Structure Generator and Mesher

Informative session

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Overview

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Salient features - structure generator

The structure generator reads in the size and shape of the device from the *config* file.
Salient features of the structure generator are –

- Creates a 2D or 3D device composed of many (possibly intersecting) *regions* of shapes –
  - Axis-aligned rectangle or cuboid,
  - 2D Polygon or 3D polyhedron from vertices,
  - Special shapes – 2D: ellipse — 3D: ellipsoid, cylinder, cone.
- Performs the required shape modifications –
  - 2D or 3D Boolean operations – add, clip, subtract shapes
  - 2D or 3D Shape transformations – translate, rotate, scale, mirror shapes
  - 2D or 3D Shape rounding, chamfering, offsetting, stretching
  - 2D Shape sweep to create prisms, pyramids, pipes, revolutions
- Doping definitions of analytic profiles such as Gaussian, exponential, linear, or user-defined can be set.
- Specifies mesh refinements globally or regions-wise or in specific areas.
- Python interface enables convenient scripting and integration.
- Import *GDS* layout file to create masks for doping, etching, or deposition.

Salient features - mesher

The mesher tool creates the specified type of mesh using the mesh refinements set by the user in the config file. Following mesh are supported.

- FEM-mesh: A triangular (2D devices) or tetrahedral (3D devices) finite-elements based mesh. It is used for electrical drift-diffusion transport simulations, and for dopant diffusion process simulations.
- Tensor-mesh: A rectangular (2D devices) or cubic (3D devices) grid based mesh. It is used for optical FDTD simulations, BPM simulations. It is also used for electrical QT simulations with NEGF formalism.
- *Triangle*[1] mesh: External 2D mesher,
- *TQMesh*[2] mesh: External 2D mesher,
- *TetGen*[3] mesh: External 3D mesher,
- *CGAL*[4] mesh: External 3D mesher.

[1] Jonathan Richard Shewchuk, *Triangle: Engineering a 2D Quality Mesh Generator and Delaunay Triangulator* . Lecture Notes in Computer Science, pages 203-222, Springer-Verlag, Berlin, May 1996

[2] Jonathan Richard Shewchuk, *TQMesh*

[3] Si, Hang (2015): *TetGen, a Delaunay-Based Quality Tetrahedral Mesh Generator*, ACM Transactions on Mathematical Software 41, S. 1–36.

[4] P. Alliez, *et al*: *CGAL User and Reference Manual*, CGAL Editorial Board, 5.6.1

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Config file for structure generation

```
Device: {
  Name = "Diode";
  MeshType = "FEM";
  Simulation = "DD";
}

RefWin*RefSi: {
  Position: ([-1.0, -0.2, 0.], [1., 0.2, 0.]);
  Shape = "Rectangle";
}

RefWin*RefCathode: {
  Position: ([0.999, -0.25, 0.], [1.001, 0.25, 0.]);
  Shape = "Rectangle";
}

RefWin*RefPDoping: {
  Position: ([-1.001, -0.25, 0.], [0., 0.25, 0.]);
  Shape = "Rectangle";
}

RefWin*RefNDoping: {
  Position: ([0.0, -0.25, 0.], [1.001, 0.25, 0.]);
  Shape = "Rectangle";
}

Region*RegSi: {
  RefWin = ["RefSi"];
  Material = "Silicon";
  //MaxEdgeLength = 0.05;
}
```

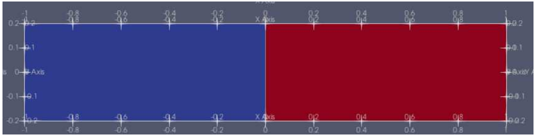


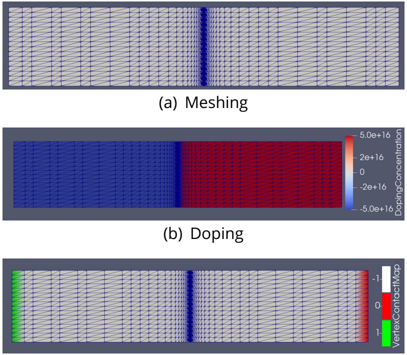
Figure: Device structure

- `Device`: selects the mesh-type and intent of simulation.
- `RefWin`: Shapes which can be used for a variety of purposes, by linking them to `Region`, `Contact`, `Doping`, etc.
- `Region`: Set `RefWin` list and the `Material`.
- `Material`: New material defined by adding a `Material.cfg` file in the working directory.

