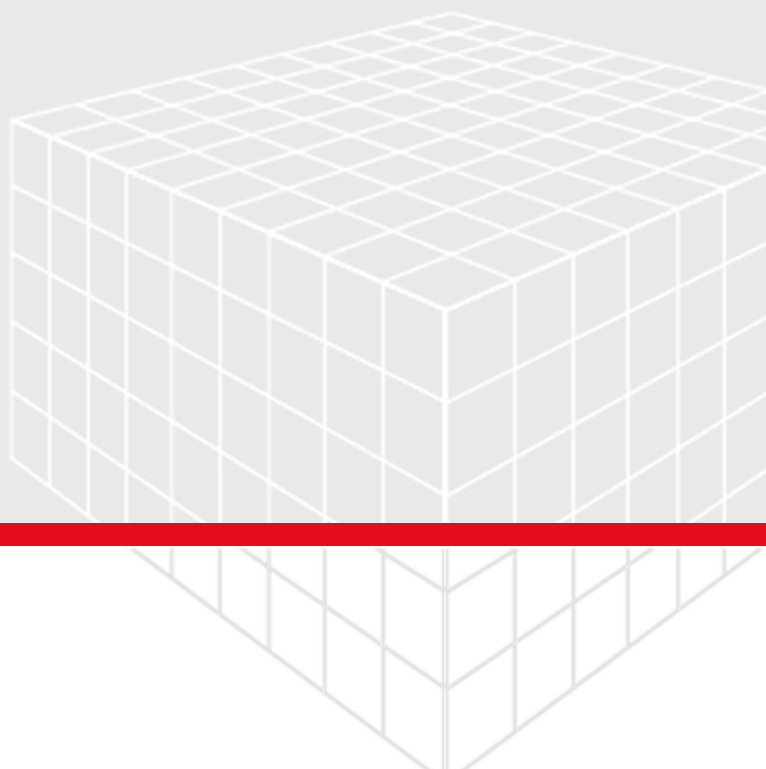


GridGeo

User Guide

GEODICT Release 2026

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GEODICT

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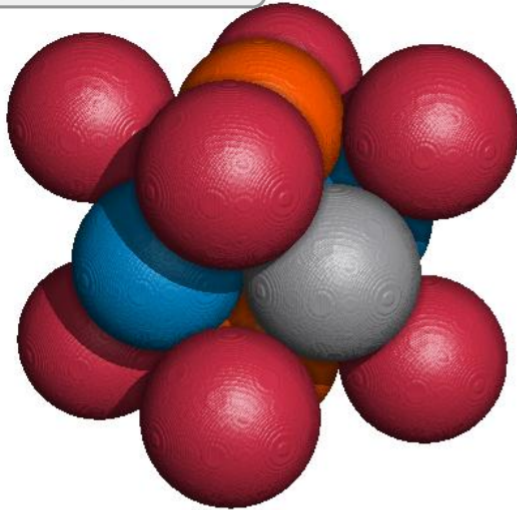
GridGeo

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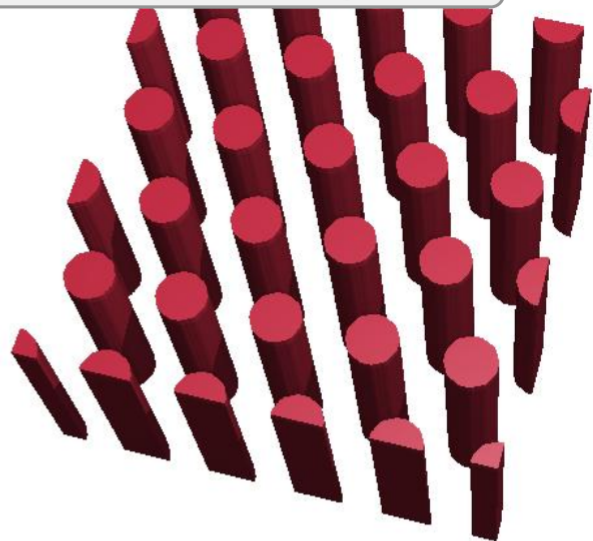
1 GridGeo

Regular lattice structures in the 2D-plane or in 3D space can be generated with GridGeo. In combination with other GeoDict modules, a wide range of applications is possible, like, e.g., structures for flow and filtration simulations, mechanical simulations, or benchmarking structures.

