Memory in silicon

notes on work in the semiconductor industry

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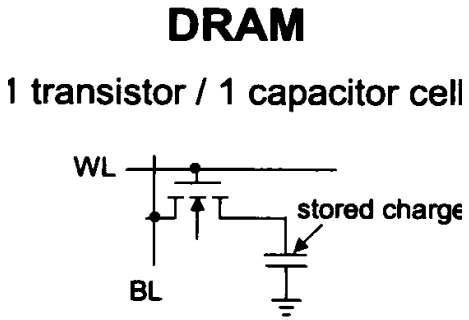
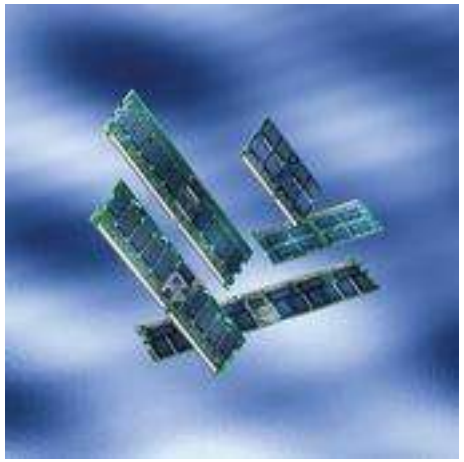
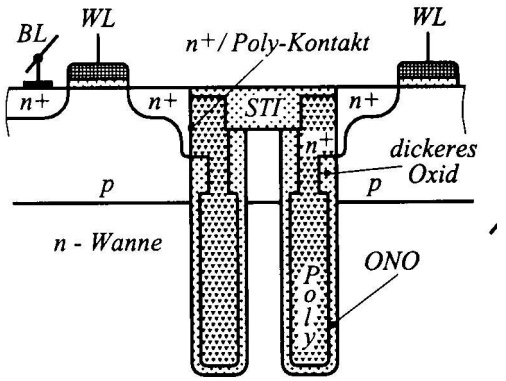
Outline:

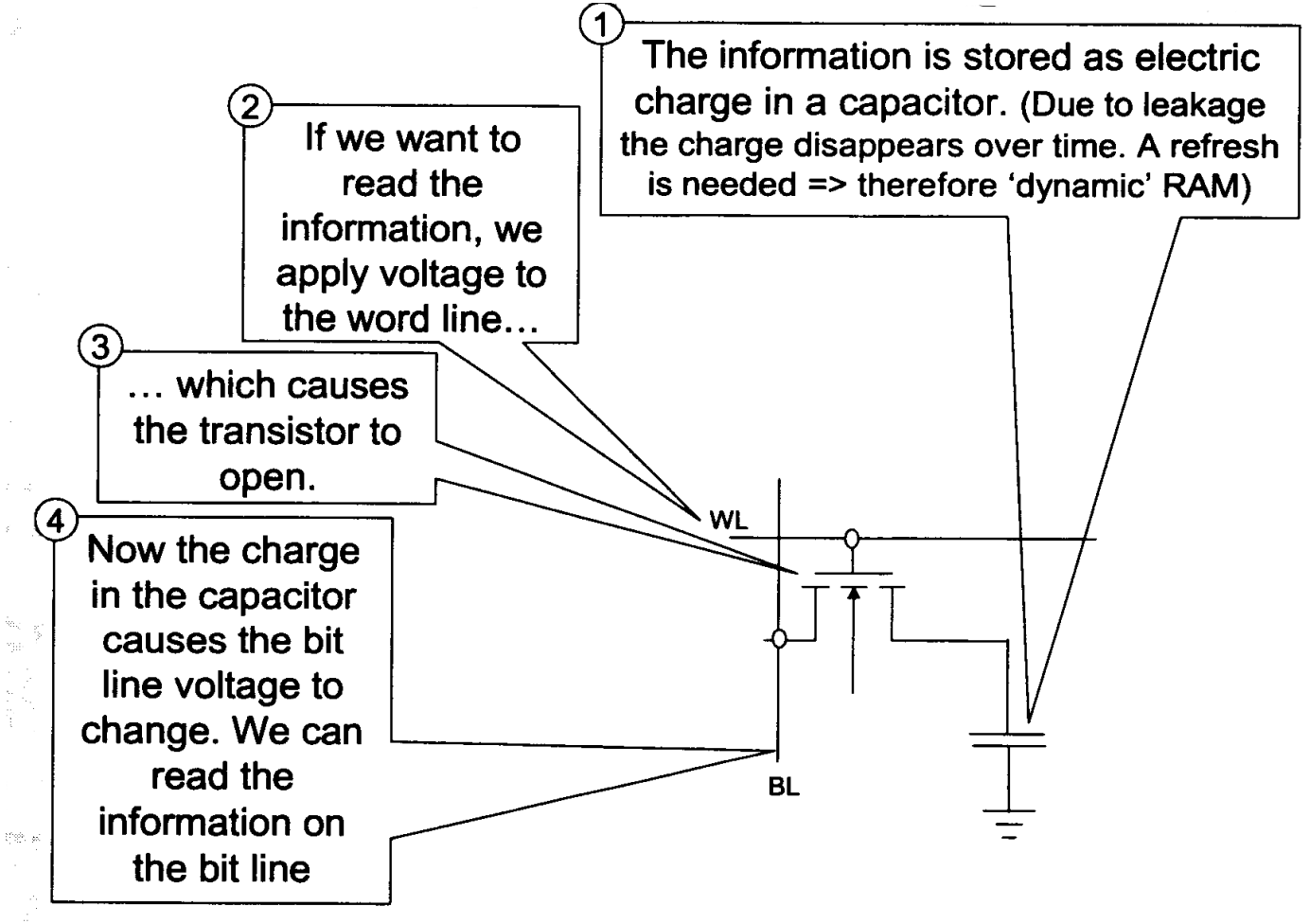
- ✗ DRAM principle
- ✗ Memory as product
- ✗ Integrated circuits and semiconductor physics