Config file for structure generation

```
MeshDef*MDefSiTop: {
  RefWin = "RefAll";
  X: {cen = 0., minspacing = 0.0001,
      maxspacing = 0.05, incr = 1.3 }
  Y: {cen = 0., minspacing = 0.025,
      maxspacing = 0.025, incr = 1. }
}

DopingDef*Pdoping: {
  RefWin = "RefPDoping";
  Type =  "Constant";
  Concentration = 5E16;
  Dopant = "Boron";
}

...

Contact*Cathode: {
  RefWin = ["RefCathode"]
}

Contact*Anode: {
  RefWin = ["RefAnode"]
}
```

- `MeshDef`: Meshing definition followed in the specified `RefWin`.
  - `cen`: center of the refined mesh.
  - `minspacing`: minimum spacing at the `cen`.
  - `maxspacing`: maximum spacing in the `RefWin`.
  - `incr`: rate of increment of mesh spacing.



(a) Meshing

(b) Doping

(c) Contacts

Figure: Mesh, doping, and contacts.

- `DopingDef`: Doping of the vertices in the `RefWin`.
- `Contact`: Vertices in the specified `RefWin` are set as contact vertices.

Set the mesh-type in `Device` as follows –

```
Device: {
  MeshType = "FEM"; // "Tensor" or "TetMesh"
}
```

Internal mesh engines –

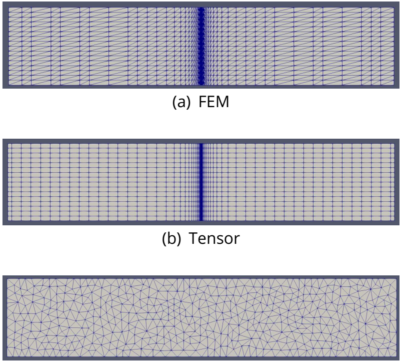
- FEM-mesh: A triangular (2D devices) or tetrahedral (3D devices) finite-elements based mesh.
- Tensor-mesh: A rectangular (2D devices) or cubic (3D devices) grid based mesh.

Note: Internal mesh engines read `MeshDef` section for mesh-spacing specification.

External mesh engines –

- *Triangle* mesh: An external mesh engine which meshes 2D device with triangular finite-elements.
- *TetGen* mesh: An external mesh engine which meshes 3D device with tetrahedral finite-elements.

Note: Mesh-spacing in the given region is set by `MaxEdgeLength` in `Region` section.



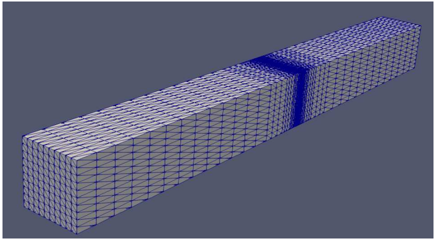
(a) FEM

(b) Tensor

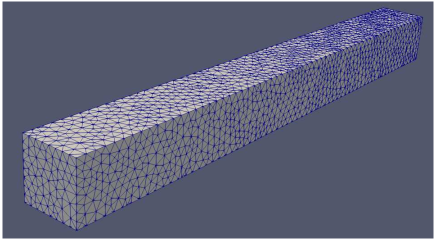
(c) TetMesh

Figure: Mesh of a 2D diode generated by running the diode config file with MeshType of (a) FEM, (b) Tensor, (c) TetMesh.

