Diode Process TCAD Simulation

Lab1

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ABSTRACT:

In this lab, we became familiarized with how to run the Technology Computer-Aided Design (TCAD) tool by implementing computer simulations that help us develop and optimize technologies and devices based on semiconductors. We began with simulating the process for building a diode which included several definitions (mask, simulation area, initial 2D grid, and metal pads) and settings (STI photo mask, N-well photo mask, and N-plus and P-plus implantations). During the diode simulation, it is important to understand the steps simulated during this process: etching, deposition, ion implantation, thermal annealing, and oxidation as they are all based on physical equations. After uploading the commands that enable us to process the diode, we used “svisual &” to view the simulation results on a 2-D graph.

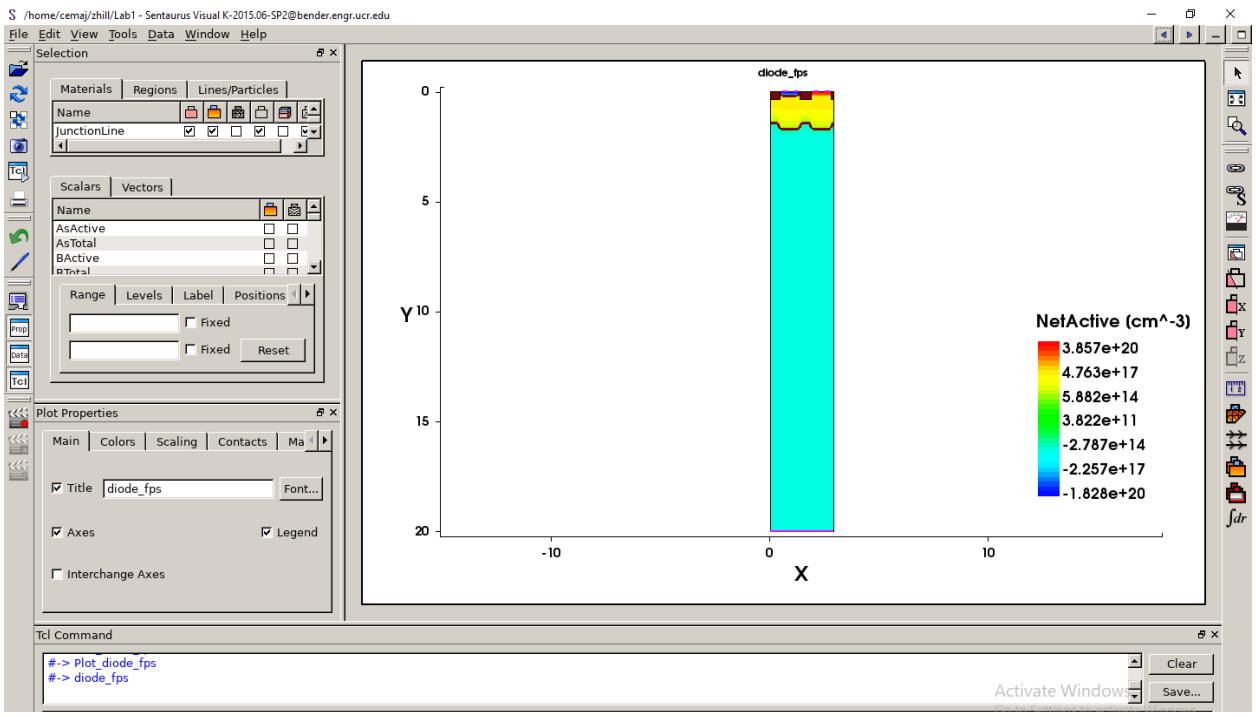
Commands:

1. bender /home/cemaj/zhill $ mkdir Lab1

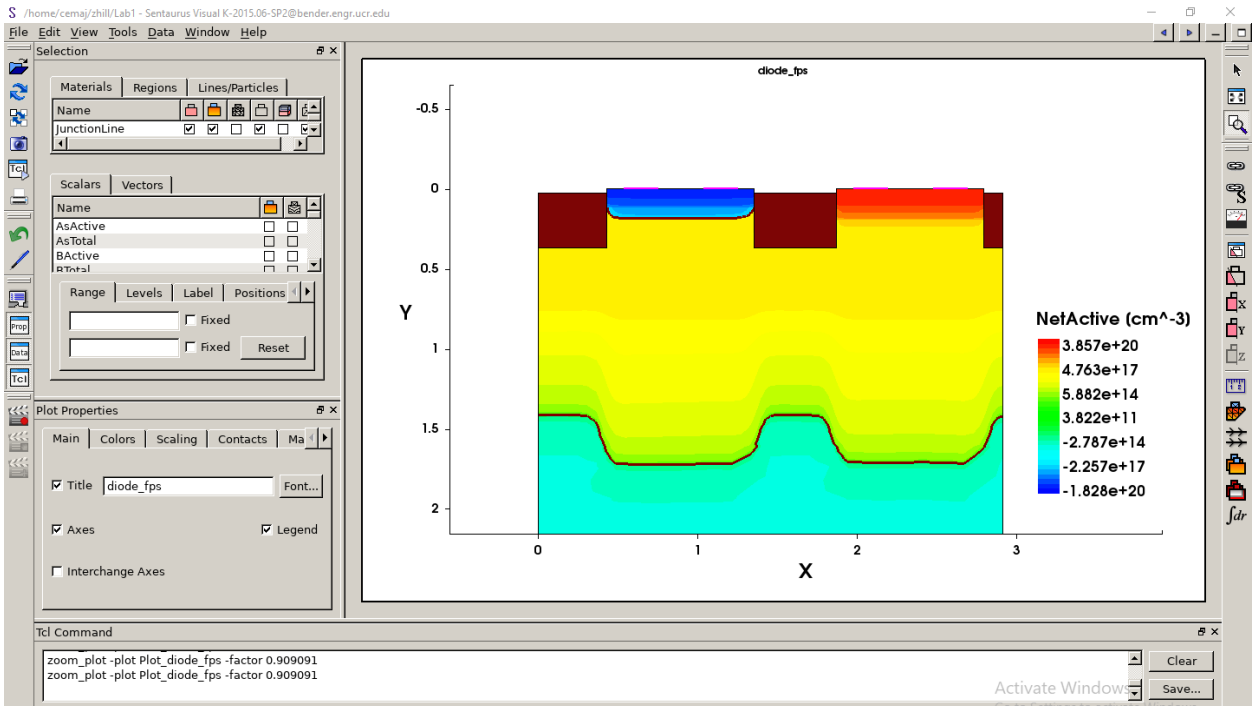
2. bender /home/cemaj/zhill $ cd Lab1

3. bender /home/cemaj/zhill/Lab1 $ sprocess