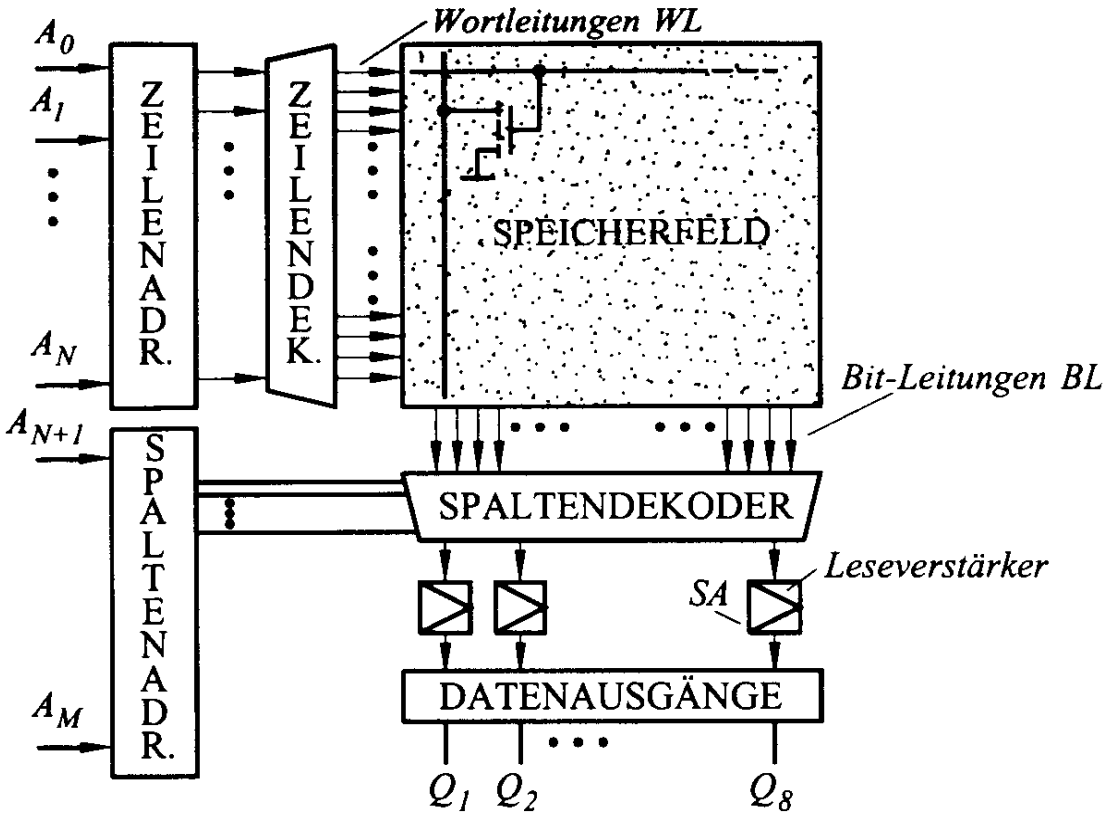


DRAM principle



Quelle: DRAM Seminar, Infineon

Computer Memory

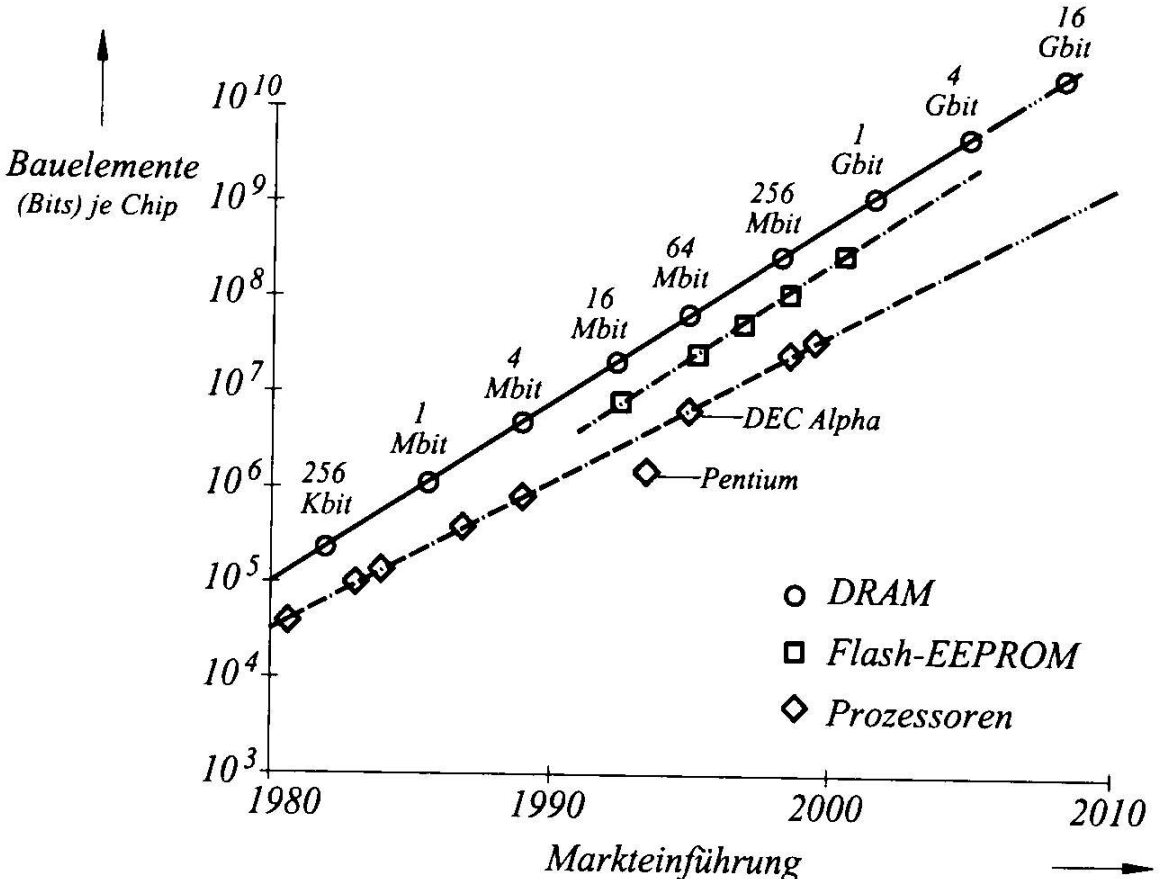


Blockschaltbild

The information is stored in the memory array. The sense amplifier (SA) reads the information and logic circuits organize the addressing and timing.

Quelle: K.Hoffmann, Systemintegration, [1]