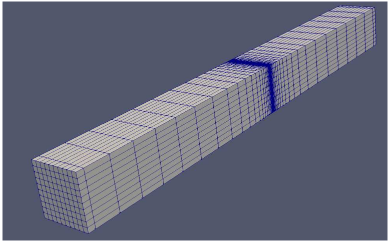
3D Mesh Types



(a) FEM



(b) TetMesh



(c) Tensor

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Python interface for structure generation

```
import device as dev
import numpy as np

# define device object
dio = dev.Device ("Diode", "FEM", "STR", 1)

xmin = -1.; xmax = 1.; xmid = 0.; ymin = -0.2; ymax = 0.2
# define RefWins
dio.setRefWin (Name="RefSi", Shape="Rectangle",
    Position=np.array ([[xmin, ymin, 0.], [xmax, ymax, 0.]]))

dio.setRefWin (Name="RefAnode", Shape="Rectangle",
    Position=np.array ([[xmax-1E-3, ymin-1E-3, 0.],
                        [xmax+1E-3, ymax+1E-3, 0.]]))

dio.setRefWin (Name="RefPDoping", Shape="Rectangle",
    Position=np.array ([[xmin, ymin, 0.], [xmid, ymax, 0.]]))

# define Regions
dio.setRegion (Name="RegSi", RefWin="RefSi", Material="Silicon")

# define Meshing
dio.setMeshDef (Name="MDefSi", RefWin="RefSi",
    Xarg=[0., 1E-4, 0.05, 1.3], Yarg=[0., 0.025, 0.025, 1.])

# define Doping
dio.setDopingDef (Name="Pdoping", RefWin="RefPDoping",
    Type="Constant", Concentration=5E16, DopantSpecies ="Boron")

# define Contacts
dio.setContact (Name="Anode", RefWin="RefAnode")

dio.createDeviceMesh () # create Mesh

dio.saveMeshData () # save Mesh
```

Argument names in *config* file and *python script* are mostly similar. Please check the manual first!

Compare `DopingDef` defined in *config* file vs. in *python* –

```
DopingDef*Pdoping: {
  RefWin = "RefPDoping";
  Type =  "Constant";
  Concentration = 5E16;
  Dopant = "Boron";
}
```

Run the *duly completed* python script as follows –

```
>> python3 diode_str.py
```

- *Equivalency*: Python interface internally runs the software commands.
- *Parametrization*: Script can be reused for a similar structure.
- *seamless integration*: `device` passed as argument to the simulator objects.
- Python libraries (e.g. scikit or optimization libs) can be used in the script.

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Editing RefWins – part 1

Define `RefWin` objects in python as follows.

```
import mesher as m

win1 = tm.refwin("RefCyl1","Polygon",poly,{},{})

win2 = tm.refwin("RefCyl2","Polygon",poly2,{},{})
```

Boolean operations on 2D/3D RefWins –

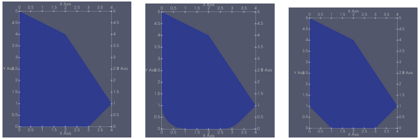
- `win1.add(win2)` : boolean unite
- `win1.subtract(win2)` : boolean subtract
- `win1.clip(win2)` : boolean intersection

Geometric transformations on 2D/3D RefWins –

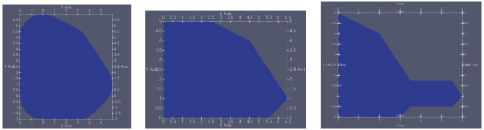
- `win1.translateBy`($\vec{d}$) and $\vec{d}$ = `tm.position(0,0,0)`
- `win1.scaleBy(0.5,`$\vec{c}$)
- `win1.rotateAroundAxis`($\vec{c}$,$\vec{d}$,45°) : point $\vec{c}$ and direction $\vec{d}$ define the axis.
- `win1.mirrorByPlane`($\vec{d}$) : $\vec{d}$ defines plane normal

Editing 2D/3D RefWins –

- `win1.chamferAt([tm.position(0,0,0)],[1])`
- `win1.roundAt([tm.position(0,0,0)],[0.5])`



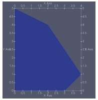
(a) shape of "win1" (b) rounding (c) chamfer



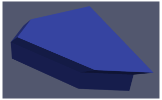
(d) offset (e) stretch (f) stretch at a point

Editing 2D/3D RefWins –

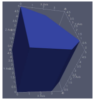
- `win1.offsetRefWin(2)`
- `win1.stretchRefWin(tm.position(2.5,0,0))`
- `win1.stretchRefWinAtPoint`($\vec{p}$,$\vec{d}$) : stretch a point $\vec{p}$ along direction $\vec{d}$
- `win1.limitRefWinSpan`($\vec{c}_m$,$\vec{c}_p$)



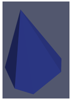
(g) shape of "win1"



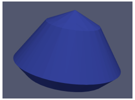
(h) sweep along a path



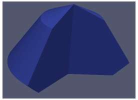
(i) make prism



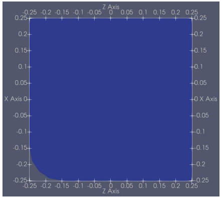
(j) make pyramid



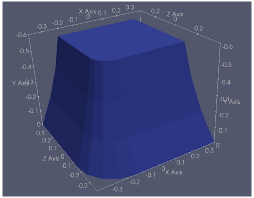
(k) revolve 360°



(l) revolve 230°



(m) Rounded etch mask



(n) Custom etch shape

Transforming 2D RefWin to 3D –

- `win.sweep2DRefWin` ($[\vec{c}_1,\vec{c}_2,\vec{c}_3]$) : sweep along a piecewise linear path defined by $[\vec{c}_1,\vec{c}_2,\vec{c}_3]$.
- `win1.makePrism2DRefWin` ($\vec{d}$) : sweep along $\vec{d}$
- `win1.makePyramid2DRefWin` ($\vec{c}$) : make pyramid with "win1" as base and $\vec{c}$ as apex point.
- `win1.revolve2DRefWin` ($\vec{c}$,$\vec{d}$,360.)

