Microelectronics Devices, Sensors and MEMS

Academic year 2023-2024

Project #3: MOSFET

Guidelines:

The files used in the laboratory classes, available on the course website, can be used as a starting point for the projects and modified according to the project requests.

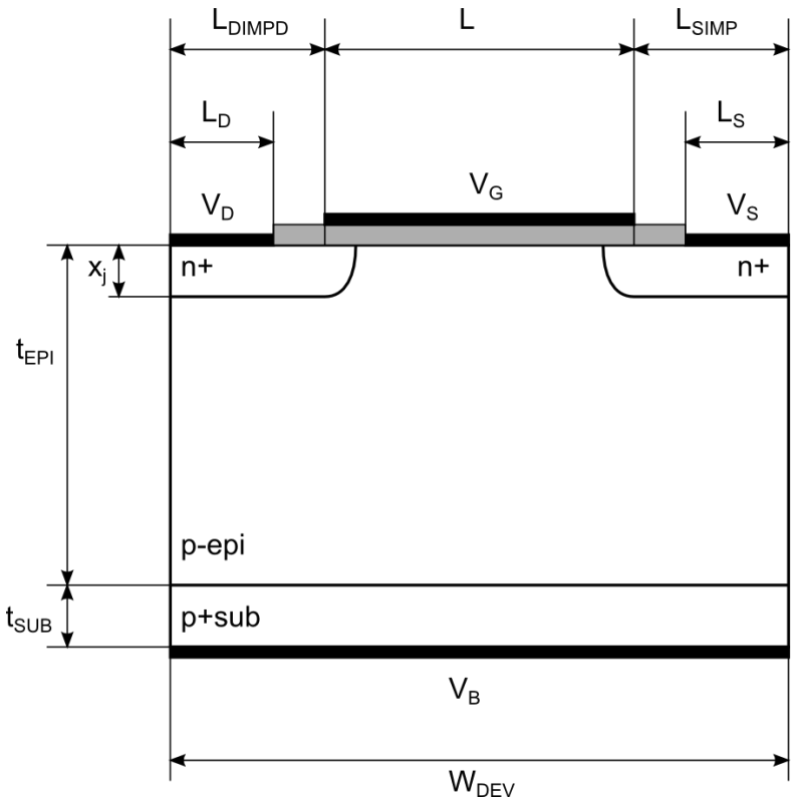

Figure 1. MOSFET structure

Create a MOSFET with the structure shown in Figure 1, using the following parameters:

W_{DEV}, device width: 1.5µm
t_{EPI}, epitaxial layer thickness, 2µm
t_{SUB}, substrate thickness: 1 µm
L, gate length: 0.5µm
L_{DIMP}, drain implantation length: 0.5µm
L_{SIMP}, source implantation length: 0.5µm
L_D, drain electrode length: 0.2µm

L_S, source electrode length: 0.2µm
Drain and source doping:
    Vertical and lateral profiles: gaussian
    X_j, drain and source junction depth: 0.3µm
    Peak donor concentration: $10^{18}cm^{-3}$
Epitaxial layer doping: $2x10^{17}$ cm^{-3}
Substrate doping: 10^{19} cm^{-3}
Gate thickness: 10nm
Gate material: n+ poly-Si

After generating a suitable mesh, perform the following simulations:

1. Equilibrium state
2. MOSFET transfer characteristic with VDS = 3.3V. Compare the obtained threshold voltage and current gain Kn with the theoretical ones.
3. MOSFET output characteristics with VG = 1,2 and 3V.
4. Biasing the MOSFET with VD = VS = VB = 0, perform an AC simulation at 1MHz, sweeping the gate voltage between -3V and 3V to extract the gate capacitance. Plot the extracted gate capacitance as a function of voltage.
5. Add a shallow boron gaussian doping profile under the gate to adjust the threshold to 0.8V. Consider for the profile a peak concentration C_P at the interface between silicon and oxide and a doping concentration of $2x10^{17}$ cm^{-3} at 0.1 µm depth. Repeat the previous simulations with the modified structure.

Write a short report including the following items:

- Final device mesh
- Potential profile in equilibrium
- Simulated transfer and output characteristics
- Simulated Capacitance-Voltage curves