Feature size

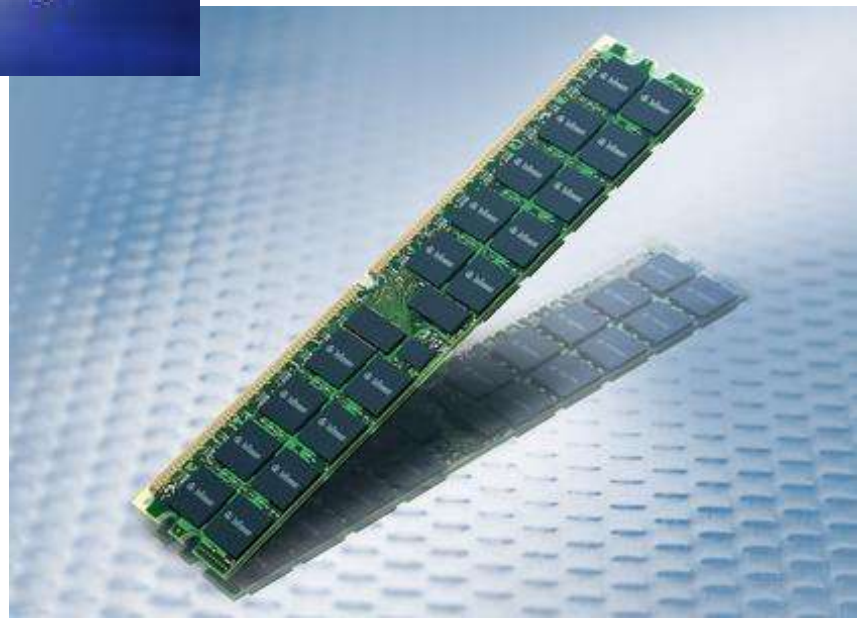


The challenge for the product is the huge number of devices and the tiny size of the capacitor which stores the information.

Quelle: K.Hoffmann, Systemintegration, [1]

Wafer, Package and Module

To deliver a reliable memory you have to test at each production step the functionality of all storage cells.