Custom etch profiles can be obtained from the mask RefWins as follows.

- `win1.sweep2DMaskDepthAngle([d1,a1,d2,a2,.])` : etch profile as depth, side-wall angle list.
- `win1.sweep2DMaskPositionList` ($[\vec{c}_1, \vec{c}_2, \vec{c}_3, \vec{c}_4]$) : etch profile as points.

Note: The 2D mask RefWin must be in XZ plane, and the sweep direction is always along y-axis.

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Analytical doping profiles

Masked dopant implantation + diffusion creates a Gaussian distribution and lateral straggle of *error function*.

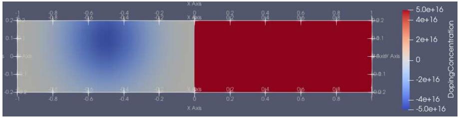
In `Gaussian` profile, doping at each vertex $C_i(\vec{r})$ is given by,

$$C_i(\vec{r}) = C \cdot \operatorname{erf}\left(-(\frac{d_{\|}}{\sigma})^2\right) \cdot \exp\left(-\frac{1}{2}(\frac{d_{\perp} - \mu}{\sigma})^2\right)$$

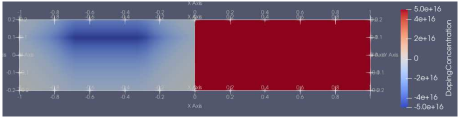
- $d_{\perp}$: perpendicular distance to the `BaseWin`.
- $d_{\|}$: lateral distance from the edges/end-points of the `BaseWin`.
- μ : Implantation depth from Si surface set by `Depth`.
- σ : Diffusion length set by `DecayLength`.
- C : scaling factor set by `Concentration`.

Alternately, `Linear`, `Exponential`, or `Constant` profiles can be set. Following syntax is used for creating a `DopingDef`.

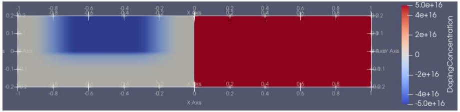
```
DopingDef*Pdoping: {
RefWin = "RefPDoping";
Type =  "Gaussian";
Concentration = 5E16; // 1/cm3
Depth = -0.1;
DecayLength = 0.2;
BaseWin = "PBaseLine";
Dopant = "Boron";
}
```



(o) Gaussian



(p) Exponential



(q) Linear

Figure: Doping profiles obtained by (a) Gaussian, (b) Exponential, and (c) linear distributions.

User-defined analytic doping profiles

Dopant distribution of any user-defined analytic expression is initialized in the `DopingDef` as follows.

```
DopingDef*Pdoping: {
RefWin = "RefPDoping";
Type =  "Analytic";
Concentration = 5E16;
AnalyticExpr = "exp(-(X+0.2)*(X+0.2)/0.02)";
Dopant = "Boron";
}
```

- `AnalyticExpr` : text containing user-defined analytic expression.
- `X`, `Y`, `Z` variables : x-, y-, and z- coordinates of each vertex.
- `Concentration` : scaling factor which internally multiplies the analytic expression.

(a) User-defined expression

Figure: Doping profiles obtained by a user-defined expression.

