Using TSUPREM4

What is TSUPREM4?

- Two dimensional process simulation program
  (if simulation is uniform in x direction, ie, no patterns on wafer, it resembles suprem 3)
- Simulates implantation, diffusion, oxidation, etching, deposition, lithography, epitaxy
- Output: stresses, boundaries of various layers, impurity distribution

Using TSUPREM-4

- See Handout for Stanford specific information (TSUPREM4tutorial)
- Create a *text* file with TSUPREM4 commands using Emacs, VI or your favorite editor
- To run your file at the command prompt, type:

```
tsuprem4 <filename>
```

- Output is in file named `<filename>out`

INPUT STATEMENTS

BASIC STATEMENTS
- Title
- Comment (or $)
- Initialize
- Stop
- +

PROCESS SEQUENCE STATEMENTS
- Implant
- Diffusion
  - anneal: temperature cycle in nitrogen ambient
  - oxidation: wet O2 or dryO2 ambient
- Epitaxy
- Etch
- Deposition

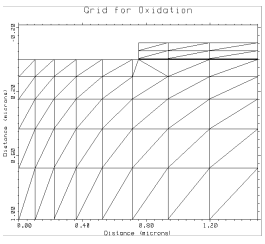
OUTPUT SPECIFICATION STATEMENTS
- Plot
- Print
- Savefile save current structure to a file

CALCULATION STATEMENTS
- VThreshold
- Electrical

Gridding in TSUPREM4

- Denser grid in areas where a lot of action occurs and where precision of information is important
  - ie thin layers, areas with steep dopant profiles
- Use the `line` command to create grid structure

Gridding in TSUPREM4 (Cont)



LINE X LOC=00 SPAC=01
LINE X LOC=15 SPAC=03

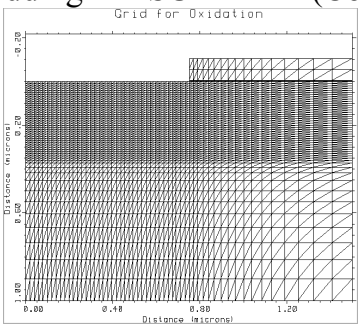
LINE Y LOC=0 SPAC=01
LINE Y LOC=1 SPAC=03

Gridding in TSUPREM4 (Cont)

- `LINE  X  LOC=00  SPAC=002`
- `LINE  X  LOC=075  SPAC=002`
- `LINE  X  LOC=100  SPAC=004`
- `LINE  X  LOC=15  SPAC=01`

- `LINE  Y  LOC=0  SPAC=001`
- `LINE  Y  LOC=35  SPAC=001`
- `LINE  Y  LOC=5  SPAC=005`
- `LINE  Y  LOC=1  SPAC=010`

Gridding in TSUPREM4 (Cont)



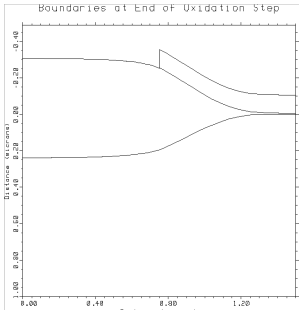
Sample File

```
$ Set up the grid
LINE  X   LOC=00  SPAC=002
LINE  X   LOC=075  SPAC=002
LINE  X   LOC=100  SPAC=004
LINE  X   LOC=15  SPAC=01
LINE  Y   LOC=0   SPAC=001
LINE  Y   LOC=35  SPAC=001
LINE  Y   LOC=5   SPAC=005
LINE  Y   LOC=1   SPAC=010

$ No impurities, for faster oxidation simulation
INITIALIZE

$ Deposit pad oxide and define nitride mask
DEPOSITION OXIDE   THICKNES=0005  SPACES=5
DEPOSITION NITRIDE  THICKNES=010  SPACES=2
ETCH      NITRIDE  LEFT P1X=75
ETCH      OXIDE   LEFT P1X=75
```

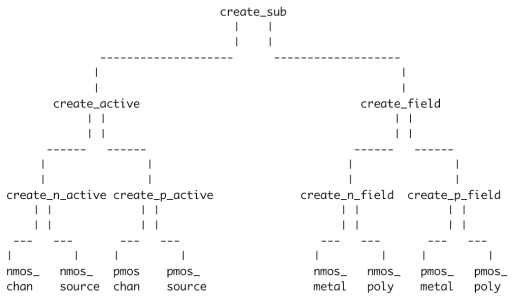
Sample File (Cont)

```
$ Plot the grid
OPTION    DEVICE=PS PLOTOUT=PLOT1ps
SELECT    TITLE="Grid for Oxidation"
PLOT2D    GRID  SCALE

$ Do the oxidation
DIFFUSION  TEMP=1000  TIME=100  WETO2

OPTION    DEVICE=PS PLOTOUT=PLOT1Aps
SELECT    TITLE="Boundaries at End of Oxidation Step"
PLOT2D    SCALE  BOUNDARY

$ Save the structure – Can use LOADFILE INFILE=EE311-1 to load structure in other files
SAVEFILE   OUTFILE=EE311-1
```

Sample File (Cont)



Hierarchy of SUPREM files



Create sub-structures (use loadfile or initialize to load structure and savefile to save structure)

Getting help

- Enter TSUPREM4 interactive mode Type help <command_name>

```
>>tsuprem4 <enter>
Enter the input file name (press return for interactive mode)
File name: <enter>
TS4> help implant <enter>
```

- Examples in the directory:
  /usr/class/ee410/tma/tsuprem4_200240/examples/
- Manual in the directory:
  /usr/class/ee410/tma/manuals_pdf/tsuprem4_200240/S4_20024pdf
- Email us: EE410TAs@cisstanfordedu