EDA for Nanoelecronics 2020-2021

Evaluation Project 2

Due on 22nd May 2021

Objectives

This work aims to develop a Python script for the automatic determination of Thin Film Transistor (TFT)model parameters.

Introduction

For the characterization of the TFT behaviour the drain current several models have been proposed in the literature. In this work, the drain current is considered as given by:

$$I_D = \begin{cases} \frac{WC_i}{L_{eff}}\mu_{eff}\left(V_{GS} - V_T - \frac{V_{DS}}{2\alpha}\right)V_{DS} & V_{DS} < V_{DSAT} \\ \frac{WC_i}{2\,L_{eff}}\mu_{eff}\alpha(V_{GS} - V_T)^2 & V_{DS} \geq V_{DSAT} \end{cases} \quad (1)$$

With

$$V_{DSAT} = \alpha(V_{GS} - V_T) \quad (2)$$

and α is a fitting parameter. The effective mobility μ_{eff} is obtained with

$$\mu_{eff} = \mu_0 \frac{(V_{GS} - V_T)^{\gamma}}{V_{AA}}, \quad (3)$$

given that μ_0 is the low bias carrier mobility. A more compact expression for the drain current is then proposed as [1]

$$I_{Dsat} = K(V_{GS} - V_T)^m, \quad (4)$$

where,

$$K = \frac{W}{L_{eff}}\frac{\mu_0}{{V_{AA}}^{\gamma}}C_i\alpha \quad (5)$$

and

$$m = 2 + \gamma \quad (6)$$

Finally

$$I_{DS} = I_D(1 + \lambda V_{DS}) \quad (7)$$

For the determination of the TFT model parameters the files containing the devices output and transfer characteristics obtained.

Methodology

For the accomplishment of this work, the Id characteristics (Vds, Vgs) obtained for from measurements are considered. Output and transfer characteristics of devices with W/L of 50/05, 50/10 and 50/20 μu are available

Part 1

The work should comprise the following steps:

1. Obtain the TFT output and transfer characteristics and plot them

2. Using the transfer characteristic, in saturation,
    a. Obtain the analytical expression for gm
    b. Obtain the analytical expression for ID/gm
    c. Numerically obtain the array containing gm
    d. Obtain Vt, and m by fitting the numerically obtained data for Id/gm to the expression in b.
3. Using the output characteristic for VGS=7V obtain λ
4. Using results in 2. And 3. Obtain *K*
5. Using the output characteristic for VGS=7V obtain α
6. Validate results obtained
7. Drive Conclusions

Part 2

In the second part of the project, contact resistances are to be considered. For the sake of simplicity, only the transfer characteristic will be considered and the contact resistance at the source is to be evaluated, i.e.,

$$I_D = \mathrm{K}\left(V_{gs} - R_s I_D - V_T\right)^{\mathrm{m}} \quad (8)$$

1. Through fitting obtain the new values for *K, Vt, m* and for *Rs*
2. Validate results obtained in 1.
3. Optional – consider obtaining λ having in mind that

$$V_{Ds} = V_{ds} - (R_D + R_s) I_D \quad (9)$$

Bibliography:

[1] R. Rodriguez-Davila, A. Ortiz-Conde, C. Avila-Avendano, and M. A. Quevedo-Lopez, "A New Integration-Based Procedure to Extract the Threshold Voltage, the Mobility Enhancement Factor, and the Series Resistance of Thin-Film MOSFETs," *IEEE Trans. Electron Devices*, vol. 66, no. 7, pp. 2979–2985, 2019