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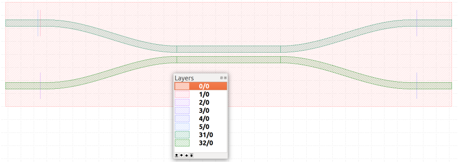
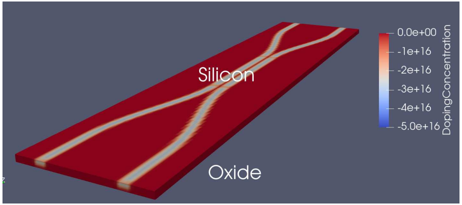
```
GDSLayerDef*C1: {
GDSFileName = "coupler.gds";
Layer*L1: {Cell="test", Layer=0, Y=0, dY=0.2};
Layer*L2: {Cell="test", Layer=31, Y=0.2, dY=0.0};
Layer*L3: {Cell="test", Layer=32, Y=0.2, dY=0.0};
Layer*L4: {Cell="test", Layer=0, Y=0.2, dY=0.2};
}

DopingDef*Pdoping: {
RefWin = "RefAll";
Type =  "Gaussian";
Concentration = 5E16;
Depth = 0.1;
DecayLength = 0.1;
BaseWinGDS = ["C1_L2", "C1_L3"];
Dopant = "Boron";
}
```

- `GDSLayerDef`: Specifies settings to create polygons from GDS mask `Layers`.
- `Layer`: Each layer creates a `RefWin`.
- `dY`: Thickness of the layer. If 0, it creates a 2D `RefWin`, else, a 3D `RefWin`.
- `RefWinGDS` in `Region`: Creates region from a 3D RefWin.
- `BaseWinGDS` in `Doping`: Sets which 2D RefWins are used as masks.



(a) GDS file of Silicon wave-guide



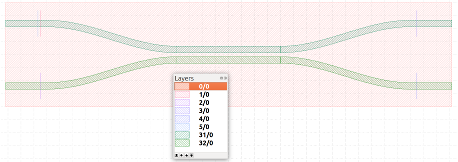
(b) Doping profile from GDS file

Figure: Doping profile in (b) using GDS mask in (a).

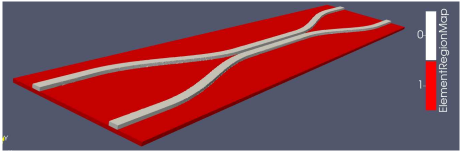
Import GDS layout – region definition (in 3D device only)

```
GDSLayerDef*C1: {
GDSFileName = "coupler.gds";
Layer*L1: {Cell="test", Layer=0, Y=0, dY=0.2};
Layer*L2: {Cell="test", Layer=31, Y=0.2, dY=0.0};
Layer*L3: {Cell="test", Layer=32, Y=0.2, dY=0.0};
Layer*L4: {Cell="test", Layer=0, Y=0.2, dY=0.2};
}

Region*RegSi: {
RefWinGDS = ["C1_L2", "C1_L3"];
Material = "Silicon";
}

Region*RegOxTop: {
RefWinGDS = ["C1_L1"];
Material = "Oxide";
}
```

- `GDSLayerDef`: Specifies settings to create polygons from GDS mask `Layers`.
- `Layer`: Each layer creates a `RefWin`.
- `dY`: Thickness of the layer. If 0, it creates a 2D `RefWin`, else, a 3D `RefWin`.
- `RefWinGDS` in `Region`: Creates region from a 3D RefWin.
- `BaseWinGDS` in `Doping`: Sets which 2D RefWins are used as masks.



(a) GDS file of Silicon wave-guide



(b) Silicon wave-guide structure

Figure: Silicon wave-guide structure in (b) using GDS mask in (a).

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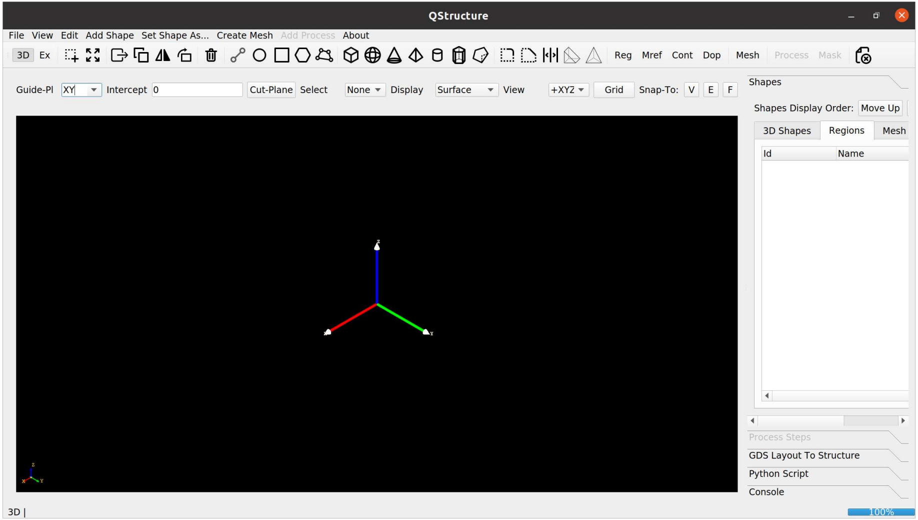
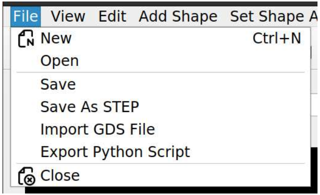
GUI - Main window



