2020 Research Day

1T-FeFET Memory Architecture

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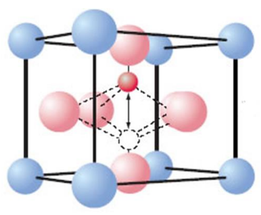
Motivation

The growing demand for fast, low power and non-volatile memories makes the FeFET promising technology. It is a high-K transistor with high-density integration, low-power scalability and CMOS-compatible.

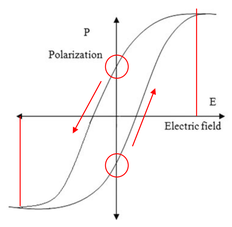
Ferroelectric Transistor

Ferroelectric materials are dielectric crystals which show spontaneous electric polarization

(a)

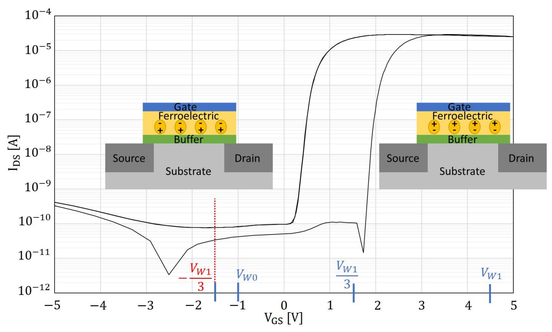


(b)



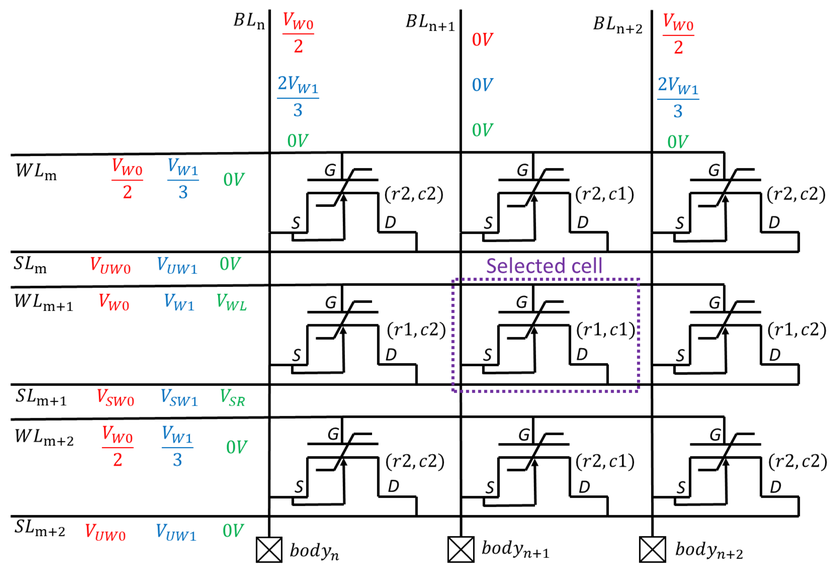
Ferroelectric materials. (a) Ferroelectric crystal structure. (b) P-E hysteresis curve of ferroelectric crystal.

Integrating ferroelectric layer in the gate stack of MOSFET enables storing digital data in terms of polarization direction.

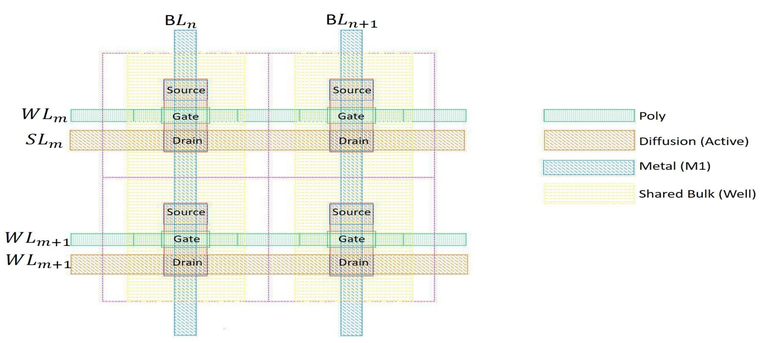


IDS-VGS curves of a FeFET, the transistor structure, and the corresponding polarization direction. Red - write error demonstration for hysteresis with asymmetric switching voltages.