Diode_NW_Pplus_CSMC.cmd &

4. bender /home/cemaj/zhill/Lab1 $ svisual &



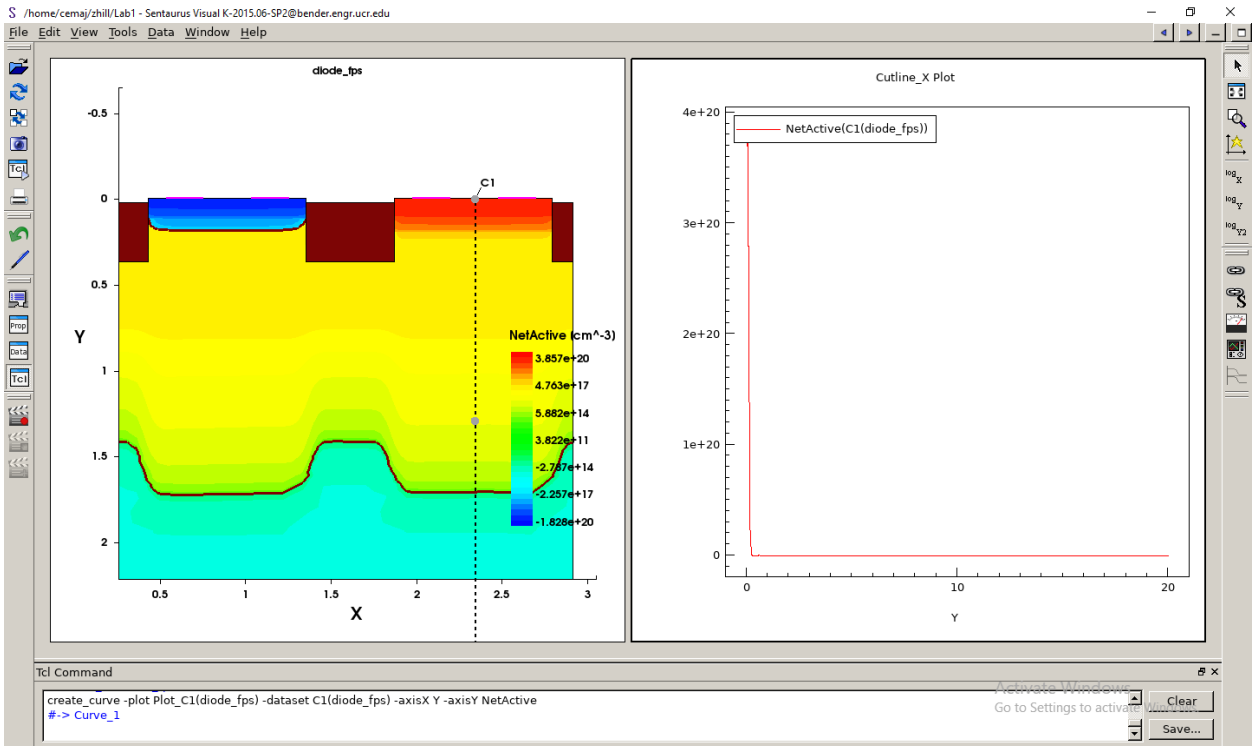
(a)



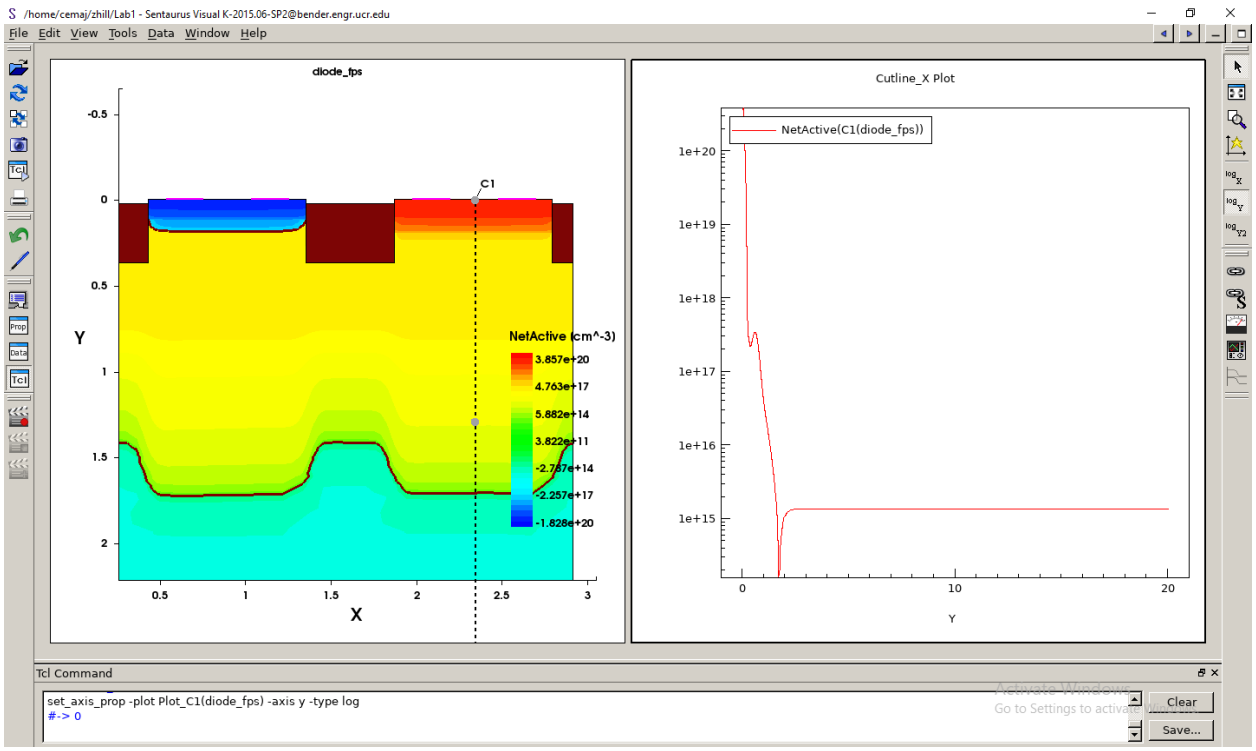
(b)