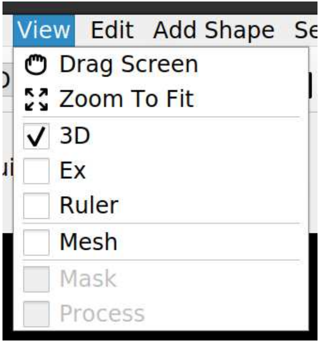
(a) Main window

GUI - File Menu



(b) File menu

- `New` Open new `circuitdraw` window.
- `Open File` Selected '*.qstr' file opened in a new window.
- `Save (As)` Current (New) '*.qstr' file is stored.
- `Save As STEP` Save current structure as a STEP file.
- `Import GDS File` Import a layout file in GDS format.
- `Export Python Script` Export python script which can generate the structure.

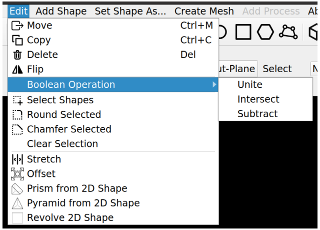


(c) File menu

To change screen viewpoint -

- `Middle Mouse Button` : Drag screen.
- `Right Mouse Button` : Rotate camera view-point.

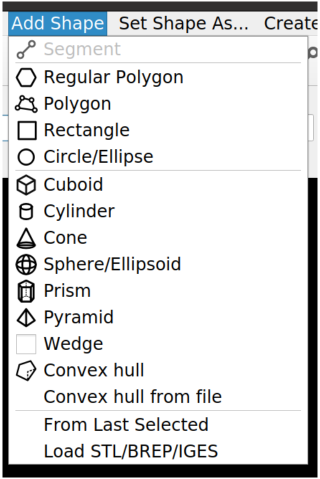
- `Drag screen` : (if middle mouse button is not available) Drag screen.
- `Zoom To Fit` : Click to zoom the structure to fit the entire window.
- `3D` : Set given structure as a 3D structure. It cannot be changed mid-way.
- `Ex` : Activate 'exact coordinates'. When active, any shape drawing action would prompt a dialog box to specify x,y,z coordinates of the point.
- `Ruler` : Activate it. Click start point of the ruler and end point to measure distance.
- `Mesh` : Click to display/hide mesh generated by the mesher.



(d) Edit menu

- `Move`, `Copy`: Activate it. Click on shape to be moved/copied and click where to place it.
- `Delete` : Activate it. Click on the shape to delete.
- `Flip` : Activate it. Click on the shape to be flipped w.r.t. guide-plane at given `intercept`.
- `Select` : Activate it. Click on shapes to be selected.
- `Clear Selection` : Click on it to clear all selected shapes.
- `Boolean operation` : *After selecting the shapes*, click on the operation.
    - `Unite` : Join all selected shapes and store in the first shape.
    - `Intersect` : Find common areas of selected shapes and store in the first shape.
    - `Subtract` : Subtract selected shapes from the first shape.
- `Round Selected`, `Chamfer Selected` : Round/chamfer all corners of selected shapes with the given rounding/chamfer radius (in μm).
- `Stretch` : Activate it. Click on the shape to be stretched at the point where to stretch. Specify stretch distance.
- `Offset` : Activate it. Specify offset distance. Click on the shape to be offset.
- `Prism/Pyramid from 2D Shape` : Activate it. click on the 2D shape and click at the apex point. A pyramid/prism would be created.
- `Revolve 2D shape` : Activate it. Click on the 2D shape. Fix location of axis of revolution.