1T-FeFET Memory Architecture for Disturb Reduction using Mixed Writing Scheme



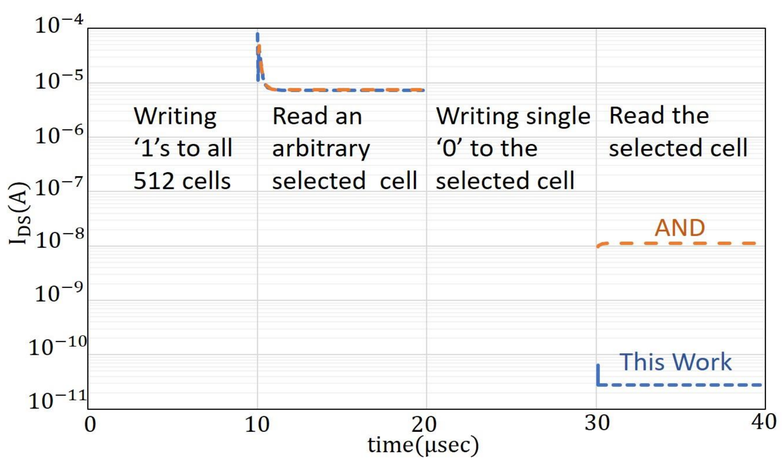
Demonstration of read and write schemes: **red** - Write '0' scheme, **blue** – Write '1' scheme, **green-** Read scheme



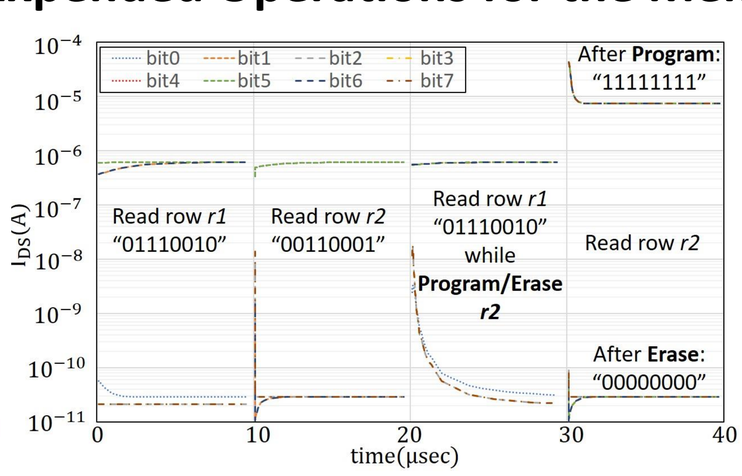
Schematic layout of our proposed structure with vertical poly and diffusion and horizontal metal and shared bulk.

This is non-volatile memory (NVM) with single element per cell and non-destructive readout operation.

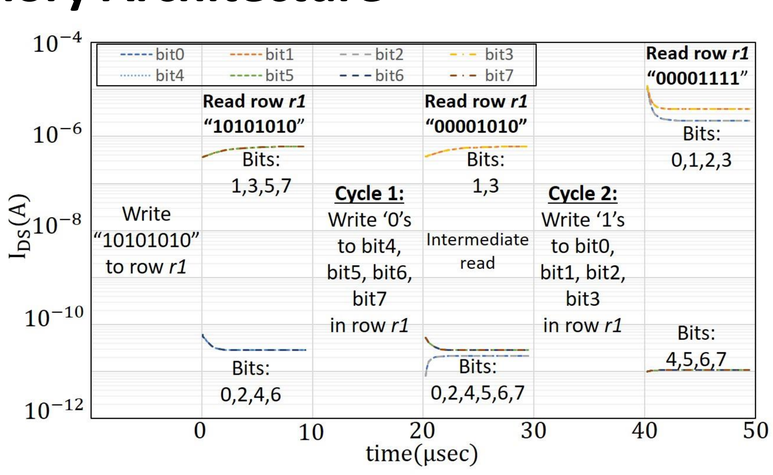
Demonstration of Expended Operations for the Memory Architecture



Comparing our proposal with long BL to AND-array.



Program (Erase) a whole word while reading another.



Write a whole word in two cycles.

Future Work

- In-memory computing using the unique properties of the FeFET and the 1T-FeFET architecture.
- Utilize FeFET's accumulative switching for analog applications.