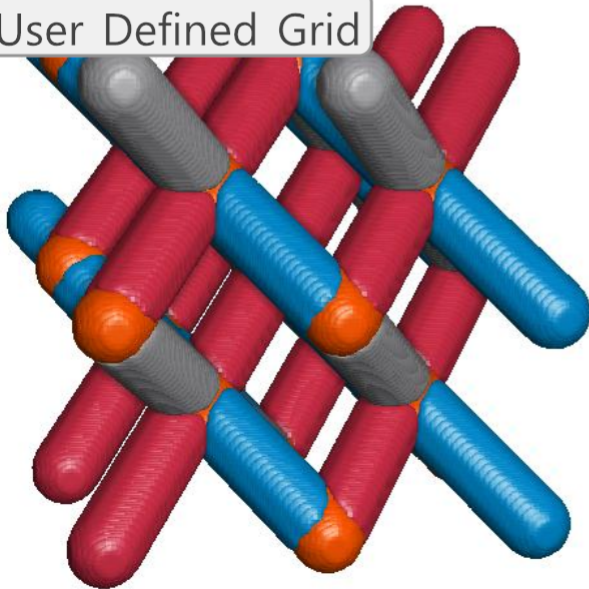
Grid of Spheres



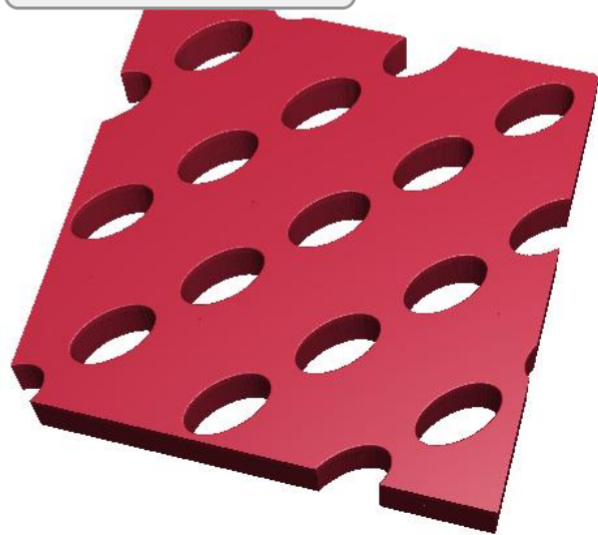
Grid of parallel Cylinders



User Defined Grid



Perforated Foil



Learn to use GridGeo:

- [Grid of Spheres](#)⁵
Create the four common sphere lattices: the Simple Cubic, Body-Centered Cubic, Face-Centered Cubic and Hexagonal grids.
- [Grid of Parallel Cylinders](#)¹⁹
Parallel cylinders are arranged in the plane.

Learn to use GridGeo:

- [User Defined Grid](#)  25
This is the most powerful option in GridGeo. Periodic arrangements of an arbitrary selection of objects can be generated in 3D, even with non-orthogonal basis vectors.
- [Perforated Foil](#)  37
The Perforated Foils are flat membrane-like structures with differently shaped holes that conform to the specified perforation parameters.
- [Grid GeoApps](#)  51
Selection of predefined macros which create specific regular structures. The macros can be found in the installation folder.



Join the conversation

Visit the Community on [GeoDict Forum](#) to be inspired and get answers to top questions.

Find illustrative application examples on the [website](#).

Our tutorials and seminar videos give you a first hands-on experience. They are collected in the [Learning Center](#).

Send your [Support Request](#) to our technical Support.

1.1 Grid of Spheres

The generated **Grid of Spheres** is a regular arrangement of spherical objects, based on the entered parameters. Four different packing modes are available: Simple Cubic, Body-Centered Cubic, Face-Centered Cubic and Hexagonal.

The **GridGeo Grid of Spheres Options** dialog opens when clicking the **Options' Edit...** button in the GridGeo section.

At the top left of the **GridGeo Grid of Spheres Options** dialog, enter the name for the files containing the generation results in the **Result File Name (*.gdr)** box. Keep the default name, or choose a new name which fits to your current project.

The available units (**m**, **cm**, **mm**, **µm**, **nm**, and **Inch**) are selectable from the drop down menu at the top right of the **GridGeo Grid of Spheres Options** dialog. When the units are changed, the entered values are adjusted automatically.

GridGeo – Grid of Spheres

GEO DICT

Result File Name (*.gdr) µm ▾

Sphere Packing Mode Simple Cubic ▾ Corner-Object Material (ID 01) Glass (Solid)...

Sphere Diameter / (µm)

☒ Sphere Center Distance / (µm)

☐ Unit Cell Length

Pore / Matrix Material (ID 00) Air...

