Atlas

Structure

Mohammad Mahdi Khatami

2016

The Order of ATLAS Commands

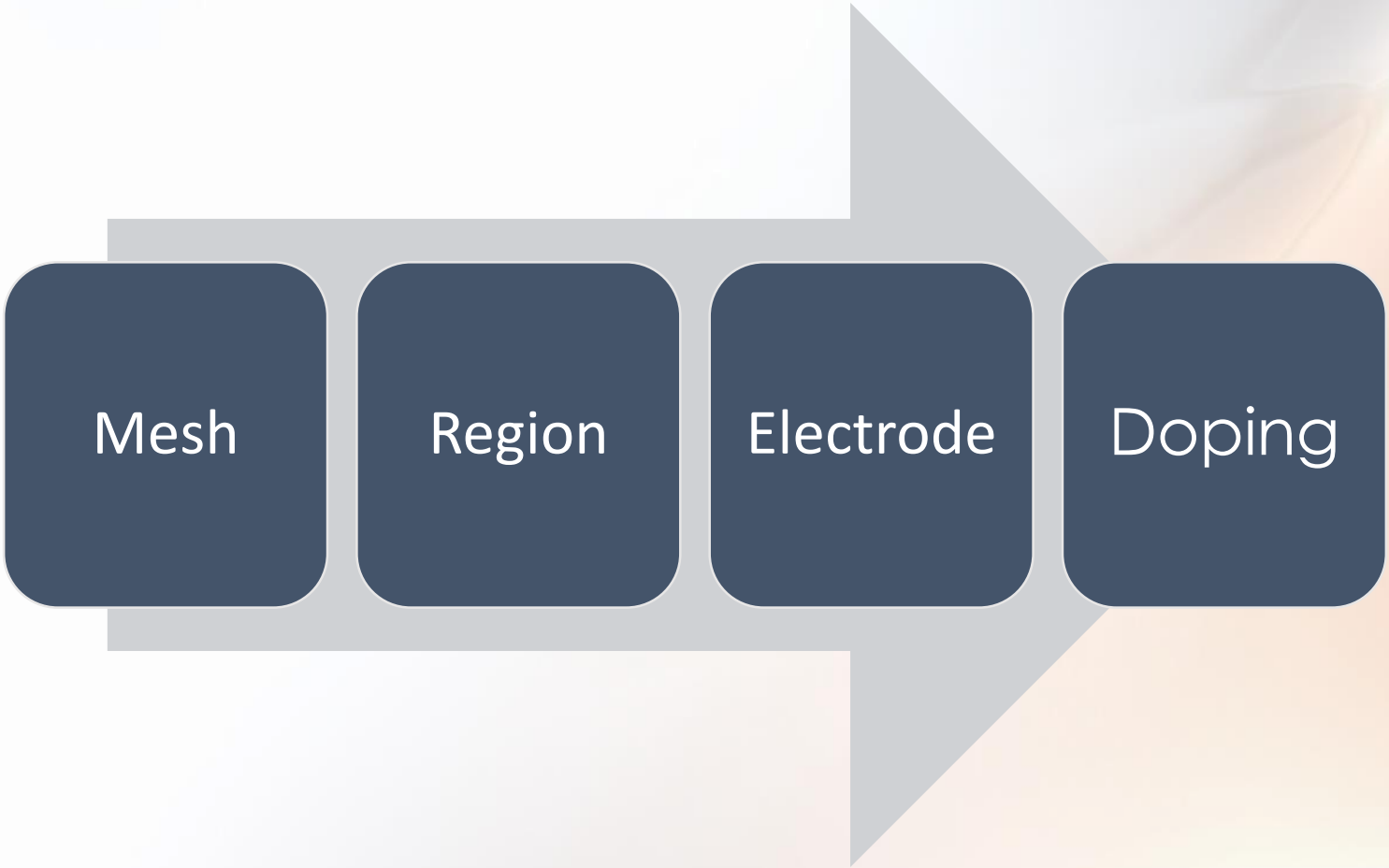
Group	*Statements*
1. Structure Specification	MESH REGION ELECTRODE DOPING
2. Material Models Specification	MATERIAL MODELS CONTACT INTERFACE
3. Numerical Method Selection	METHOD
4. Solution Specification	LOG SOLVE LOAD SAVE
5. Results Analysis	EXTRACT TONYPLOT

Define A Structure

1. Reading an existing structure file:
   MESH INFILE=<filename>
2. **Automatic Interface** feature from DECKBUILD (transfer the input structure from ATHENA)
3. ATLAS command language

mmkhatami@aut.ac.ir, mm.Khatami@modares.ac.ir

Define A Structure



Mesh

- Mesh statement specifies: 1-simulation steps 2-the device dimensions.

1. Mesh size has a direct influence on simulation accuracy and time.
2. Finer mesh grid should exist in where more accuracy is needed e.g. p-n junction.
3. Mesh node should be available in different material interfaces.

Mesh Statement

Mesh space.mult=<value>

x.mesh location=<value> spacing=<value>

y.mesh location=<value> spacing=<value>

- SPACE.MULT parameter value is used as a scaling factor (Values greater than 1 will create coarser mesh for fast simulation.)

