



## Ultra-Compact Non-Volatile Memory Technology with Embedded RRAM

Tech ID: 32924 / UC Case 2021-861-0

### BACKGROUND

To meet the demands of next-generation artificial intelligence (AI), edge computing, and neuromorphic architectures, memory technology must evolve beyond the limitations of silicon-based solutions. Traditional charge-based memories like DRAM and Flash are rapidly approaching scaling and performance bottlenecks, particularly below the 10-nanometer node, where volatility, endurance, and retention degrade significantly. The need is clear: the industry requires a compact, fast, energy-efficient, and non-volatile memory platform capable of supporting computation-in-memory paradigms and ultra-dense chip architectures.

### DESCRIPTION

Researchers at UC Santa Barbara have developed a first-of-its-kind, ultra-compact resistive random-access memory (RRAM) cell that redefines what's possible in non-volatile memory technology. This pioneering design integrates a transition-metal dichalcogenide (TMDC)–graphene heterojunction field-effect transistor, with a hexagonal boron nitride (h-BN) based RRAM element, into a single, hybrid structure that functions as a “0.5T0.5R” memory cell—cutting the conventional device footprint in half. This compact architecture marks a historic milestone in RRAM development. The result is blazing-fast switching (<10 nanoseconds), ultra-low power operation, excellent data retention, and exceptional endurance—all manufactured using industry-compatible processes below 500 °C. It offers a future-ready, scalable alternative to conventional memories, ideally suited for high-performance, data-intensive applications.

Patent application: <https://patents.google.com/patent/US20230124085A1/en>

Publication: <https://ieeexplore.ieee.org/document/9385834>

Nature Electronics Highlight: [Transistors and memory get together](#)

### ADVANTAGES

- ▶ <10 ns Switching Speed, among the fastest reported for RRAM technologies
- ▶ Ultra-Compact Design that halves transistor and resistor count compared to standard memory cells
- ▶ Energy-Efficient Operation that dramatically lowers power consumption, ideal for mobile and edge devices
- ▶ Non-Volatile Memory that maintains data integrity even after power-down
- ▶ Manufacturing-Ready, which enables low-temperature deposition compatible with BEOL integration

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### OTHER INFORMATION

#### KEYWORDS

RRAM, computer memory, graphene, resistive-random-access-memory, ultra compact, non-volatile, switching speed

#### CATEGORIZED AS

- ▶ [Computer](#)
- ▶ [Hardware](#)

#### RELATED CASES

2021-861-0

## APPLICATIONS

- ▶ Artificial Intelligence (AI) & Machine Learning
- ▶ In-Memory Computing
- ▶ High-Density Memory for Mobile & Edge Devices
- ▶ Neuromorphic Hardware Platforms
- ▶ Consumer Electronics & IoT

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	12363914	07/15/2025	2021-861

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