# LAB ASSIGNMENT 2
# Sentaurus Tool


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BATCH 4

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# SHORT NOTE ON SENTAURUS TOOL:

## Introduction:

Technology Computer-Aided Design (TCAD) refers to using computer simulations to develop and optimize semiconductor processing technologies and devices. TCAD simulation tools solve fundamental, physical, partial differential equations, such as diffusion and transport equations for discrete geometries, representing the silicon wafer or the layer system in a semiconductor device. This deep physical approach gives TCAD simulation predictive accuracy. Therefore, it is possible to substitute TCAD computer simulations for costly and time-consuming test wafer runs when developing and characterizing a new semiconductor device or technology.

TCAD simulations are used widely in the semiconductor industry. As technologies become more complex, the semiconductor industry relies increasingly more on TCAD to cut costs and speed up the research and development process. In addition, semiconductor manufacturers use TCAD for yield analysis, that is, monitoring, analyzing, and optimizing their IC process flows, as well as analyzing the impact of IC process variation.

TCAD consists of two main branches: ***process simulation and device simulation.***

## SDE(Sentaurus Device editor):

Device simulations can be thought of as virtual measurements of the electrical behaviour of a semiconductor device, such as a transistor or diode. The device is represented as a meshed finite-element structure. Each node of the device has 3properties associated with it, such as material type and doping concentration. For each node, the carrier concentration, current densities, electric field, generation and recombination rates, and so on are computed.

Electrodes are represented as areas on which boundary conditions, such as applied voltages, are imposed. The device simulator solves the Poisson equation and the carrier continuity equation (and possibly other equations). After solving these equations, the resulting electrical currents at the contacts are extracted. Sentaurus Structure Editor is a structure editor for 2D and 3D device structures. It has three distinct operational modes: 2D structure editing, 3D structure editing, and 3D process emulation.

From the graphical user interface (GUI), 2D and 3D device models are created geometrically, using 2D or 3D primitives, such as rectangles, polygons, cuboids, cylinders, and spheres. Rounded edges are generated by filleting, 3D edge

blending, and chamfering. Complex shapes are generated by intersecting primitive elements.

The GUI of Sentaurus Structure Editor features a command-line window, in which Sentaurus Structure Editor prints script commands corresponding to the GUI operations.

In process emulation mode, Sentaurus Structure Editor translates processing steps, such as etching and deposition, patterning, fill and polish, into geometric operations. This mode supports various options such as isotropic or anisotropic etching and deposition, rounding, and blending.

## SDevice(Process Simulation):

Sentaurus Process is a complete and highly flexible multidimensional process modeling environment. With its modern software architecture, it constitutes a new-generation tool and a solid base for process simulation. Calibrated to a wide range of the latest experimental data using proven calibration methodology, Sentaurus

Process offers unique predictive capabilities for modern silicon and nonsilicon technologies.

In process simulation, processing steps such as etching, deposition, ion implantation, thermal annealing, and oxidation are simulated based on physical equations, which govern the respective processing steps. The simulated part of the silicon wafer is discrete (meshed) and represented as a finite-element structure.

## Work Bench:

Sentaurus Workbench is the primary graphical front end that integrates TCAD Sentaurus simulation tools into one environment. It is used throughout the semiconductor industry to design, organize, and run simulations.

Simulations are organized comprehensively into projects. Sentaurus Workbench automatically manages the information flow, which includes preprocessing user input files, parameterizing projects, setting up and executing tool instances, and visualizing results.

Sentaurus Workbench allows you to define parameters and variables to run comprehensive parametric analyses. The resulting data can be used with statistical and spreadsheet tools.