Wafer level:
bit and word line repair

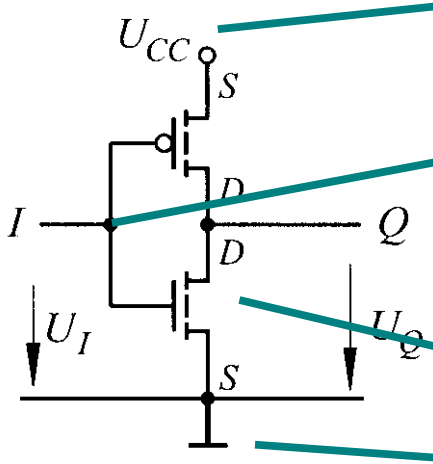
Package level:
speed sort

Module level:
application test

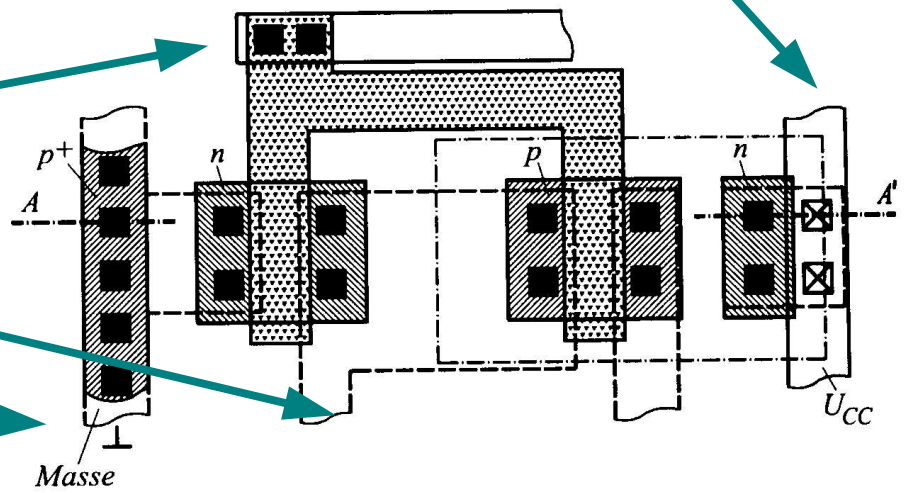
Design, Layout and Hardware

To develop a memory product you have to bring the circuit design onto the wafer:

Design of the integrated circuit:

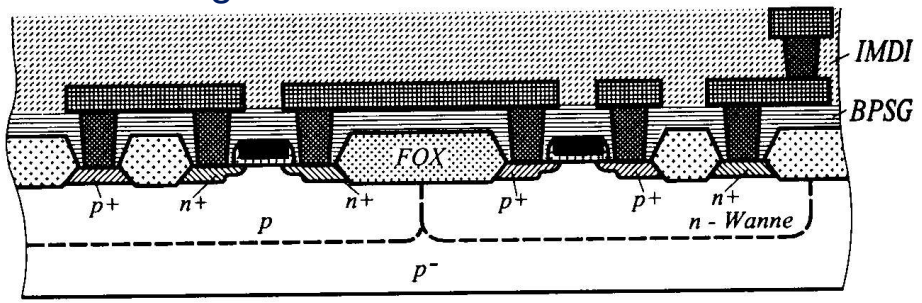


Layout of the integrated circuit:



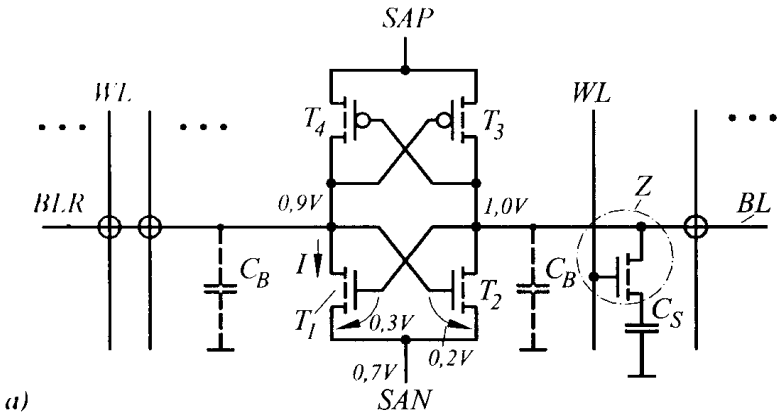
For the design and layout computer simulations are essential which predict the behavior of the integrated circuit on the wafer.