☐ Touching Configuration

☒ Resolve Overlap

☐ Mark Contact Voxels

Domain

Unit Cells X-Direction	1	Voxel per X-Unit Cell	49
Unit Cells Y-Direction	1	NX	49
Unit Cells Z-Direction	1	NY	49
☐ Periodic Domain		NZ	49
Inlet / (µm)	0	Width (X) / (µm)	86.6025
Outlet / (µm)	0	Length (Y) / (µm)	86.6025
Voxel Length / (µm)	1.76739796	Height (Z) / (µm)	86.6025

? OK Cancel

The dialog can be divided into three main components which are described in the following.

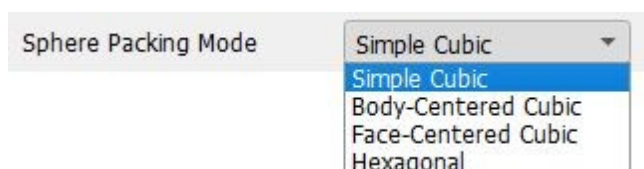
The Grid of Spheres parameters

- [Unit Cell Definition](#)^[6]
Define Packing Mode and Size of the spheres inside a unit cell.
- [Object Materials](#)^[12]
Select the materials of the grid objects and how overlap is handled.
- [Domain Panel](#)^[15]
Define the general properties of the grid.

1.1.1 Unit Cell Definition

Sphere Packing Modes

With **Grid of Spheres**, sphere lattices of the four most common types can be generated. These are chosen from the **Sphere Packing Mode** drop down menu.



Below, for every available grid, one unit cell is shown. The left figure shows the packing, where the spheres are cut at the boundary of the unit cell domain. The right figure shows the packing with the whole spheres. Additionally, the highest achieved packing density without overlapping spheres is given. The highest packing density for any grid type will be reached in the [Touching Configuration](#)^[11]. In the **Face-Centered Cubic** and the **Hexagonal** grid the highest possible packing density can be achieved.

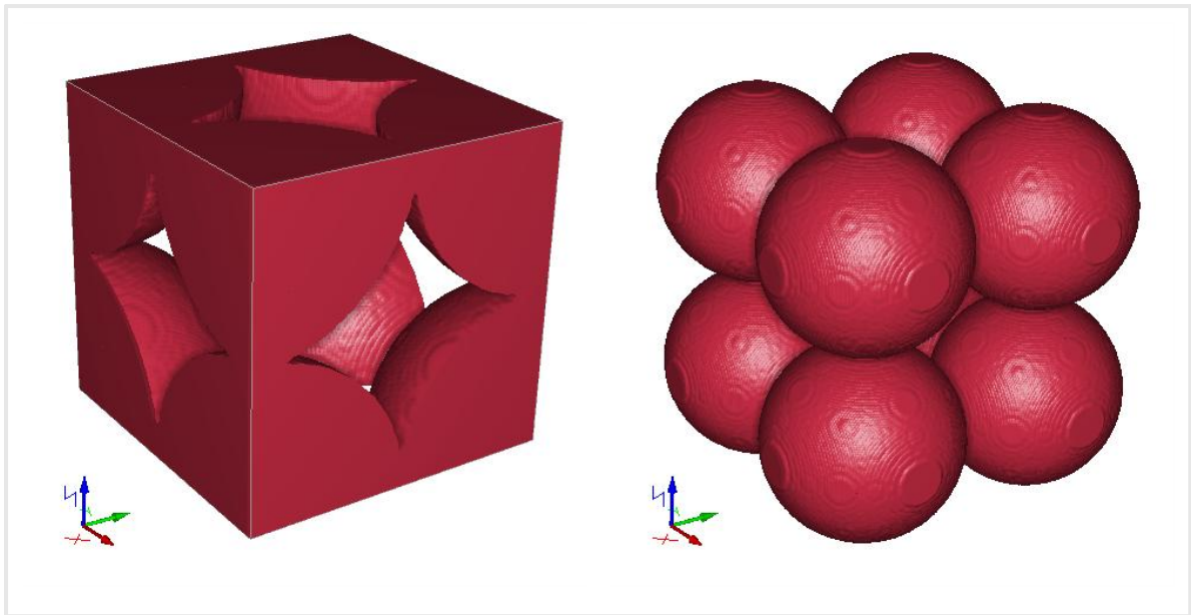
✓ Simple Cubic Grid (SC)

In the **Simple Cubic** grid, the spheres are placed at the corners of the cubic unit cell.

$$\frac{1}{6}\pi \approx 52.36\%$$

(1) Highest
achievable
packing
density in
SC-grid

In the [Touching Configuration](#)^[11] the unit cell length equals the sphere diameter.