Mesh Statement

- At least two mesh lines for each direction should be specified.
- 2D ATLAS simulations have a maximum node limit of 100,000. 3D ATLAS simulations have an upper limit of 40,000,000 nodes.

Region

REGION number=<integer> <material_type> <position parameters>

- Region numbers must start at 1 and are increased for each subsequent region statement.
- Up to 200 different regions can be defined in ATLAS.
- If a composition-dependent material type is defined, the x and y composition fractions can also be specified in the REGION statement.

Region

- Example :

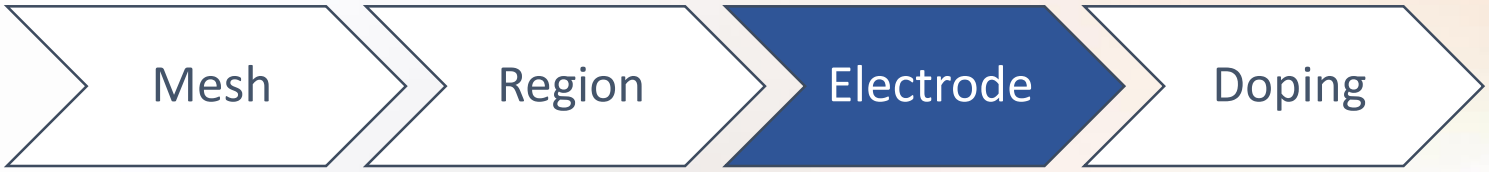
REGION NUM=1 Y.MAX=0 MATERIAL=OXIDE

REGION NUM=2 Y.MIN=0 MATERIAL=SiGe X.COMP=0.2

Electrode

ELECTRODE NAME=<electrode name> <position_parameters>

- You can specify up to 50 electrodes.
- Electrodes with the same name are electrically connected.
- If no Y coordinate parameters are specified, the electrode is assumed to be located on the top of the structure.

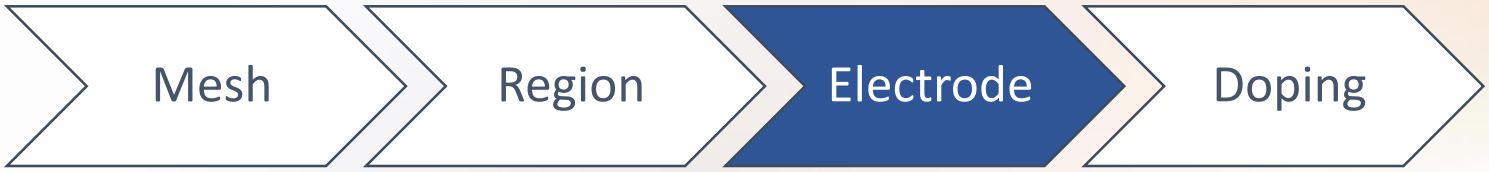


Electrode

- RIGHT, LEFT, TOP, and BOTTOM parameters can be used to define the location.

- Example:

ELECTRODE NAME=SOURCE LEFT LENGTH=0.5



Doping

DOPING <distribution_type> <dopant_type> <position_parameters>

- Distribution types: 1. uniform 2. gaussian 3. complementary error function
- Dopant type: 1. n.type 2. p.type

Uniform

Example 1:

DOPING UNIFORM CONCENTRATION=1E16 N.TYPE REGION=1

Specifies a uniform n-type doping density of 10^{16} cm^{-3} in the region that was previously labelled as region #1.

Gaussian

Example 2:

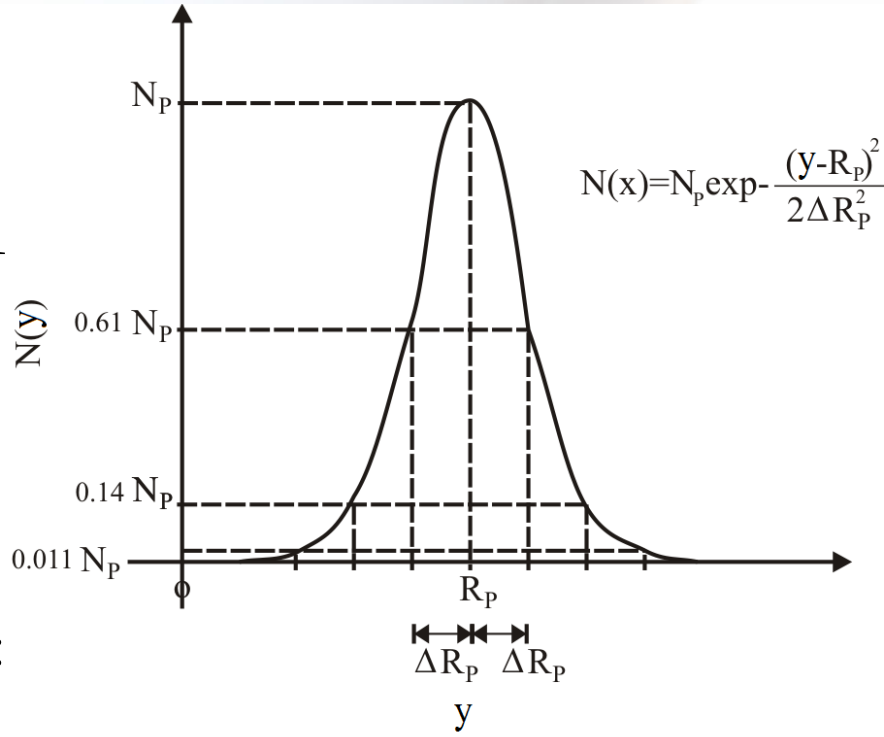
DOPING GAUSSIAN CONC=1E18 CHARACTERISTIC=0.05 P.TYPE X.LEFT=0.0 X.RIGHT=1.0 PEAK=0.1