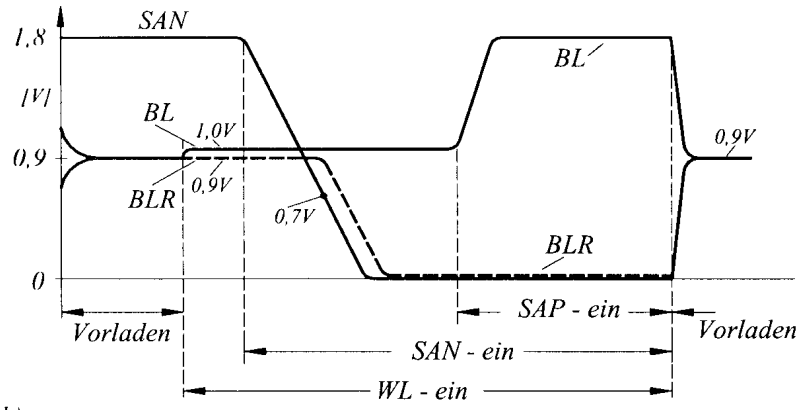
The integrated circuit on the **wafer**:



Simulation: Circuit simulation

Schematics -> SPICE netlist -> voltages and currents





✗ The circuit is simulated recording the voltages and currents at nodes

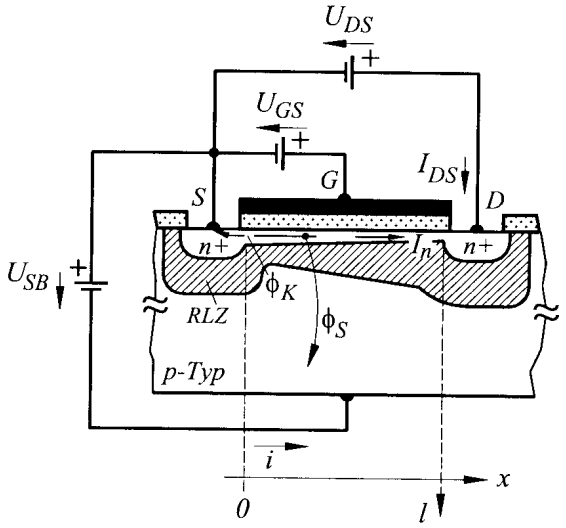
✗ From the layout parasitic elements are extracted.

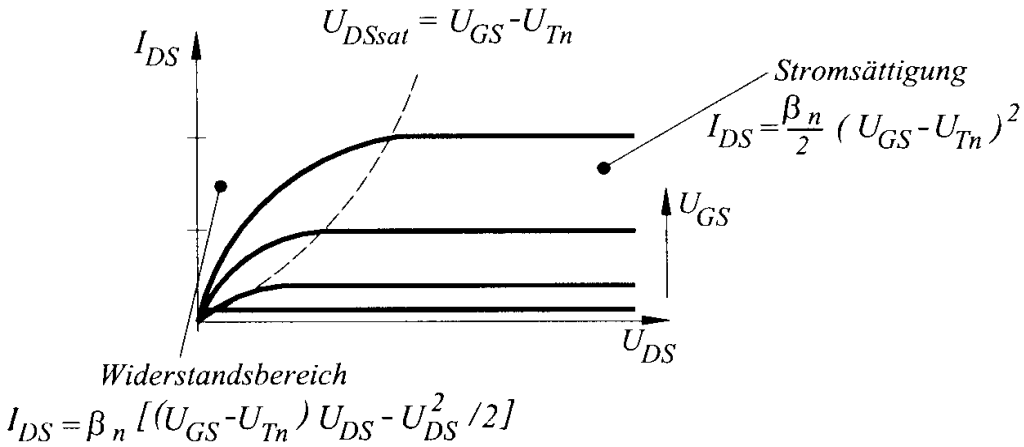
✗ Also the logic is verified.

BUT: For circuit simulation you have to know how your transistors are working.

Device simulation

device layout/measurements -> model/parameter table -> iv characteristic





✗ The device simulation takes care of the current and voltages on the transistor terminals.

✗ From measurements on devices with different geometries physical effects are modeled.

