Diode Mesh and Sdevice TCAD Simulation

Lab2

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ABSTRACT:

In this lab, we used the same devices from lab 1 (TCAD simulation, Sentaurus Structure Editor, and Sentaurus Device (new)) to initiate build mesh for the device structure of Pplus Nwell Diode. The meshing strategies are set up to provide 2D images, in the SDE simulation, to define the maximum and minimum meshing sizes to a specific target. This target can be one of various representations such as a material, device region, or user-defined evaluation window. We also learned about the new device, Sentaurus Device, which is a numeric semiconductor device simulator that can simulate different characteristics (electrical, thermal, and optical) for various semiconductor devices. Although we still simulated 2D images, the device operates on a wide variety of operating conditions, including mixed-mode circuit simulation. We are able to see the simulation results, under the condition of HBM (human body model) standard 2KV pulse, for the diode's electrical and thermal characteristics. Also, the 2D images (current density and temperature distribution) and the graphs (I vs. V and Tmax vs. time) are shown in different devices, either 'svisual' or 'inspect'.

Commands:

1. bender /home/cemaj/zhill $ mkdir Lab2

2. bender /home/cemaj/zhill $ cd Lab2

3. bender /home/cemaj/zhill/Lab2 $ sde –l m3d_mine.jrl -noopenGL

4. bender /home/cemaj/zhill/Lab2 $ sdevice hbm_for_diode18_csmc.cmd &

5. bender /home/cemaj/zhill/Lab2 $ svisual &

6. bender /home/cemaj/zhill/Lab2 $ inspect &

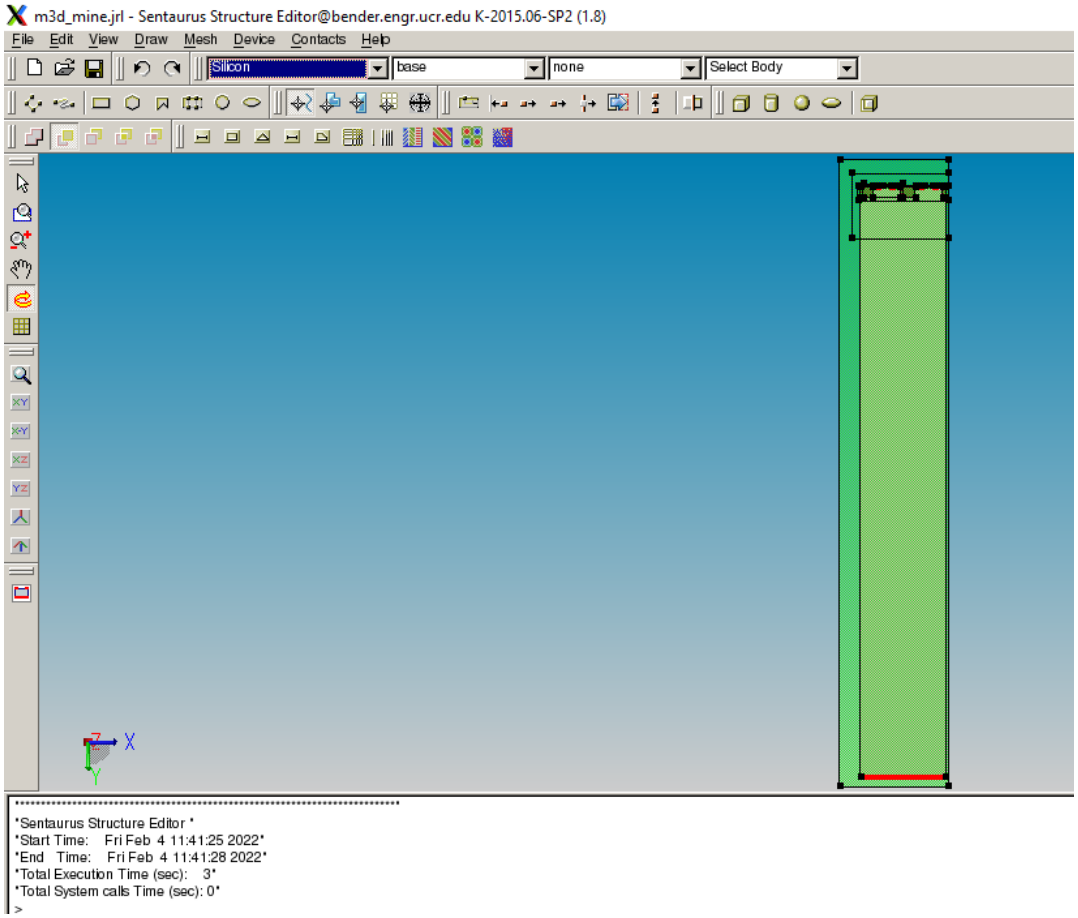


Figure 1: diode (Pplus Nwell) device structure simulation

After inputting the command “sde -l m3d_mine.jrl” to initiate the sde implementation, we acquire the 2D image, in Figure 1, of the diode device structure using the same Sentaurus Structure used in lab 1. We can see two layers laden over with black lines forming the shapes of each component of the diode.

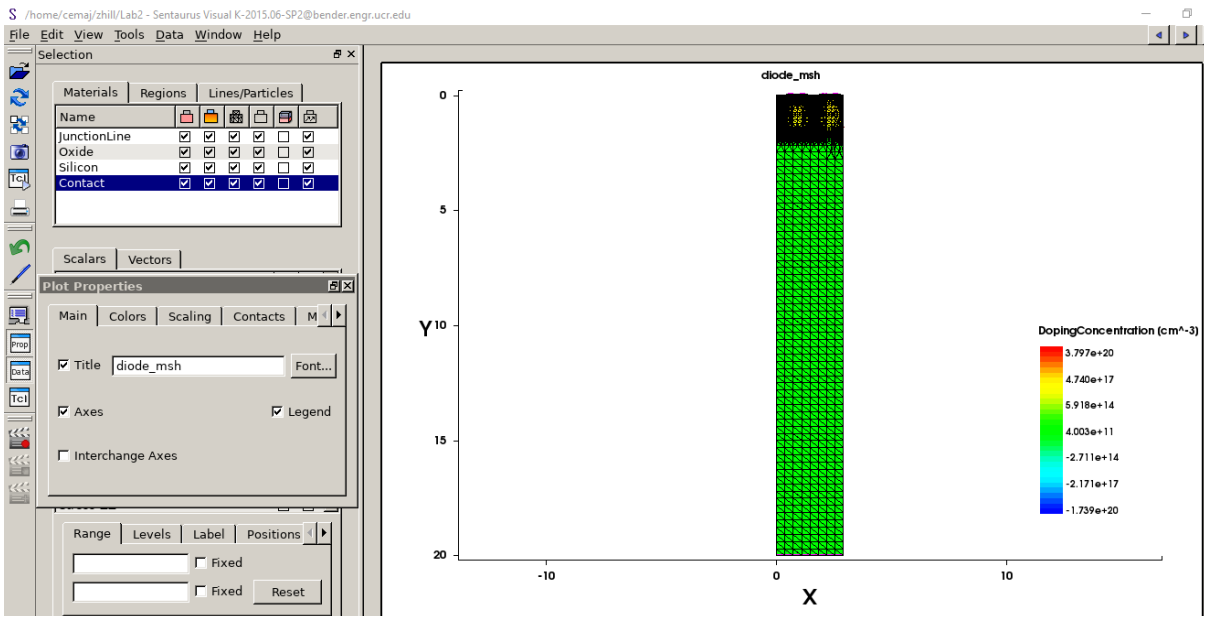


Figure 2: diode (Pplus Nwell) with built mesh

After checking each mesh box for all four materials, the build mesh representation of the diode structure is shown in Figure 2. Most of the structure consists of green colored doping with various contact points with more activity towards the top since that is where the main components lie. The image only goes up to X ~ 4 and Y ~ 20 and, unlike in Figure 1, only one green layer is visible.

