

NDR FERROELECTRIC FET AND METHOD OF OPERATING THE SAME

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PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	WO 2025/245394	11/27/2025	2024-134

BRIEF DESCRIPTION

This technology introduces a field-effect transistor (FET) designed with a ferroelectric (FE) material layer integrated directly into the gate-insulating stack. Developed by researchers at UC Berkeley, the device is distinguished by its ability to exhibit tunable negative differential resistance (NDR) within its output characteristics while remaining fully compatible with standard CMOS manufacturing processes. The device operates by manipulating the electrical polarization of the FE layer; at low drain-to-source voltage (V_{DS}), the positive polarization maintains a low threshold voltage (V_{th}), allowing current to increase. However, as V_{DS} rises beyond a specific level, the polarization reduces and eventually flips, causing a sudden surge in V_{th} and a corresponding rapid decrease in current. This unique transition creates an NDR region where the drain current drops even as the drain voltage increases, offering new possibilities for high-speed switching and compact circuit design.

SUGGESTED USES

- » High-Frequency Oscillators: Utilizing the NDR characteristic to create simplified, tunable oscillators for communication hardware and signal processing.
- » Low-Power Logic Gates: Implementing ultra-compact logic circuits that require fewer components than traditional CMOS layouts by exploiting the NDR switching behavior.
- » Neuromorphic Computing: Developing hardware-based artificial neurons and synapses that mimic biological spiking behavior through the device's non-linear voltage responses.
- » Memory Applications: Integrating these FETs into static memory cells to reduce the transistor count and overall footprint of high-density cache memory.
- » Fast Switching Circuits: Employing the rapid polarization flip mechanism for high-speed digital triggers and pulse generators.

ADVANTAGES

- » CMOS Compatibility: Designed to be fabricated using standard semiconductor industry processes, allowing for immediate integration into existing chip manufacturing pipelines.
- » Tunable Performance: The NDR characteristic can be precisely controlled by adjusting the gate voltage or the properties of the ferroelectric layer stack.
- » Enhanced Scaling: Offers a path toward increasing component density on integrated circuits by reducing the complexity of functional blocks that traditionally require multiple transistors.
- » Efficient Operation: The sudden increase in threshold voltage allows for sharp switching transitions, which can contribute to lower static power consumption in certain circuit configurations.
- » Robust Polarization Control: Uses a predictable physical mechanism—the switching of FE polarization—to achieve stable and repeatable NDR regions.

RELATED MATERIALS

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INVENTORS

- » Tatum, Lars Prospero

OTHER INFORMATION

CATEGORIZED AS

- » **Computer**
- » Hardware
- » **Materials & Chemicals**
- » Thin Films
- » **Nanotechnology**
- » Electronics
- » **Semiconductors**
- » Design and Fabrication

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ [Memory Cells using Negative Differential Resistance Ferroelectric FETs](#)



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