Ultra-Compact Non-Volatile Memory Technology with Embedded RRAM

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BACKGROUND

Next-gen deep learning applications rely on devices with high-performance memory in a small footprint. While silicon-based memory technologies are widely used, they are insufficient for the emerging computation-in-memory architecture. Alternatives are held back by large energy consumption, memory volatility, large device footprints, low operation speed, and limited endurance. Furthermore, charge-based memories (DRAM & FLASH) are struggling to be miniaturized down to a 10-nm node because the stored charge could be lost at nanoscale dimensions, exacerbating the device endurance and retention issues. To enable a new frontier of neuromorphic computing, the industry requires a high-density memory technology that is fast, low-power, highly reliable, and more cost-effective.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed an ultra-compact resistive-random-access-memory (RRAM) cell with industry-leading switching speed (<10ns), low access latency, and low energy consumption. This nonvolatile and manufacture-friendly memory technology combines a transition-metal-dichalcogenide (TMDC) graphene-based heterojunction field-effect-transistor with hexagonal boron nitride (h-BN) based RRAM to form a single device. The hybrid structure, which can be considered as a “0.5T0.5R” memory cell, reduces the device count by half and is the first of its kind in RRAM technology history. Its design affords lower operation voltage, extraordinarily fast switching speed, long retention time, high ON/OFF ratio, high endurance, and low switching energy in contrast to ubiquitous charge- and silicon-based memory. This invention stores much more information with higher performance compared to conventional alternatives and can serve as the foundation for a new generation of intelligent chips, changing the ways we process and store information.

ADVANTAGES

- Uniquely fast switching speed of <10ns
- Ultra-compact footprint reduces device count by half
- Non-volatile nature of the embedded h-BN RRAM retains info after each SET or RESET operation
- Unprecedented energy-efficiency which would extend the lifetimes of batteries in devices such as laptops and cell phones
- Simple manufacturing method allows for low-temperature deposition technology below 500°C

APPLICATIONS

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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

- Computer memory
- Consumer electronics

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20230124085	04/20/2023	2021-861

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