Figure 1: Diode simulation result; (a) initial bar graph, (b) zoomed-in version of top

After using “svisual &”, the X-section diode simulation result (diode_fps) and doping profile is shown in Sentaurus Visual. You can begin to see the color differences that form the STIs, Pplus, Nplus, N-well, and P-sub. There is clearly a major difference in the net-active concentration starting just below Y = 1.5, the STIs are just below 0.5, Pplus and Nplus are around 0.25, and the range for X is 0 ~ 2.9.



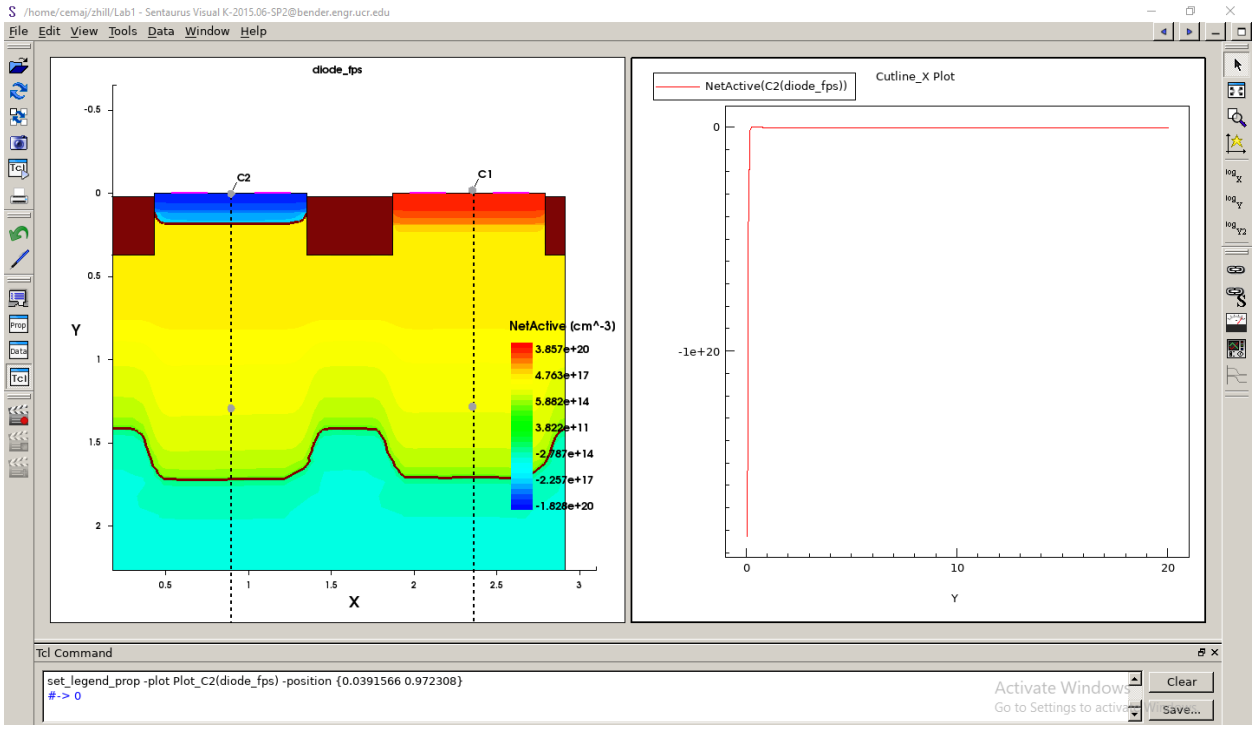
(a)