GUI - Add Shape Menu

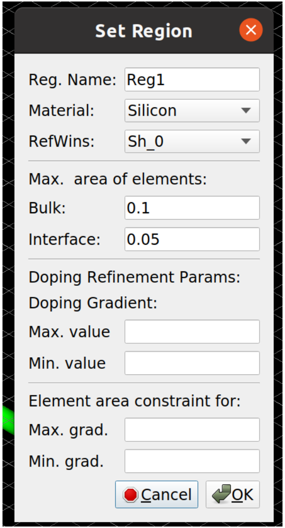


(e) Add Shape menu

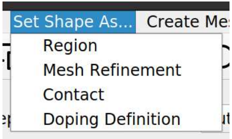
To add a `RefWin` of a given shape, activate its icon by click. Then perform –

- `Segment` : Click on two opposite points of the segment.
- `Regular Polygon`, `Rectangle`, `Ellipse`: Click on two diagonally opposite points of the axis-aligned rectangle to add the respective shape inscribing the rectangle.
- `Polygon` : Click on the consecutive corners of the polygon. Double click on the last corner to add polygon.
- `Cuboid`, `Cylinder`, `Cone`, `Ellipsoid`, `Prism`, `Pyramid`, `Wedge` : Click on two diagonally opposite points of the axis-aligned rectangle to add the *base of* the respective shape. Then click on the third point (not in the same plane) to specify height of the shape.
- `Convex Hull` : Click on the points of the convex hull. Double click on the last point to add convex hull.
- `Convex Hull From File` : Load points of the convex hull from a csv file. It has N x 3 table. Each row has one point and x,y,z co-ordinates are stored in 3 columns.
- `From Last Selected` : Select a shape, an edge, or a face. Then click to convert that item to a `RefWin`.
- `Load STL/BREP/IGES` : Load the files in the specified format to create a new `RefWin`.

GUI - Set Region



(f) Set Region menu



(g) Set Shape As menu

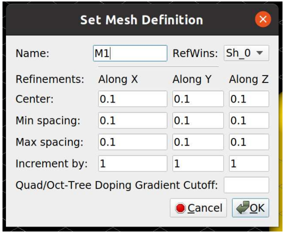
To set a `Region` from one or more `RefWins` (shapes) –

- Edit → Select the desired shapes.
- Click Set Shape As → Region to open the dialog box.

Region dialog box is described below –

- `Reg. Name` : Set name of the region.
- `Material` : Set material from available materials.
- `RefWins` : Names of the selected RefWins are listed here.
- `Max area of elements` : Maximum area of elements in `bulk` and at `interface` for meshing using `Triangle` or `TetGen` mesher.
- `Doping gradient` : `max` and `min` gradient and their corresponding `element area constraints`. Element area is linearly interpolated between max and min gradients (only valid for meshing using `Triangle` or `TetGen` mesher).

GUI - Set Mesh Definition



(h) Set Mesh Definition

To set a `MeshDef` from a `RefWin` –

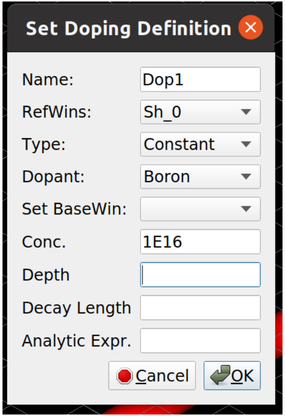
- [Edit] → [Select] the desired shape.
- Click [Set Shape As] → [Mesh Definition] to open the dialog box.

[Mesh Definition] dialog box is described below –

- `MeshDef Name` : Set name of the mesh-definition.
- `RefWins` : Names of the selected RefWins are listed here.
- `Refinements` along X, Y, and Z direction are specified in respective columns.
- `Center` : Center of the refinement point
- `Min spacing` : spacing at the center.
- `Max spacing` : max spacing in the refinement box.
- `Increment by`: As one moves away from `Center`, spacing increases from `min` to `max`. Mutiplying factor is set in `Increment by`.
- `Doping gradient Cutoff` : Quadtree or octtree leaves are split if doping gradient along a side is more than this value.

Note: This mesh definition box is used only in quadtree (2D) or octtree (3D) meshers.

GUI - Set Doping Definition



(i) Set Doping Definition

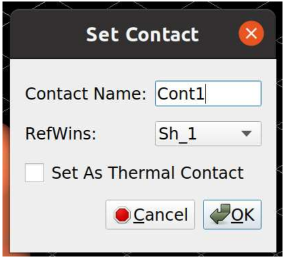
To set a `MeshDef` from a `RefWin` –

- Edit → Select the desired shape.
- Click Set Shape As → Mesh Definition to open the dialog box.

