MARKET SHEET

ECRAM

Electrochemical Random Access Memory

Sandia National Laboratories

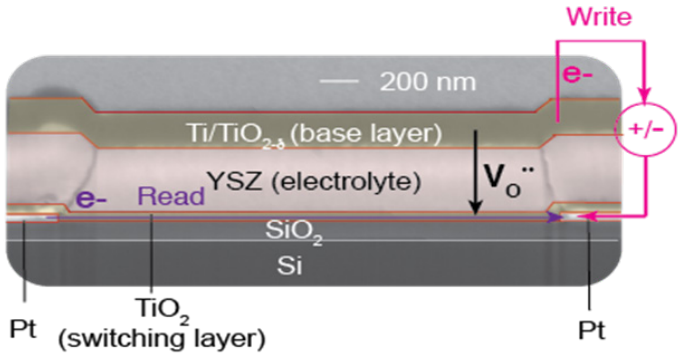
An oxygen vacancy insertion with CMOS compatible oxide materials results in analogue operations with non-volatile memory.

Patent Pending

Technology Readiness Level: 3

Artificial neural networks have become increasingly relevant and desired in today's market; however, they are extremely energy intensive. Neuromorphic computing, which involves operations being conducted in analogue directly on memory elements, is seen as a solution to the problem. A key need for neuromorphic computing is to create artificial synapses that conduct analogue operations with non-volatile memory. In addition, desired key attributes include having hundreds of distinguishable states, the ability to switch linearly and predictably between these states, and non-volatile retention in the days to weeks' timescale when scaled to nanosized dimensions. Past redox transistors were based on lithium ion and proton insertion. These synapses were not CMOS compatible, and the devices lacked these attributes.

Researchers at Sandia National Laboratories have developed oxygen vacancy Electrochemical Random Access Memory (ECRAM) for neuromorphic computing. ECRAM functions as artificial synapses to conduct operations in analogue for artificial neural network. In addition to the functional attributes listed above, a key benefit of this technology is its ability to be integrated into existing CMOS processes. Because the redox transistor operates on oxygen vacancy insertion, the transistor has a very long retention at room temperature. The technology is relevant for neuromorphic computing and provides a potential solution for developing a non-volatile synaptic memory that has a large number of analogue states.



Above: ECRAM based on oxygen vacancy migration utilizes an electrolyte which also acts as a thermally-activated switch.

Technical Benefits

- Operates on oxygen vacancy insertion
- Uses CMOS compatible oxide material
- Long retention at room temperature

Industries & Applications

- Neuromorphic computing
- Transistors
- Semiconductors

Contact Us SD# 15312

ip@sandia.gov ip.sandia.gov

U.S. DEPARTMENT OF ENERGY NNSA National Nuclear Security Administration

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525. SAND2022-9896 M