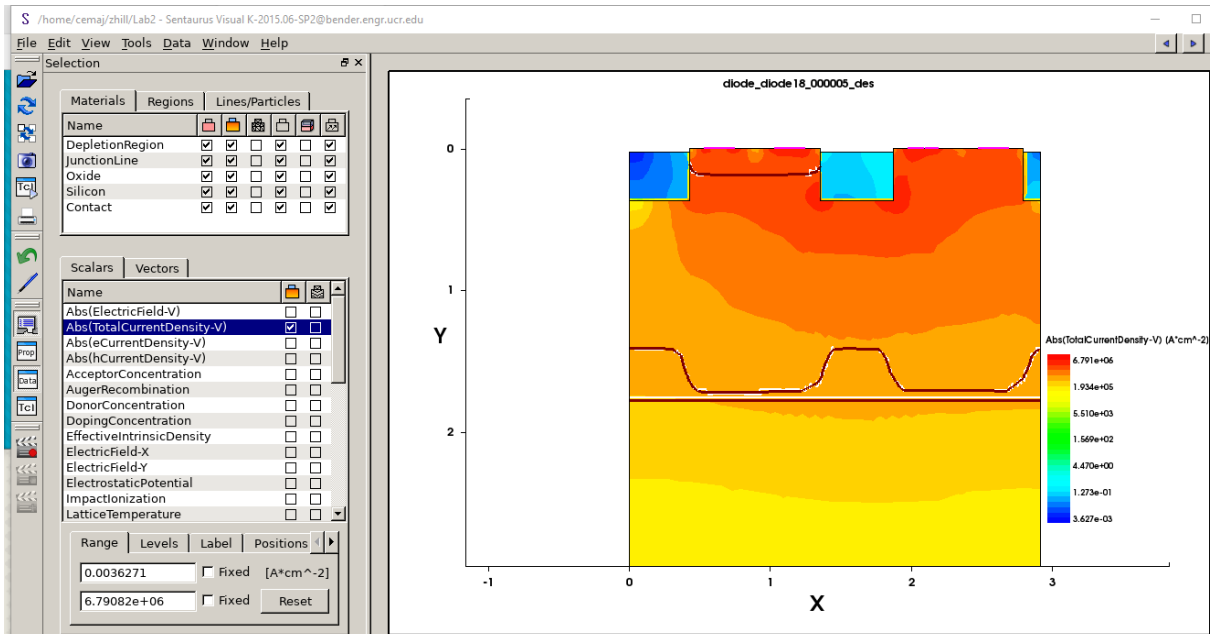
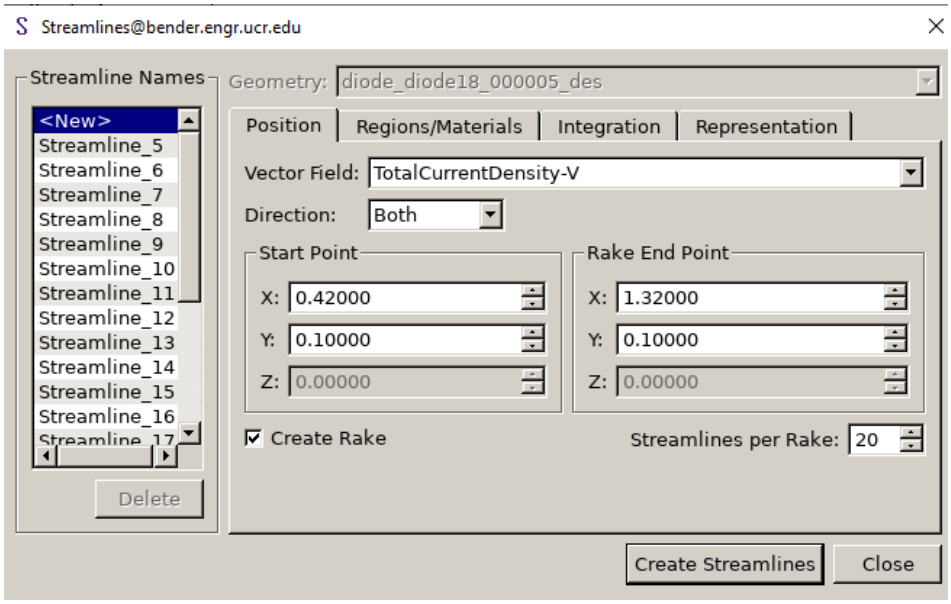