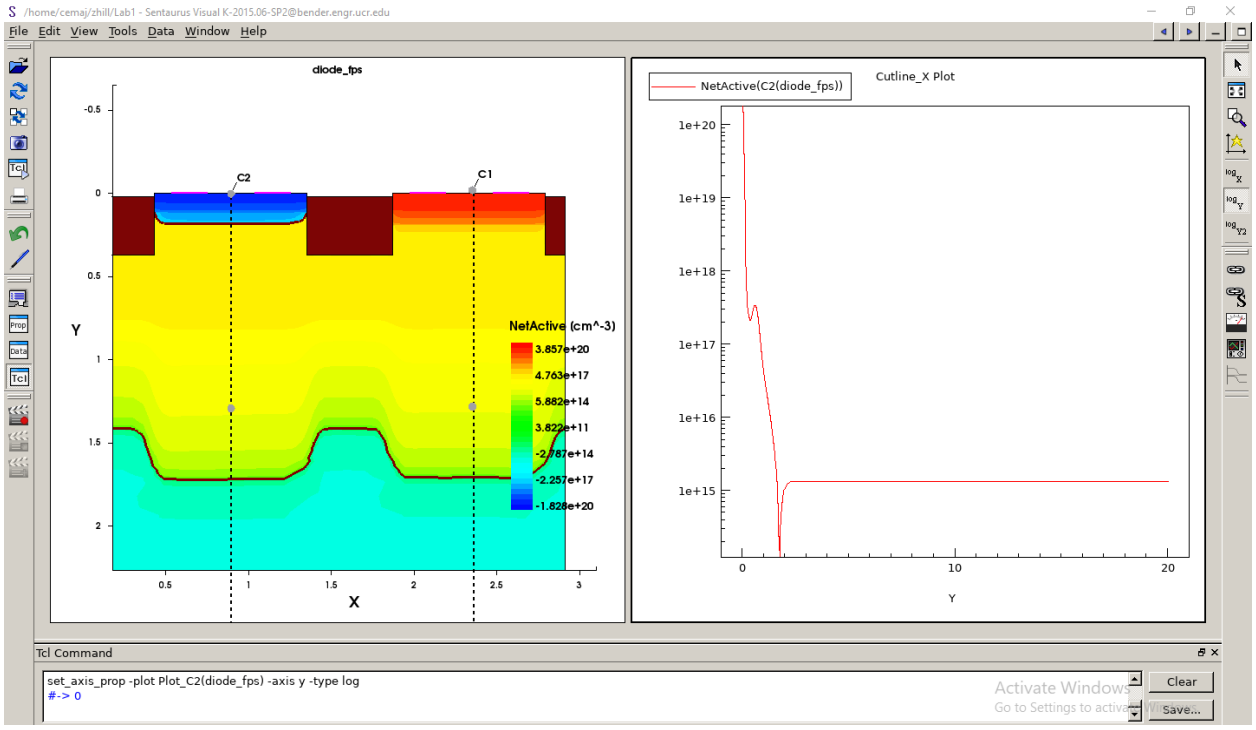
(b)

Figure 2: One-dimensional profile of net-active in Nplus; middle of Nplus selected: (a) initial graph (Nplus vs. Depth), (b) log(y) graph (Nplus vs Depth)

By clicking the X-cut tool then clicking the middle of the nplus region, a 2-D graph, Nplus vs. Depth, is displayed showing a one-dimensional profile of net-active concentration. The first graph shows the line moving straight down very slowly until it reaches zero where it becomes fixed at Y=0. The second graph shows a little more movement as it goes down but then shoots back up until it reaches Y=0 then remains fixed at Y = 3e+15.