Summary

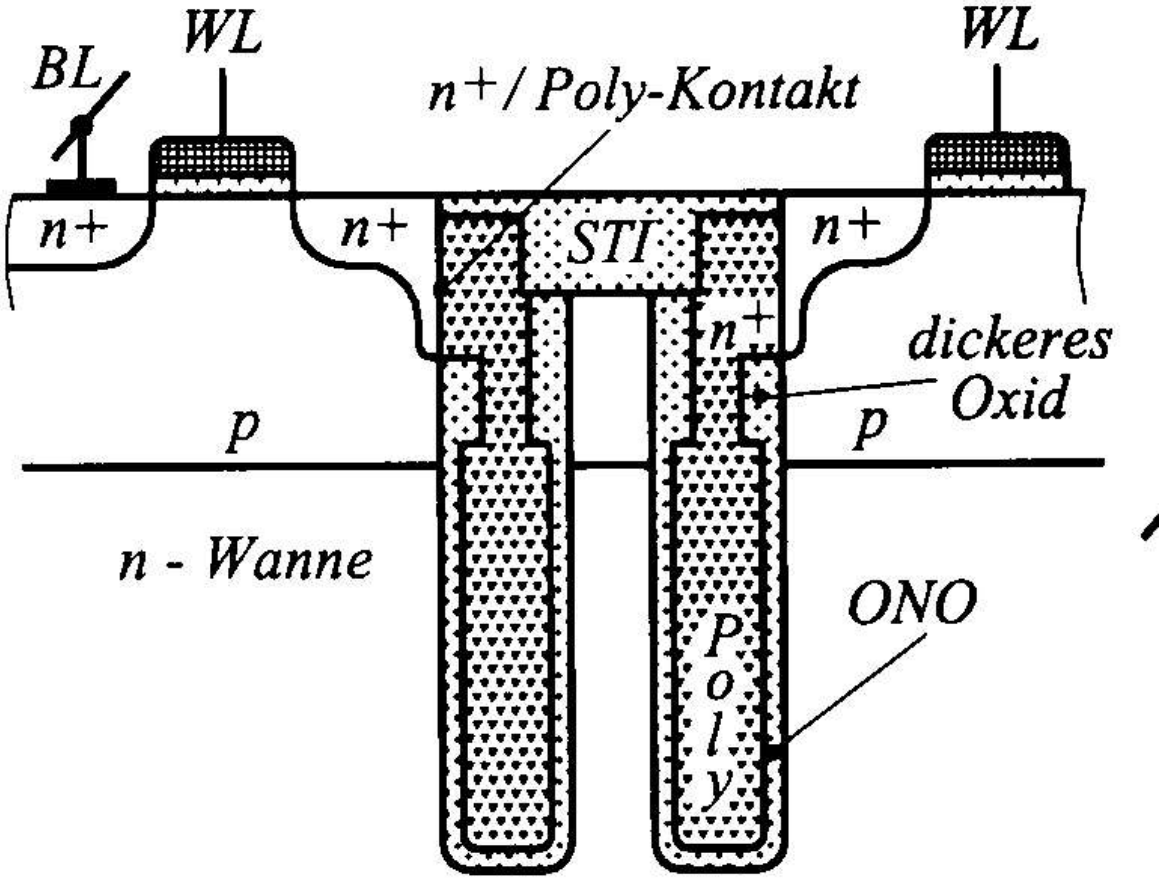
- ✗ Simple DRAM principle.
- ✗ Challenge is the realization of reliable memory.
- ✗ Interaction between electrical engineering and semiconductor physics.

Literature

[1] K.Hoffmann: Systemintegration, Oldenburg Verlag, München (2003) .

[2] D.Widmann, H.Mader, H.Friedrich:Technologie hochintegrierter Schaltungen, Springer Verlag, Berlin (1996).

The Trenchcell



Quelle: K.Hoffmann, Systemintegration, [1]