PRESS RELEASE

EU Funds €4M Project to Develop an Extremely Power Efficient Ferrosynaptic Computing Technology

Logo of the BeFerroSynaptic project

The amount of data that is being generated in today's electronic devices, and exchanged over communication networks is rapidly increasing. While this is required to unleash the full potential of applications such as image and speech recognition, signal processing for smart sensors and autonomous driving, medical diagnosis from symptoms and scans, handling such a huge amount of data requires novel computing strategies. So far, the most advanced computing algorithms are still mostly executed on traditional large power-hungry computing platforms. The problem, however, is that many small-scale devices, such as smartphones, simply don't have the compute power, energy budget size and complexity that would be required for many tasks. For this reason, applications such as virtual assistants (e.g. Apple's Siri) typically upload speech to the cloud for processing. A strongly growing use of cloud services is expected in near future, resulting in a tremendous increase of energy consumption up to thousands of TWh for data transmission, corresponding to tens of billion tons of CO_2 emission. In fact, the transfer of these large amounts of data to cloud-based systems takes a large amount of energy in itself.

With an international team of researchers, the EU-funded Horizon 2020 project ***BeFerroSynaptic*** aims at developing an ultra-low-power neuromorphic computation platform for adoption not only in cloud, but also in portable, small-scale, battery-powered devices, to achieve a marked reduction of the amount of data that has to be transmitted between portable devices and the cloud; hence, substantial power and energy savings.

In traditional computers, the data has to be transferred continuously between computing and memory units, which is a slow and energy-hungry process that severely limits the overall performance and energy efficiency. The solution is to bring the memory closer to the computation engines, ultimately resulting in architectures that resemble the one found in the human brain. Such neuro inspired architectures merge logic and memory functionality together by using new electron devices that work as synaptic elements. It has been estimated that the energy consumption for the operation of a large-scale neural network based on synaptic elements can be more than one thousand times smaller as compared to conventional advanced computing platforms.

The main concept of the ***BeFerroSynaptic*** project is to develop an advanced "ferrosynaptic" technology by providing innovative synaptic devices that are fully integrated with conventional nanoelectronics. The synaptic devices are made from ferroelectric hafnium zirconium oxide (HZO). "The data storage in this material is based on the ferroelectric polarization reversal, one of the most energy efficient mechanisms that are currently under investigation for the realization of artificial synaptic devices" – explains Dr. Stefan Slesazeck, the coordinator of the project. It is a strategic decision of ***BeFerroSynaptic*** partners to investigate two kinds of "ferrosynaptic" elements in parallel (ferroelectric field effect transistor – FeFET - and ferroelectric tunneling junctions - FTJ). The "ferrosynaptic" devices will be integrated in a mainstream industrial technology platform. The ultimate goal of the ***BeFerroSynaptic*** consortium is to demonstrate the superior performance of "ferrosynaptic" technologies by building an ultra-low power neuromorphic processor.

Different partners, different roles

To achieve the objectives, the consortium catalyses expertise from the fields of material science and electronic device development, modelling and simulation, circuit design, and integrated circuit manufacturing. The consortium is led by NaMLab (Germany), who have pioneered the field of HZO ferroelectricity since 2008 and have established a worldwide leading position since then with important new contributions in material and device development.

Commissariat à l'énergie atomique et aux énergies alternatives (CEA-LETI, France), with strong commitment in advanced semiconductor processing offers its 200mm platform line for the integration of FTJ synaptic devices with conventional nano-electronic circuits. IBM Research GMBH (IBM), pioneering the field with one of the first advanced neuromorphic processors (TrueNorth), and currently leading the efforts in computation for big data, guarantees a fast route to exploitation in line with their business in the area of IT systems and services. In parallel, IBM Research Europe in Zurich (Switzerland) is actively involved in the integration of FeFET synaptic devices. Top neuromorphic circuit designers at Universitat Zurich (UZH, Switzerland) and Bielefeld University (UNIBI, Germany) are essential for the co-development of the neuromorphic processor demonstrator. X-FAB Dresden GmbH & Co. KG (X-FAB, Germany) will implement the neuro inspired circuit designs from project partners in their open-platform CMOS technologies, and will deliver to IBM and Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (HZB, Germany) for integration of ferroelectric synaptic devices on CMOS chips. X-FAB, a key European semiconductor manufacturer and leading specialty foundry, is expected to benefit from project results to develop advanced new products with built-in intelligence. The stakeholders mentioned above are supported by a number of academic institutions namely HZB, EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH (ETH Zurich, Switzerland), NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS" (NCSRD,Greece), and the IUNET Consortium with its two affiliated Italian universities Università degli Studi di Udine (UNIUD) and Università degli Studi di Modena e Reggio Emilia (UNIMORE), assisting the project with device modelling and reliability analysis, and by exploring materials aspects that will result in performance improvements of synaptic devices.

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