Doping Definition dialog box is described below –

- `DopingDef Name` : Set name of the doping definition.
- `RefWins` : Names of the selected RefWins are listed here.
- `Type` : Set the type of definition - Gaussian, constant, analytic, etc.
- `Dopant` : Specify dopant among available ones.
- `Set BaseWin` : Set basewin for the doping profile
- `Conc` : Set peak concentration (cm^{-3})
- `Depth`and `Decay Length`: For Gaussian and Exponential profiles, set distance of peak from basewin and its decay length.
- `Analytic Expr.` : For analytic profiles, define analytic expression.

GUI - Set Contacts



(j) Set Contact

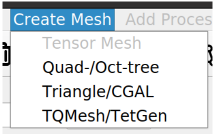
To set a `Contact` from a `RefWin` –

- Edit → Select the desired shape.
- Click Set Shape As → Contact to open the dialog box.

Contact dialog box is described below –

- `Contact Name` : Set name of the contact.
- `RefWins` : Names of the selected RefWins are listed here.

GUI - Create Mesh Menu

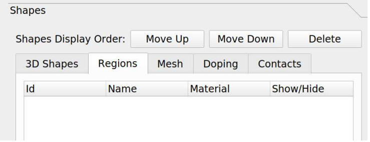


(k) Set Contact

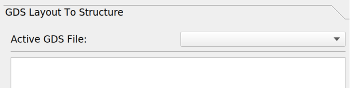
- Once all the regions, mesh definitions, doping definitions, and contacts are set, a mesh can be created.
- Click Create Mesh and then choose the desired mesh engine to perform meshing.
- On succesfull meshing, the Mesh mode is activated and mesh is shown in the drawing board. To toggle to structure view, deactivate Mesh mode.

Following meshing options are available.

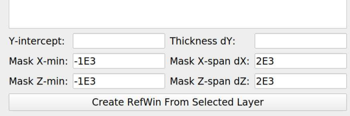
- Tensor mesh : Rectangular (2D) or Cubic (3D) meshing can be performed.
- Quad-/Octtree : FEM mesh is created using quadtree (2D) or octtree (3D) algorithm.
- Triangle/Tetgen : FEM mesh is created using `Triangle` or `Tetgen` package.



(l) Shapes Side-pane



(m) GDS Layout to structure - I



(n) GDS Layout to structure - II

- `Shapes` tab displays all the shapes as well as entities (regions, mesh defs, etc.) which have been added to the structure generator. They are displayed in different tabs in the table.
- To display/hide a shape linked to the given entity, click on the check-box in the last column of the table.
- Order in `Regions` as well as `Contacts` tab is important. If there is an overlap, regions/contacts added later **replace** the region/contact added before.
- Entity order can be changed by clicking on it and click move up/down.
- Delete entity by clicking on it and click Remove.

- Layers defined in imported layout files are listed in this tab. The files can be selected from the drop-down list.
- Check/uncheck the check-box to show/hide the layout of that layer.
- Set the parameters `Y intercept`, `Thickness`, mask `Xmin`, `dX`, `Zmin`, `dZ`.
- Click Create RefWin to add a `RefWin` as per the parameter specifications.

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Conclusions

The structure generator supports creating –

- A 2D/3D device from a rectangle/cuboid, polygon/polyhedron, ellipse (2D), ellipsoid, cylinder, or cone (3D).
- Boolean operations, transformations, and sweeps of 2D/3D devices.
- Doping definitions of analytic profiles such as Gaussian, exponential, linear, or user-defined.
- Mesh refinements globally or in specific regions.
- Python interface for convenient scripting and integration.
- Import *GDS* layout file to create masks for doping, etching, or deposition.
- FEM-mesh, Tensor-mesh, *Triangle* mesh, and, *TetGen* mesh.
- A graphic-user-interface for convenient creation of the structure.

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Easy-to-install licenses

For ordering a license, along with the name and the organization details, please also provide –

- For the node-locked licenses: Ethernet mac address of the client machine on which the software will run.
  OR
- For the server licenses: Ethernet mac address of the server machine at the client organization.

If you purchased one or more node-locked licenses, you will receive the following license file by secured email.

1. NodeLockedLicense_<id>_<Info>.lic, where <id> stands for license id and <Info> stands for customer identification in short.

Copy the license file to `/var/local/oesoft/licenses/` on the machine whose mac-address has been provided and change its access rights to `777`.

If you purchased one or more server licenses, you will receive the following license file by secured email.

1. ServerLicense_<id>_<Info>.lic

Copy the license file to `/usr/share/oesoft/licenses/` on the *server machine* whose mac-address has been provided.

The End

Questions? Comments?