Schottky-junction transistors for non-volatile reconfigurable electronics and neuromorphic computing

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Deep learning algorithms have recently demonstrated extraordinary success, rapidly becoming ubiquitous. However, energy requirements and carbon emissions for training and operating artificial neural networks are on a steep increase and will soon reach unsustainable levels, given the current hardware. A great deal of resources is spent moving data from processing units to memory and back, strongly impacting data-intensive applications. Thus, the need for novel hardware platforms that can merge logic and memory functionalities into a single device is extremely high.

This talk will firstly illustrate how Schottky-Junctions can be exploited to engineer Si-based transistors that, without the need of doping, can be reconfigured at run-time between p- and n-type transport behavior, allowing to obtain devices that possess an inherent flexibility, thanks to the electrostatic tuning of the Schottky barriers. Such devices can be employed to realize reconfigurable logic gates [1] with a lower number of transistors compared to CMOS standards.

Subsequently, we will focus on how the integration of thin ferroelectric $Hf_{0.5}Zr_{0.5}O_2$ (HZO) layers can be exploited to enable a multi-level, non-volatile tunability of these devices, thanks to the ferroelectric-modulation of the Schottky Barriers, effectively integrating a memory element into the transistors [2].

Finally, we will explore the use of HZO-enhanced Schottky-Junction transistors as promising devices for enabling neuromorphic computing (NC) on a CMOS-compatible platform, benchmarking their characteristics against other known NC-enabling platforms.

[1] L. Wind *et al.*, “Reconfigurable Si Field-Effect Transistors With Symmetric On-States Enabling Adaptive Complementary and Combinational Logic,” *IEEE Trans. Electron Devices*, vol. 71, no. 2, pp. 1302–1307, Feb. 2024, doi: 10.1109/TED.2023.3346361.

[2] D. Nazzari *et al.*, “Nonvolatile Reconfigurable Transistor via Ferroelectrically Induced Current Modulation,” *ACS Appl. Mater. Interfaces*, vol. 17, no. 7, pp. 10784–10791, Feb. 2025, doi: 10.1021/acsami.4c16400.