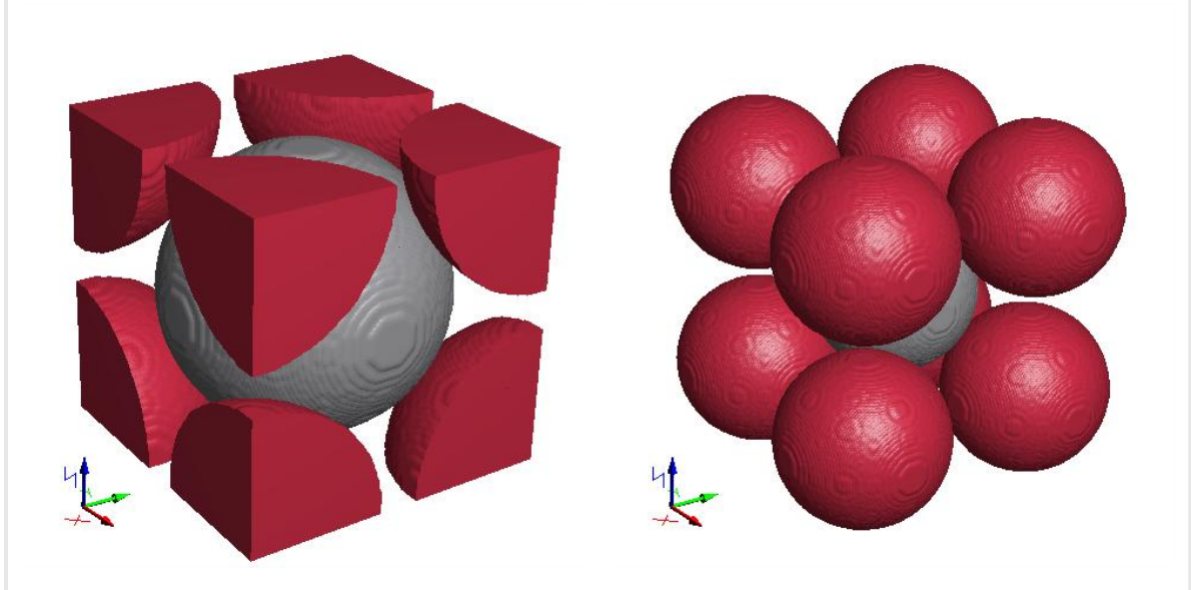
✓ Body-Centered Cubic Grid (BCC)

In the **Body-Centered Cubic** grid, one sphere is in the middle of the unit cell and one at every corner.

$$\frac{\sqrt{3}}{8}\pi \approx 68.02\%$$

(2) Highest achievable packing density in BCC-grid

In the [Touching Configuration](#)^[11] the unit cell length is $2/\sqrt{3}$ times the sphere diameter.



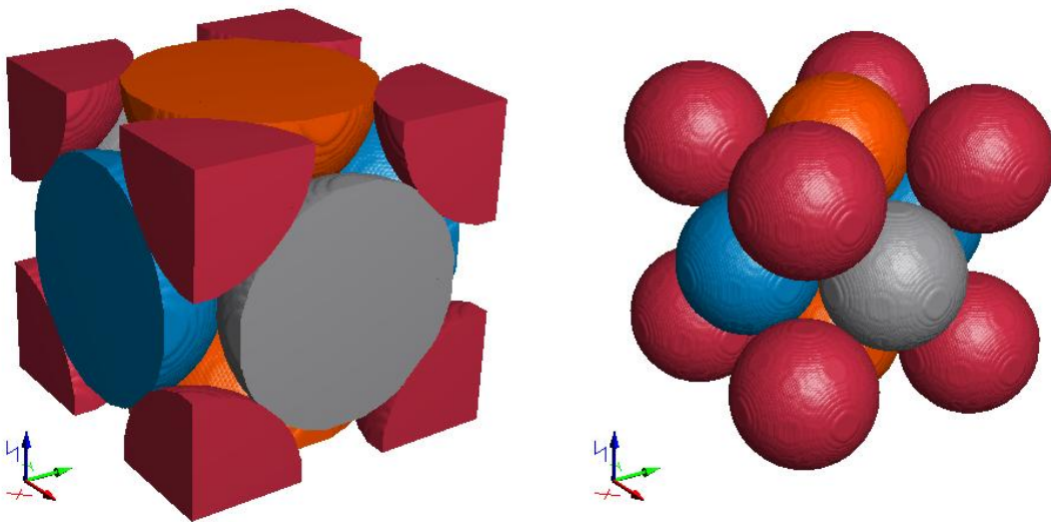
✓ Face-Centered Cubic Grid (FCC)

In the **Face-Centered Cubic** grid, one sphere is located at each corner of the unit cell, and one at each face of the cube. The achieved packing density is the highest possible value for all types of grids with equal diameter spheres.

$$\frac{1}{3\sqrt{2}}\pi \approx 74.05\%$$

(3) Highest achievable packing density in FCC-grid

In the [Touching Configuration](#)^[11] the unit cell length is $\sqrt{2}$ times the sphere diameter.