# nMOS layout:

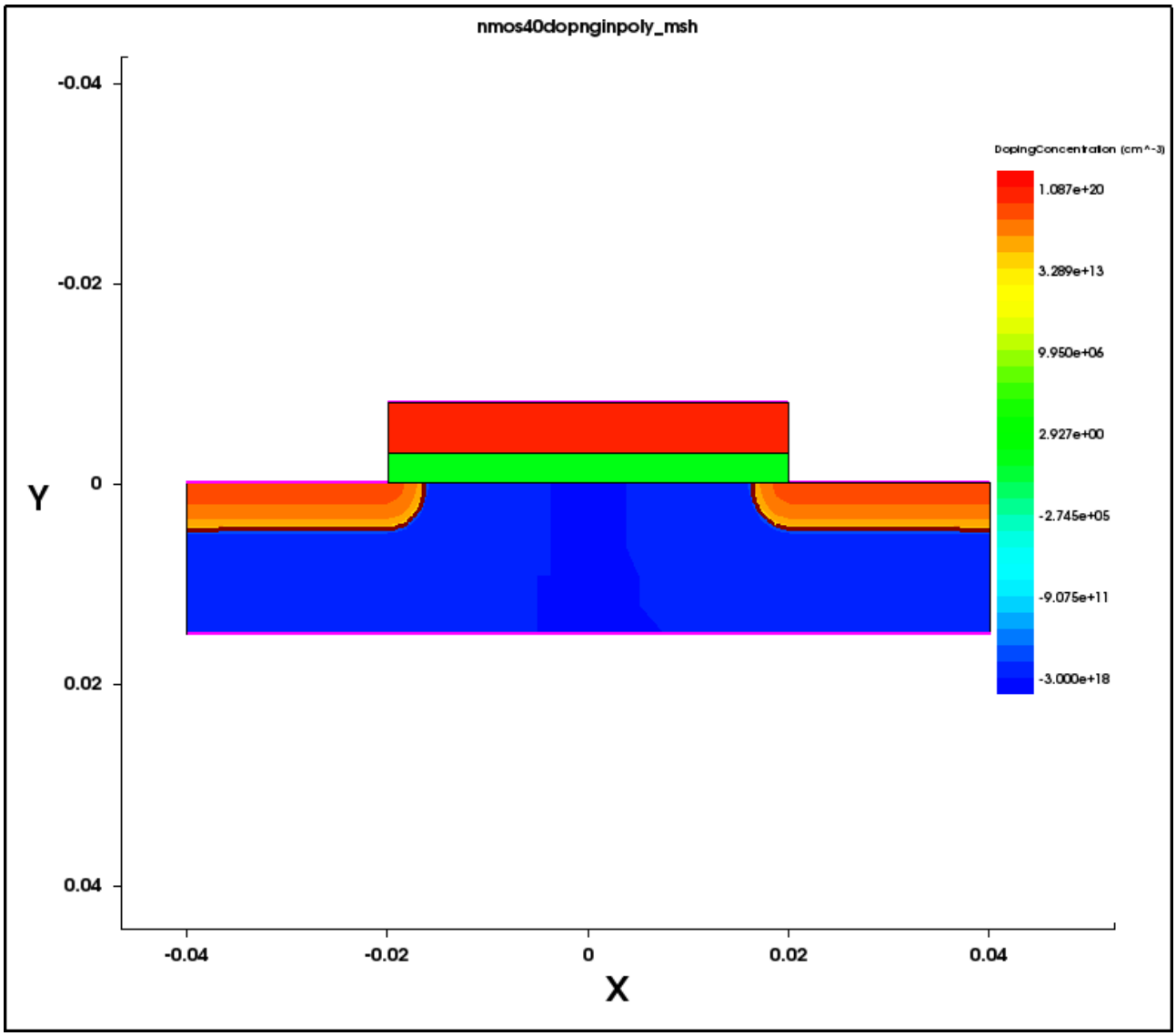


Fig 1: nMOS device layout

## Steps for creating NMOS:

1. Open terminal and enter sde command. Sentaurus tool gets open.
2. Create 2D structures for nMOS.

a. Drawing substrate
Draw ->2D shapes ->Rectangular (Silicon material) -> Enter coordinates.

b. Drawing oxide
Draw ->2D shapes ->Rectangular (Silicon Dioxide(SiO2) -> Enter coordinates.

c. Drawing Polysilicon
Draw ->2D shapes ->Rectangular (Silicon Dioxide(SiO2) -> Enter coordinates.

3. Create contacts
Contacts -> contact set (Gate , Source , Drain , Substrate).

4.Define referral window.

a. Line referral window created for doping
Mesh ->Def Ref ->Line.

b. Rectangular referral window created for meshing for whole device
Mesh ->Def Ref ->Rectangle

c. Rectangular referral window created for meshing for channel
Mesh ->Def Ref ->Rectangle

5. Doping
a. Uniform doping for substrate with Boron
Device -> Constant profile placement

b. Gaussian doping for source and drain with Arsenic
Device -> Analytical profile placement

