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Press release

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Research projects
Electrical engineering, Information technology, Materials sciences
transregional, national

Pioneering energy-efficient AI with innovative ferroelectric technology

As artificial intelligence (AI) becomes increasingly integrated into sectors such as healthcare, autonomous vehicles and smart cities, traditional computing architectures face significant limitations in processing speed and energy efficiency. The "ViTFOX" project unites eight partners from Europe and Korea to create a groundbreaking Vision Transformer architecture based on ferroelectric oxide, allowing for significant reductions in energy consumption and latency. Unlike traditional architectures, which often rely on separate memory and processing units, ViTFOX aims to integrate computing directly into memory for exceptional energy efficiency. The EU is funding the project with € 1.5 million.

Traditional computing architectures face significant limitations in processing speed and energy efficiency when handling the vast amounts of data generated in today's digital landscape. Neuromorphic systems, systems that imitate the working method of the human brain, leverage specialized hardware, such as ferroelectric devices, to execute computations more efficiently and effectively, enabling real-time processing and decision-making. This approach not only enhances the performance of AI applications, such as image recognition and natural language processing, but also reduces energy consumption, making it a sustainable solution for future technology.

The ViTFOX project is at the forefront of advancing AI by developing energy-efficient neuromorphic computing systems. At the heart of the ViTFOX project is the Vision Transformer (ViT) architecture, which is designed to perform complex AI computations while consuming less energy. Vision Transformers are a type of neural network architecture that excels in image recognition tasks by processing visual data more effectively than traditional methods. The project aims to create a ViT that utilizes ferroelectric oxide materials to achieve exceptional energy efficiency of over 50 TOPS/W, which is crucial for AI-powered edge applications. "We aim to push the boundaries of current technology by developing hardware-software co-optimization platforms, novel materials, and integration methods that will not only enhance AI performance but also ensure sustainability in energy consumption, " says Prof. Dr. Thomas Kämpfe, project leader at Fraunhofer IPMS, one of the partners in the consortium. "We want to significantly contribute to the semiconductor industry, addressing both the technical challenges of emerging memory technologies and the societal need for efficient computing solutions," he adds.

Collaboration between Europe and Korea to advance the state-of-the-art technology

In total, the ViTFOX consortium consists of eight partners from leading research institutions, universities and technology development laboratories from Europe and Korea. The project aims to strengthen the leading position of EU and Korea in Hafnia-based Silicon-compatible ferroelectric electronics, a field which was pioneered in Europe and has attracted significant interest from Korean researchers. The project will advance the technology beyond the state of the art in the whole value chain from materials and devices to heterogeneous and monolithic integration as well as design and simulation of the ViT circuits and systems. The project is particularly significant as it capitalizes on the recent advancements in ferroelectric materials, specifically hafnium-zirconium oxide (HZO). Which has shown to be compatible with conventional silicon components and is an exceptional promise in enhancing memory devices and reducing power

consumption.

Three of the project objectives target the design and fabrication of the main components of the ViT, namely a Compute-in-Memory demonstrator, a circuit level simulator and a hardware-software co-optimization platform with ferroelectric oxides. The platform will support two types of emerging memories, high-density 3D FeRAM developed in Korea and epitaxial ferroelectric tunnel junctions developed in Europe. This strong collaboration allows the partners to leverage their collective expertise in materials science, semiconductor technology, and artificial intelligence to push the boundaries of this emerging field. More information about the project can be found on the official website www.vitfox.eu.

Fraunhofer IPMS in the project

Fraunhofer IPMS is a key partner in the ViTFOX project, contributing its extensive expertise in neuromorphic systems and semiconductor technologies. Fraunhofer IPMS will focus on the development of advanced materials and devices for neuromorphic computing applications, particularly utilizing ferroelectric materials. This includes the design and testing of novel ferroelectric tunnel junctions (FTJs) and the integration of these devices into functional prototypes. By leveraging its state-of-the-art clean room, Fraunhofer IPMS aims to facilitate the scaling and optimization of ferroelectric technologies, ensuring they meet the stringent requirements for energy-efficient computing systems.