- $N_p = 10^{18}\ cm^{-3}$
- $R_P = 0.1$
- Standard deviation in the region:

$\Delta R_P = characteristic/\sqrt{2}$

- Standard deviation outside the region:

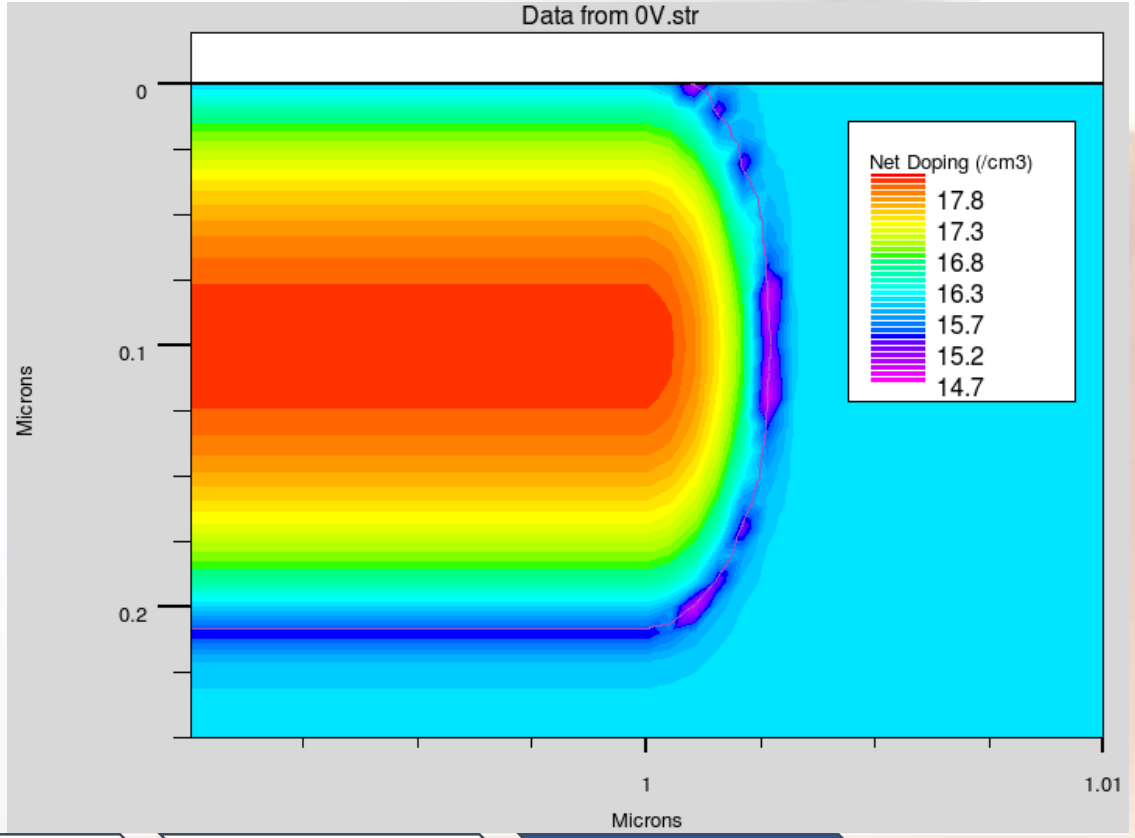
$0.7*(characteristic/\sqrt{2})$



Mesh → Region → Electrode → Doping

Gaussian

- Lateral roll-off can be altered with the RATIO.LATERAL parameter.
- JUNCTION also can be used to specify the position of the junction.



Mesh → Region → Electrode → Doping

Complementary Error Function

Example 3:

DOPING ERFC N.TYPE PEAK=0.5 JUNCTION=1.0 CONC=1.0E19 X.MIN=0.25 X.MAX=0.75 RATIO.LAT=0.3 ERFC.LAT

DOPING P.TYPE CONC=1E18 UNIFORM

- Doping profile=N_p*Erfc[(y-PEAK)/CHAR]

Where char is calculated from the relationship:

Erfc[(junction-peak)/char]=0.1

Standard deviation of outside the defined region is 0.3 times the standard deviation of the region

More about Silvaco TCAD

http://ucourse.ir/open-courses/silvaco/