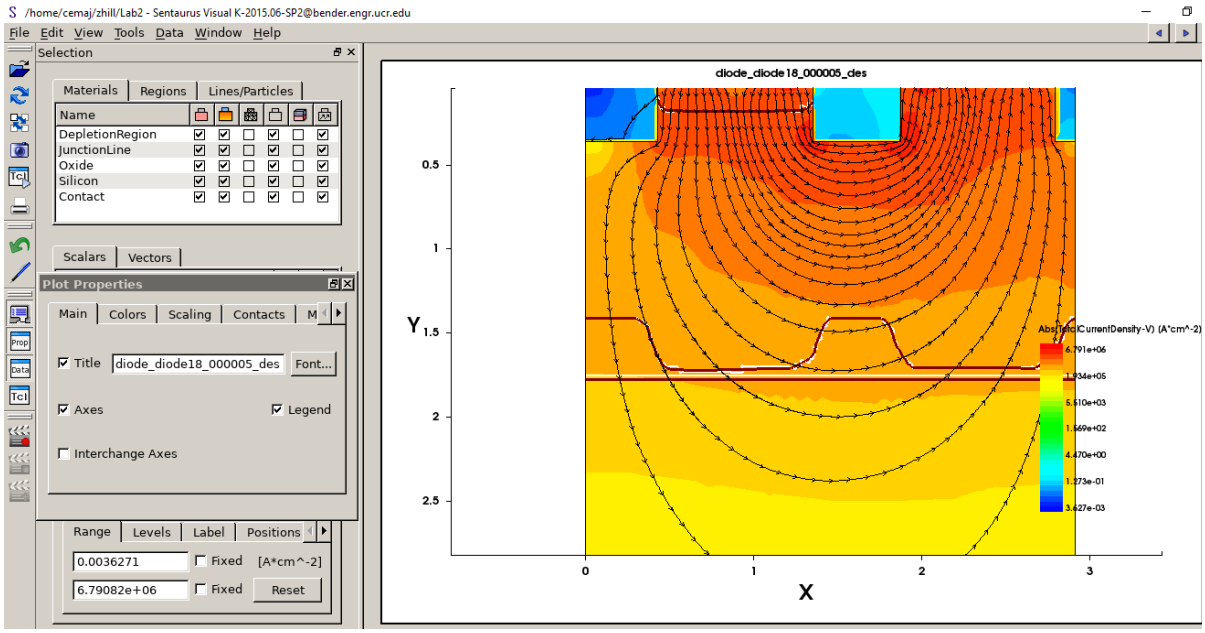


