PRESS RELEASE

Taming AI's hunger for data: Using the smallest technology nodes for energy-efficient AI

Artificial intelligence works fast, but its energy consumption is growing rapidly. A German-Taiwanese research team is now developing a solution: new memory for leading chip technologies smaller than 3 nm. These innovative nanosheet devices enable computing operations directly in memory, thereby drastically reducing energy consumption. They are based on ferroelectric field-effect transistors (FeMFETs) made from hafnium oxide, which are particularly efficient. With a joint research program, Fraunhofer IPMS, Fraunhofer IMWS, and the Taiwanese research institute TSRI are laying the foundation for the next generation of energy-efficient AI chips – from smartphones and automobiles to medical devices.

Given the rapidly growing demand for artificial intelligence (AI) and neuromorphic computing, the energy consumption of data centers and edge systems is increasing dramatically. A key bottleneck is the transfer of data between main memory and the computing unit. A joint German-Taiwanese project aims to address precisely this issue: innovative memory technology will enable computing "directly in memory", with significantly lower latency and energy consumption.

"We are designing a platform that more closely links the memory technology and computing power of state-of-the-art chips. This opens new possibilities for AI systems while reducing energy consumption," says Dr. Maximilian Lederer, project manager at Fraunhofer IPMS.

Hafnium oxide-based ferroelectric FETs (FeFETs) are considered particularly suitable for this purpose: thanks to thin hafnium oxide layers, the technology can be integrated into modern semiconductor processes. In addition, these components operate capacitively (rather than resistively) and thus consume up to about 100 times less energy in embedded systems than comparable non-volatile memory solutions.

The goal of the collaboration is to establish a 300 mm research line that develops memory not only for consumer applications, but also for automotive, industrial, and medical technology.

"The German-Taiwanese cooperation combines key competencies – from material development and high-resolution material characterization to state-of-the-art device architectures. Together, we are creating a platform for the next generation of energy-saving memory technologies," adds Dr. Chien-Nan Liu, Director General of the Taiwan Semiconductor Research Institute, National Institutes of Applied Research (TSRI, NIAR).

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About Fraunhofer IPMS

Fraunhofer IPMS is a leading international research and development service provider for electronic and photonic microsystems in the application fields of Smart Industrial Solutions, Bio and Health, Mobility as well as Green and Sustainable Microelectronics. Research focuses on customer-specific miniaturized sensors and actuators, MEMS systems, microdisplays and integrated circuits as well as wireless and wired data communication. Services range from consulting and design to process development and pilot series production. With the Center Nanoelectronic Technologies (CNT), Fraunhofer IPMS offers applied research on 300 mm wafers for microchip producers, suppliers, device manufacturers and R&D partners.

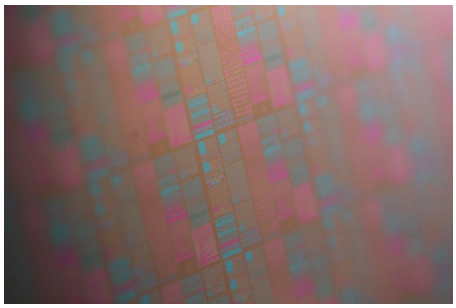
About TSRI, NIAR

The Taiwan Semiconductor Research Institute (TSRI) under the National Institutes of Applied Research (NIAR) is Taiwan's national research center dedicated to advancing semiconductor technologies and cultivating next-generation talent. TSRI provides advanced R&D platforms and integrated services in semiconductor device design, fabrication, and testing, bridging academia and industry to accelerate innovation. Through strategic collaborations with global research organizations and industrial partners, TSRI strengthens Taiwan's role in the international semiconductor ecosystem and drives sustainable technological development.

About Fraunhofer IMWS

The Fraunhofer Institute for Microstructure of Materials and Systems IMWS offers microstructure-based diagnostics and technology development for innovative materials, components and systems. Building on its core competencies in high-performance microstructure analysis and microstructure-based materials design, the Institute investigates questions of functionality and application performance as well as the reliability, safety and service life of materials used in various market and business areas with major importance for social and economic development. For its partners in industry and the public sector, Fraunhofer IMWS enables the accelerated development of new materials, increases material efficiency and cost-effectiveness, and helps to conserve resources. In doing so, the Institute contributes to ensuring the innovative capacity of key future fields and to sustainability as the greatest challenge of the 21st century.

Images



Close-up (Dieshot) of ferroelectric memory chips on a 300 mm wafer from Fraunhofer IPMS.