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.

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Consortium partners in the ViTFOX project.
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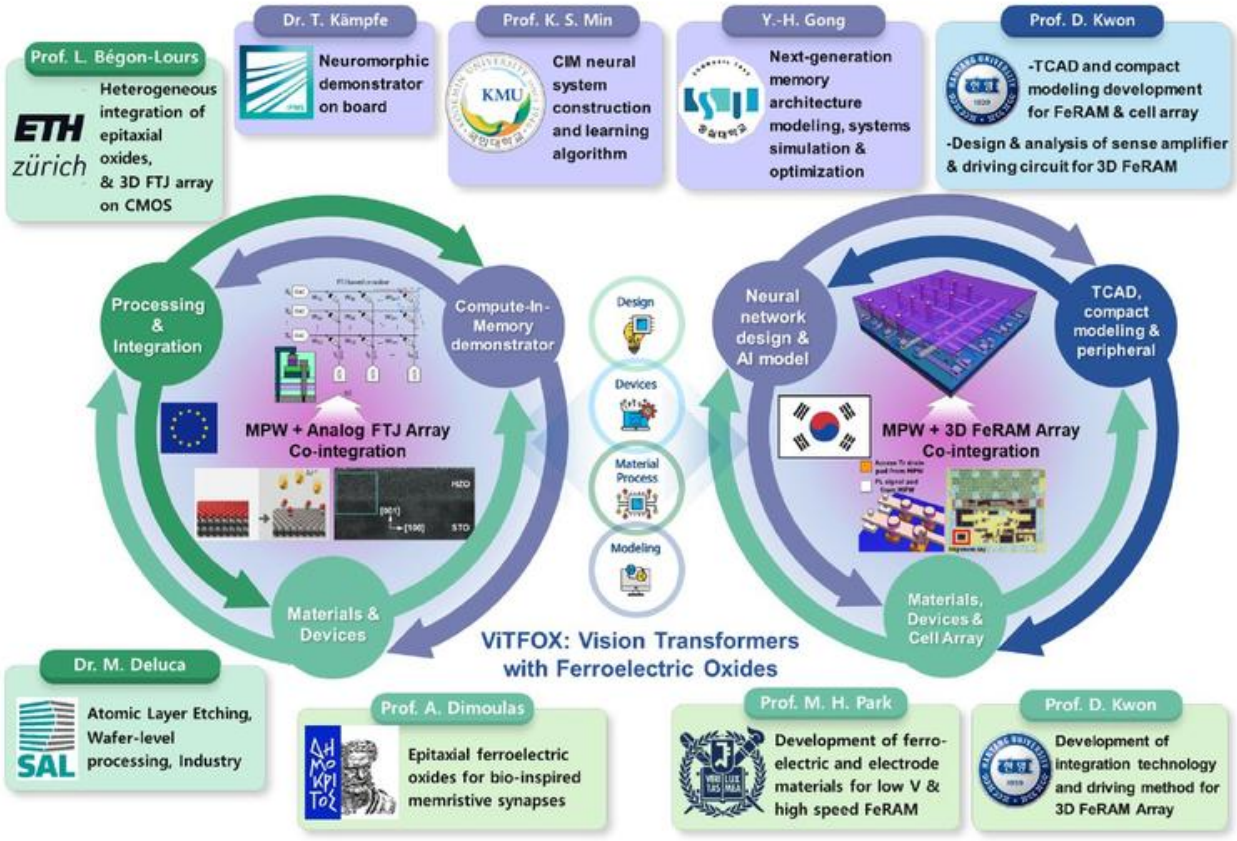

Synergies and complementary competences uniting ViTFOX EU and Korean consortia
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