Figure 3: Current flow for diode

The values of current, i.e. the hotter contact spots, are closer to Pplus, Nplus, and outside the STIs while the STIs themselves contain the lowest values in the image. Both X and Y range from 0 ~ 3 and the same measurements for the components and curved line as in lab 1.



(a)



(b)

Figure 4: streamlining the diode; (a) types of streamlines being created, (b) streamlines curving within the diode

Twenty streamlines are created per rake, each initialized with starting point (X = 0.42 and Y = 0.1), end point (X = 1.32 and Y = 0.1), two-way directional, and total current density as the vector field. You can see each streamline curves around the middle STI, and avoids the other two STIs, with very little distance between them but this distance increases as each new streamline curves out more within the light-orange and yellow areas. These streamlines are mainly used to measure the diode current flow; the color gradient represents the thermal characteristics.

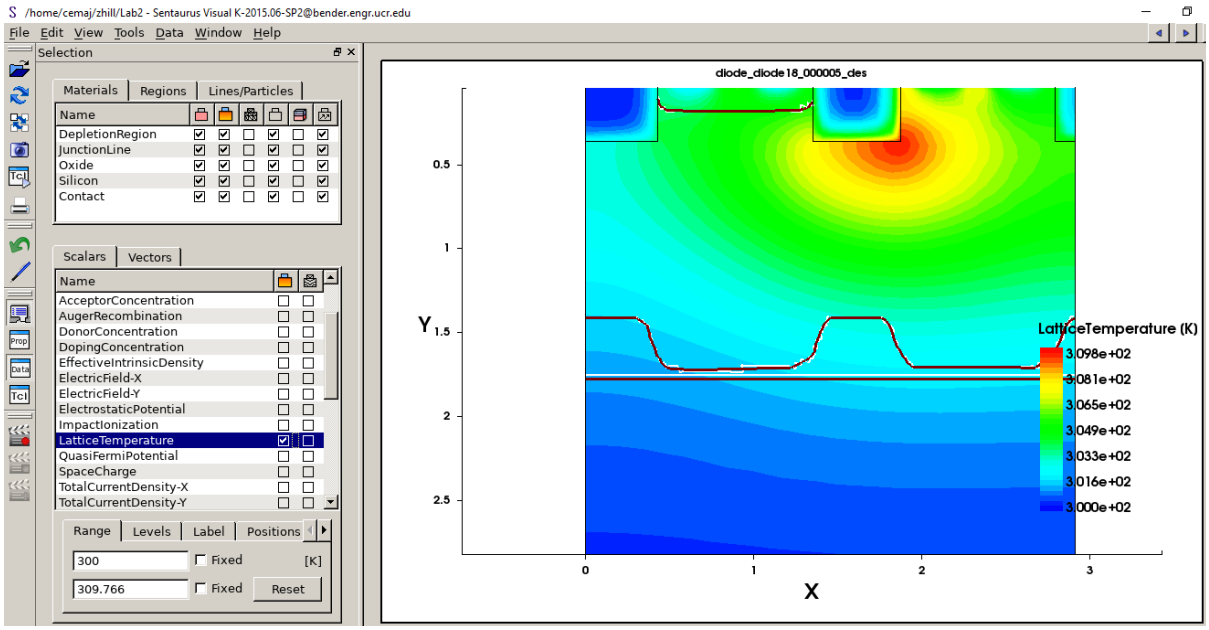


Figure 5: temperature distribution for diode

The temperature appears to get hotter towards the top around the middle STI but the right. For this HBM diode, warmer regions refer to contact points that are accessed quite often.

