ECE139 Spring 2009
Problem Set #3

Handed Out: May 5 Due date: May 14

Objective

This problem set deals with MOSFET simulations using Silvaco software.
For simplicity, the Silvaco problems are closely related to the Silvaco file templates mosproc.in and locosproc.in.

- *Login to ieng9 or ee3327-10, 11, 12...*
- *Type prep ee139s, this provides path entries to our course*
- *In directory ee139s/public, find mosproc.in, locosproc.in and mostest.in; copy them to your directory*
- *Type prep silvaco, this provides path entries to the silvaco software*
- *Type deckbuild &, this starts silvaco menu driven control program.*
- *After modifying and executing your programs, type tonyplot &, this starts the silvaco plotting program in order to view the results.*

If you are using your own computer (rather than an ACS workstation) in order to allow the program to open windows you should use Xmanager or related software. This can be downloaded from the web.

Problem 1

Simulate the fabrication process of the field oxide in the neighborhood of an n-channel MOSFET, using the Silvaco program Athena according to the process listing provided (locosproc.in). This simulates the LOCal Oxidation of Silicon (LOCOS) process.
a) Use the template provided, with suitable modifications, to determine how the oxide thickness changes as a function of oxidation time under the specified conditions (1000C wet oxidation). Make a plot (using excel or just simple graph paper) of thickness vs representative times, ranging between 10 and 200 minutes.
b) Determine the profile of boron after implantation, and after the oxidation step. Comment on the changes. Estimate how much of the implanted boron remains in the silicon.
c) Estimate the threshold voltage of the FET formed between the aluminum "gate electrode" placed on the surface and the "channel" at the bottom of the oxide.
(this is already provided, in simple 1 dimensional approximation, by the extract function in the file).
d) Modify the process so that the threshold is increased by 1V. Explain your reasoning for the process changes.

Problem 2

Simulate the fabrication process of an n-channel MOS transistor in a p-well, using the Silvaco program Athena according to the process listing provided (mosproc.in).
a) Determine how much doping there is in the LDD regions of the device, and in the source/drain regions. For example, determine the peak doping concentration in these two regions, using a cutline.
b) Estimate the sheet resistance (in ohms/square) of the source/drain material. An "extract" command in the athena file can be used for this; the data shows up in the deckbuild output window at the bottom of the deckbuild gui.

c) Determine the oxide thickness at the center and the edges of the gate. Can you suggest why it varies at the edges?
d) How deep does the doping concentration from the threshold shifting implant extend?
e) Vary the implant dose of the threshold shifting implant in order to shift the threshold voltage (for a large channel device, as estimated by Athena). It is desired to shift the threshold by +0.5V. Determine the proper dose to accomplish this shift, and show the results using Athena. Compare the simulated result with the expectations based on simple theory.