. It operates a cleanroom for 200mm wafer processing. CEA-LETI has many years of experience in (SOI-)CMOS device modelling, wide band gap materials like SiC and GaN and design of specific drivers for these devices.

Our advantage:
Synergic partners at your service

The partners in this project cover a broad range of technologies in the field of high temperature and power electronics. This ranges on the CMOS side from device modelling and process integration to mixed signal circuit design and CMOS wafer processing. On the side of wide band gap materials (SiC and GaN) the whole range from power device development to drive circuit design is available. In addition packaging solutions for high temperature applications are also a strong focus of the partners.

The partnership of Fraunhofer IMS and CEA-LETI makes use of synergies by their complementary strengths and technology basis to address new markets and applications in the field of high temperature electronics.

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