(a)



(b)

Figure 3: One-dimensional profile of net-active concentration in Pplus; middle of Pplus selected: (a) initial graph (Pplus vs. Depth), (b) log(y) graph (Pplus vs Depth)

Similar to Figures 2(a) and (b), except the 2-D graph represents the one-dimensional profile of net-active concentration for Pplus vs. Depth. While the first graph shows the reverse effect with the line going up from negative values then remaining fixed at Y=0, the second is the exact same as that of Nplus.

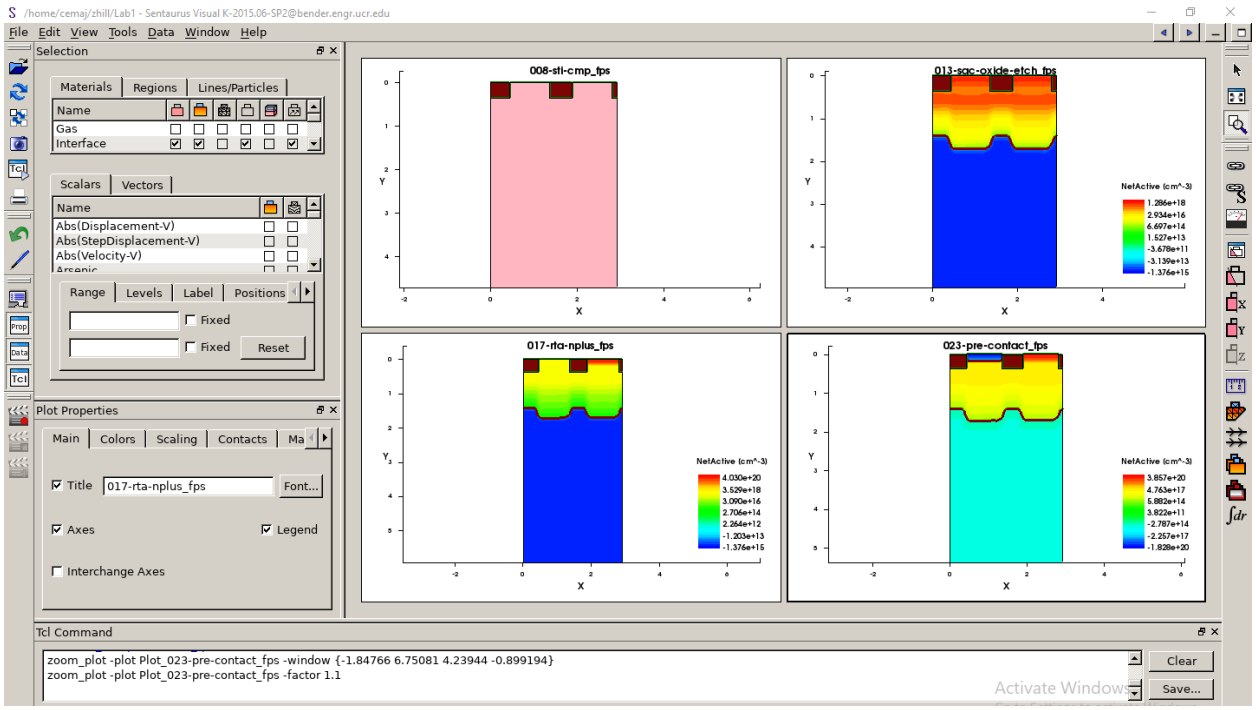


Figure 4: The entire process of forming a diode

Top-left (STI formed); Top-right (N-well implanted);

Bottom-left (Nplus implanted); Bottom-right (Pplus implanted)

Here are all four process steps that represent the diode simulation result when (1) STI is formed, (2) N-well is implanted, (3) Nplus is implanted, and (4) Pplus is implanted. These are four individual components of the actual diode structure in addition to P-Sub, Anode, and Cathode. Very similar designs except for STI which basically remains the same color throughout.