6. Creating Mesh
a. Coarse meshing in full device
Mesh -> Refinement Placement

b. Refine meshing in channel area
Mesh -> Multi Box Placement

7. Save the device
File ->save model as

8. Building Mesh
Mesh -> Build Mesh

9. Device is build

10. Analysis
Run in terminal Idvg.cmd file

## Id-Vg curve:

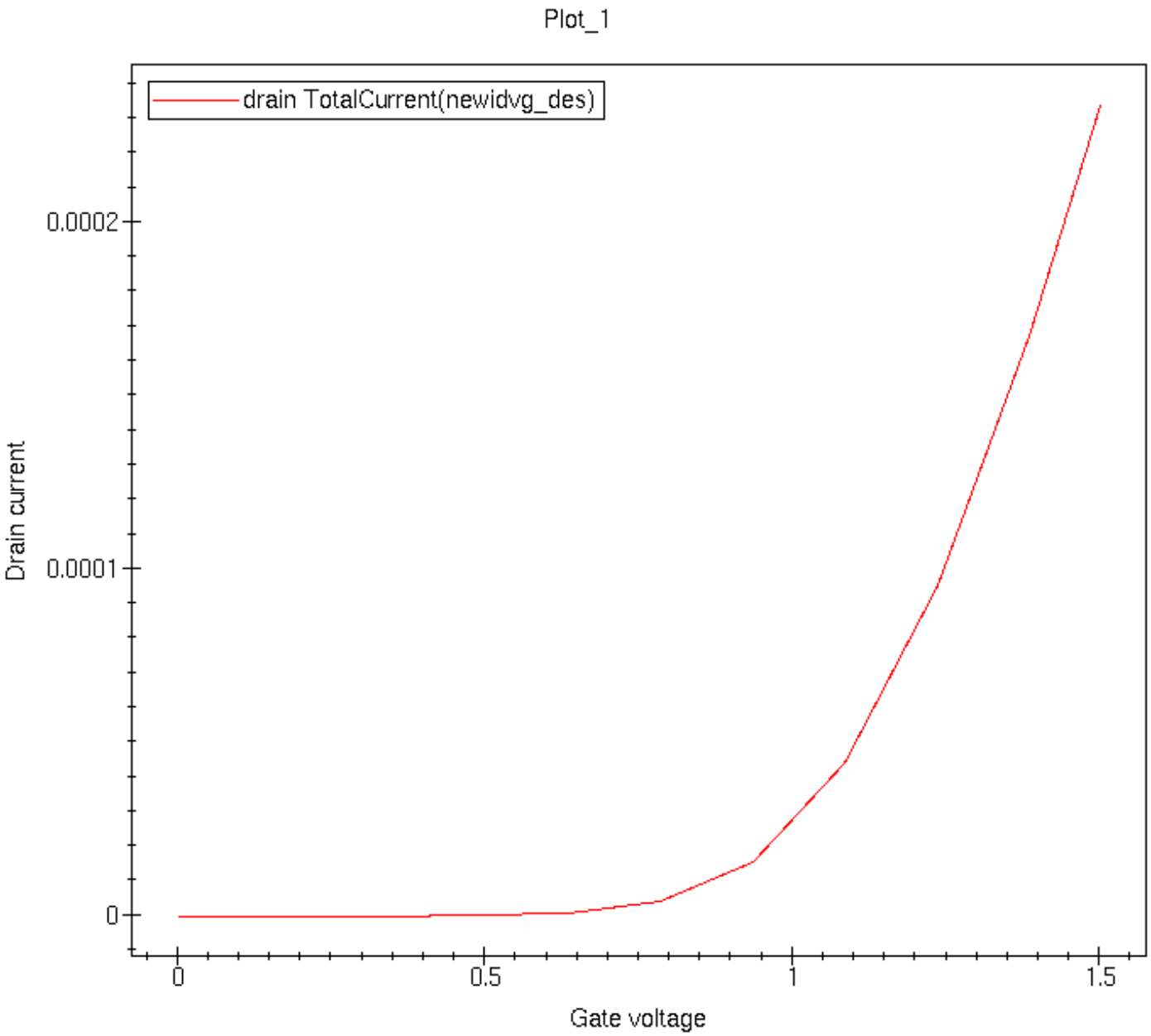


Fig 2: Id-Vg plot

**Results:**

| S.NO | Parameters | Values |
|---|---|---|
| 1. | Vth | 1.2251Volt |
| 2. | Ioff | 1.45878e-14 Amp |
| 3. | Idsat | 2.68642e-10 Amp |
| 4. | Gm(max) | 0.00097673 Amp/Volt |

**Conclusion:**

After making device and performing process flow steps we get plot through svisual.