**TAKE HOME MIDTERM: SILVACO**

**(100 POINTS TOTAL)**

UPLOAD YOUR BEST DEVICE’S “.in” FILE

Best device will earn **+10 pts**2nd and 3rd best device will earn **+5 pt**The remainder of the top 50% of devices will earn **+1 pt**

**Take Home Project Objective**

Design and characterize an improved TFT device without changing material properties. Practice presenting and reporting the new device design.

**Given Files**TFT\_old.in

**Overview of Design Criteria**

* Pick one or more device figures of merit (FOM) to improve
  + Field Effect Mobility, **µFE** [cm2/V-s] (**not** effective mobility, µEFF)
  + Subthreshold Swing, **S** [V/dec]
  + On-current Density, **J** [A/cm2] (use output curves to compare)
* **Design parameters** that can be studied
  + **Device** **geometry parameters** (*mandatory to study at least one*)
    - Channel length, **L**
    - Channel width, **W**
    - Channel height, **H**
    - Gate oxide thickness, **tdi** (minimum oxide thickness 35 nm)
  + Materials used for
    - Metal contacts (different metals have different metal work functions)
  + Device architecture
    - Number of Gates
    - Shape of semiconductor, gates, and contacts
* Design parameters that cannot be changed
  + Material parameters
  + Semiconductor channel material

**Report (100 Points)**

***General Instructions****: Make device improvements for one or more of the FOM by changing one or more of the design parameters; your new design must change at least one device geometry parameter. Pick one (or more) design geometry parameter(s) to examine and use a parametric sweep to track how the design parameters impact the FOM. In report, pick one design parametric sweep to write up. Structure the report as follows.*

**Report overview (10 pts)**: Summarize the results of your best design in a FOM data table that includes the value of the FOM, % improvement from old device, and units. Then in a sentence or short paragraph, summarize the parametric study chosen for the report and the trends on the behavior that you saw.

**Table of Old Device Characteristics (30 pts)**: Fill out the following table for the device given in TFT\_old.in.

|  |  |
| --- | --- |
| Figures of Merit | |
| Field Effect Mobility, µFE [cm2/V-s] |  |
| Subthreshold Swing, S [V/dec] |  |
| On-current Density, J [A/cm2] |  |
| Semiconductor Channel | |
| Channel length, L [nm] or [um] |  |
| Channel width, W [um] |  |
| Channel height, H [nm] |  |
| Gate Dielectric | |
| Thickness, t­di [nm] |  |
| Metal Contact | |
| Source work function, Ws [eV] |  |
| Drain work function, Wd [eV] |  |

**Summary of parameter sweep (4 pts)**: Descriptive name of parameter being swept, symbolic name of parameter being swept, values swept, units. Sweep should include at least **5 parameter values**.

**Reasoning for sweeping parameter (4 pts)**:

1. Hypothesis: Expected relationship between device parameter and all 3 FOM. State which FOM(s) enhancement is the focus of this parametric sweep.
2. Bonus: Cite a slide from class or a publication to support your reasoning for +0.1 pts.

**Device analysis (24 pts)**: Plot all FOM with respect to the device parameter being changed. 3 FOM, one plot showing the trend of each FOM, 3 plots total for this section. Each plot should include a caption that explains the general trend in the figure. Choose axis scales that represent the data the clearest. Label units.

**Parametric Study Conclusion (4 pts)**: Summarize your parameter sweep findings. How does this parametric study inform your next TFT design iteration?

**Full Summary of Best Device (24 pts)**:

1. **Figure of Device** (4 pts): Device schematic of your TFT design. Can use an image of the tonyplot “.str” file.
2. **Design Choice** (4 pts): Explain why this device design is the best device. What performance tradeoffs did you experience, if any? Are there fabrication challenges with your design?
3. **Design summary table** (16 pts): Rows are all the parameters that you changed in your device design (including parameters you changed outside of the parameter sweep you reported). The columns compare the old device parameter with your new device parameter. Include units.

**Additional Notes**

**Field effect mobility, µFE [cm2/V-s]**: Report the field effect mobility for the transfer curve at VDS = 10 V and VGS = 15 V.

**Current Density, J [A/cm2]**: Absolute current out divided by the cross section of the TFT channel. (See figure below.) Use output curve to attain one value to use as the J FOM. Report the saturation current density for the output curve at VGS = 10 V.

