

University of California

College of Engineering

Department of Electrical Engineering

and Computer Science

EE143: LAB REPORT 2 — CHARACTERIZATION

LAB SESSION: XXX

**STUDENT A:**

|  |  |
| --- | --- |
| **NAME** | Last First |
| **SID** |  |

**STUDENT B:**

|  |  |
| --- | --- |
| **NAME** | Last First |
| **SID** |  |

**STUDENT C:**

|  |  |
| --- | --- |
| **NAME** | Last First |
| **SID** |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| I /50 | II /25 | III /25 | IV /15 | Total /100 |

1. **Measurements & Parameter Extraction** (50 points)
2. Line Width/Misalignment (2 points)
   1. Summary of measured line widths from each lithography step:

Table 3.1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nominal Linewidth | ACTV  (dark field) | POLY  (clear field) | CONT  (dark field) | METL  (clear field) |
| 2 μm |  |  |  |  |
| 3 μm |  |  |  |  |
| 4 μm |  |  |  |  |
| 8 μm |  |  |  |  |

* 1. Misalignments

1. Four-Point Resistors [2a, 2b] (2 points)
   1. Measurement setup
   2. I-V plot for the diffusion resistor, 2a
      1. Extract resistance, sheet resistance, doping concentration, electron mobility, **
   3. I-V plot for the poly resistor, 2b
      1. Extract resistance, sheet resistance
2. Four-Point Contact Resistor [17a, 17b] (2 points)
   1. Measurement setup
   2. I-V plot for 17a
      1. Extract metal-to-poly contact resistance
   3. I-V plot for 17b
      1. Extract metal-to-diffusion contact resistance
3. Four-Point Contact-Chain Resistor [2c, 2d] (2 points)
   1. Measurement setup
   2. I-V plot for 2c
      1. Extract the resistance
      2. Extract metal-to-diffusion contact resistance
   3. I-V plot for 2d
      1. Extract the resistance
      2. Extract metal-to-poly contact resistance
4. Gate Oxide Capacitors (4 points)
   1. Measurement setup
   2. *C-V* plot of gate oxide capacitor w/ lights ON
      1. Minimum capacitance
   3. *C-V* plot of gate oxide capacitor w/ lights OFF
      1. Minimum capacitance …etc
5. Field Oxide Capacitors (2 points)
   1. Measurement setup
   2. *C-V* plot of field oxide capacitor
   3. Capacitance in the accumulation region
   4. Field oxide thickness
6. Intermediate Oxide Capacitors (2 points)
   1. Measurement setup
   2. *C-V* plot of intermediate oxide capacitor
   3. Capacitance in the accumulation region
7. Diode (2 points)
   1. Measurement setups for forward and reverse operations
   2. *I-V* plots for forward and reverse operation
   3. Extract the turn-on voltage and the series resistance
8. MOSFETs with varying length (10 points)
   1. Measurement setups for *ID-VDS*and *ID-VGS*
   2. Plots of *ID-VDS*, sweeping *VG*
      1. channel-length modulation coefficient, 
      2. vs. *L* plot
   3. Plots of *ID-VGS*, sweeping *VB*
      1. *VT* for each device
      2. *∆L* extraction
      3. *VT* vs. *Leff* plot
9. MOSFETs of varying width (10 points)
   1. Plots of *ID-VDS*, sweeping *VG*
   2. Plots of *ID-VGS*, sweeping *VB*
      1. *VT* for each device
      2. *∆W* extraction
      3. *VT* vs. *Weff* plot
10. Plots of large MOSFETs (10 points)
    1. Plots of *ID-VDS*, sweeping *VG*
    2. Plots of *ID-VGS*, sweeping *VB*
       1. *µeff* vs. *VG* plot
       2. *µsurface*
       3. *VT* vs. plot; explain
       4. the body effect factor ******and substrate concentration *NA*
       5. subthreshold slope
11. Inverters (2 points)
    1. Measurement setup
    2. *Vin*-*Vout* plot
    3. Estimate *VM*
12. **Theoretical Calculation** (25 points)
    1. Measured/calculated physical dimensions and process parameters (1 points)

|  |  |
| --- | --- |
| **Parameter** | **Measured Value** |
| Field *tox* |  |
| Gate *tox* |  |
| Intermediate *tox* |  |
| *Xj* |  |
| *Xj, lateral* |  |
| *ND* |  |

* 1. Resistor (2 points)
  2. Contact Resistance (2 points)
  3. Contact-Chain Resistor (2 points)
  4. Capacitors (4 points)
     + (What is a MOS cap?)
     + Gate oxide capacitance
       - *VT* and *VFB*
     + Field oxide capacitance
       - *VT* and *VFB*
  5. Diode (2 points)
  6. MOSFETs (8 points)
  7. Inverter (4 points)

1. **Discussion** (25 points)
2. **Optional Questions** (15 points)

**Summary of Device Parameters**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Device** | **Parameter** | **Units** | **Measured/ Extracted** | **Theoretical** | **% Error** |
| [2a] | *Rsq* | /□ |  |  |  |
| [2a] | *ND* | cm-3 |  |  |  |
| [2b] | *Rsq* | /□ |  |  |  |
| [17a] | Contact *RC* |  |  |  |  |
| [17b] | Contact *RC* |  |  |  |  |
| [2c] | Resistance *R* |  |  |  |  |
| [2c] | Contact *RC* |  |  |  |  |
| [2d] | Resistance *R* |  |  |  |  |
| [2d] | Contact *RC* |  |  |  |  |
| [3] | Field *tOX* | nm |  |  |  |
| [3] | Field *VT* | V |  |  |  |
| [4] | Gate *CFB* | F/cm2 |  |  |  |
| [4] | Gate *CMIN* | F/cm2 |  |  |  |
| [4] | Gate *VT* | V |  |  |  |
| [4] | Gate *VFB* | V |  |  |  |
| [4] | Gate *tOX* | nm |  |  |  |
| [7] | Turn-on *V* | V |  |  |  |
| [8] | ∆*L* | m |  |  |  |
| [9] | ∆*W* | m |  |  |  |
| [10] | *VT* | V |  |  |  |
| [10] | Body effect *γ* | V1/2 |  |  |  |
| [10] | *NA* | cm-3 |  |  |  |
| [10] | Low-field ** | cm2/(V-s) |  |  |  |

Note: “Measured/Extracted” is the data measured and/or extracted in Section I. “Theoretical” is the data estimated theoretically in Section II or obtained from Lab Report 1.

**EECS 143 Lab Report 2**

Spring 2010

In signing below, I attest to the fact that I have read and have adhered to the policies

and guidelines discussed in the EECS Departmental Policy on Academic Dishonesty,

as found at: <http://www.eecs.berkeley.edu/Policies/acad.dis.shtml>

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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