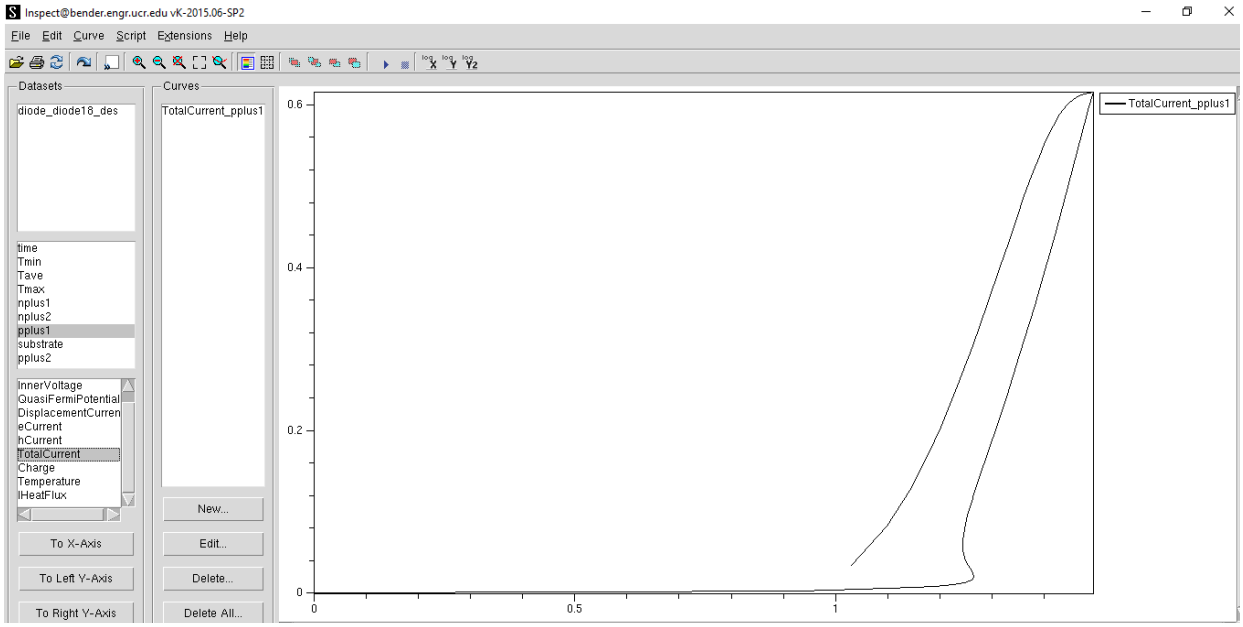


Figure 6: current vs. voltage curve

The curve begins to move up slowly until it reaches X > 1.25 where it changes direction and curves upward much more quickly. At X < 1.25, the direction changes again and remains constant up until X = 1.5. After changing direction yet again, only this time going downward, the line remains straight for a while then begins to slowly curve and comes to a complete stop almost right before X=1.

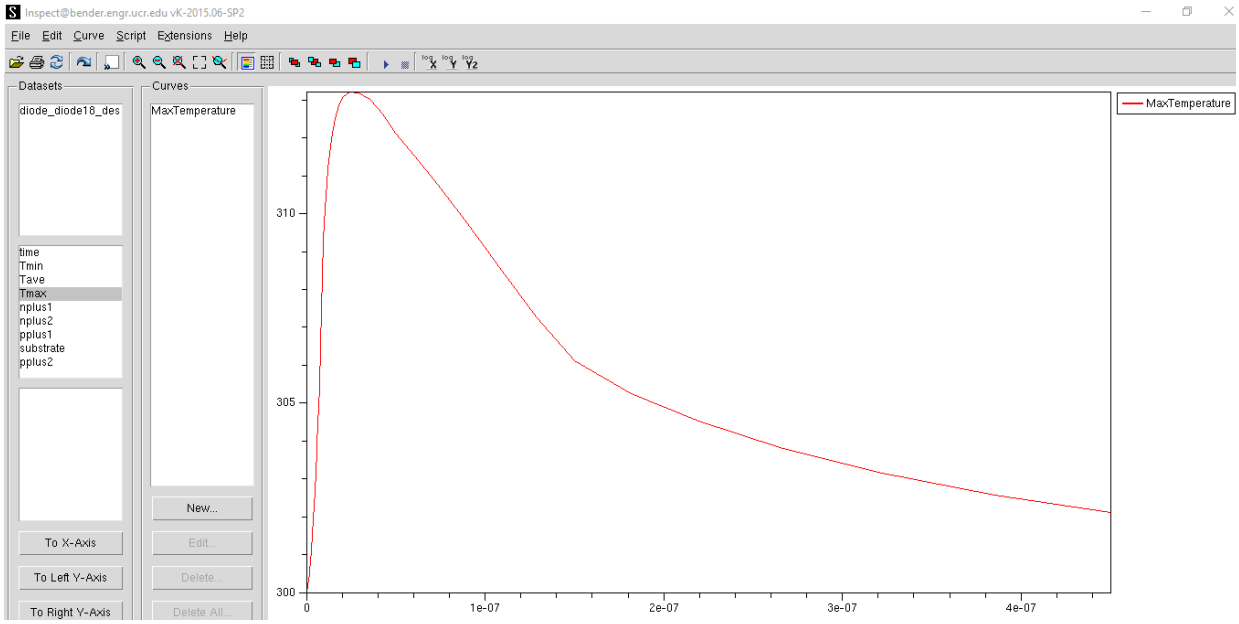


Figure 7: temperature vs. time curve

The graph in Figure 7 is a bit more consistent than that Figure 6 since we're not comparing any output of the diode. The line moves straight up very quickly up until about X = 0.4e-07, along with max temperature ~ 314, where it begins to curve downward. You can clearly see a few curved and straight lines within this next portion of the graph, going from convex (outward) to concave(inward), but the line keeps moving downward throughout.