The Face-Centered Cubic grid, the closest to the hexagonal grid, can also be regarded as a stacking of hexagonally arranged layers of spheres, see [Relationship between the Face-Centered Cubic and Hexagonal lattices](#)^[9].

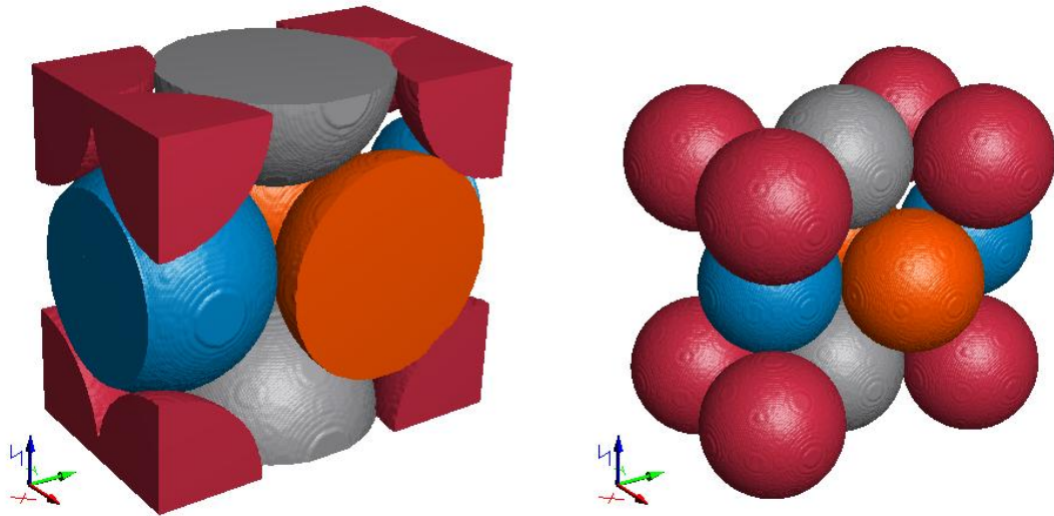
✓ Hexagonal Grid

In the **Hexagonal** grid, layers of hexagonally arranged spheres are stacked on top of each other. In the figure on the right-hand side, the first layer (A) consists of the red and gray spheres, while the second (B) consists of the blue and orange spheres. Each layer fits perfectly in the "gaps" of the preceding layer and vice versa.

$$\frac{1}{3\sqrt{2}}\pi \approx 74.05\%$$

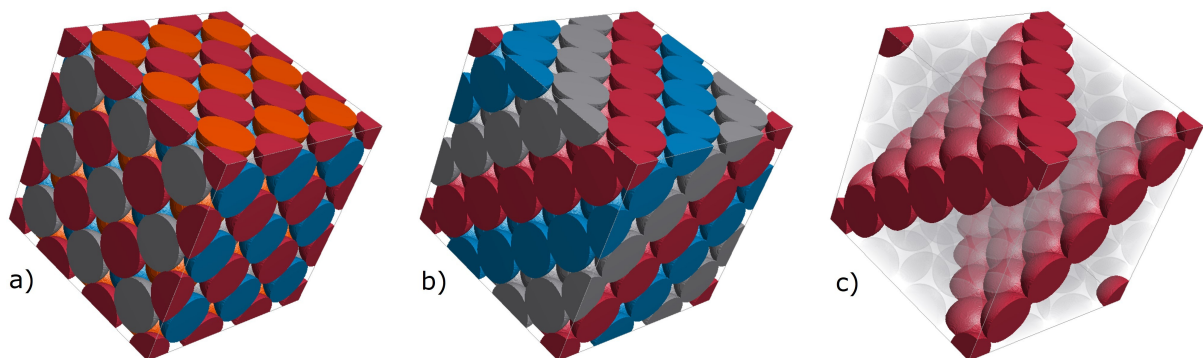
(4) Highest achievable packing density in Hexagonal-grid

The unit cell length in Z-direction in the Hexagonal grid is $\sqrt{8/3}$ times the sphere diameter.

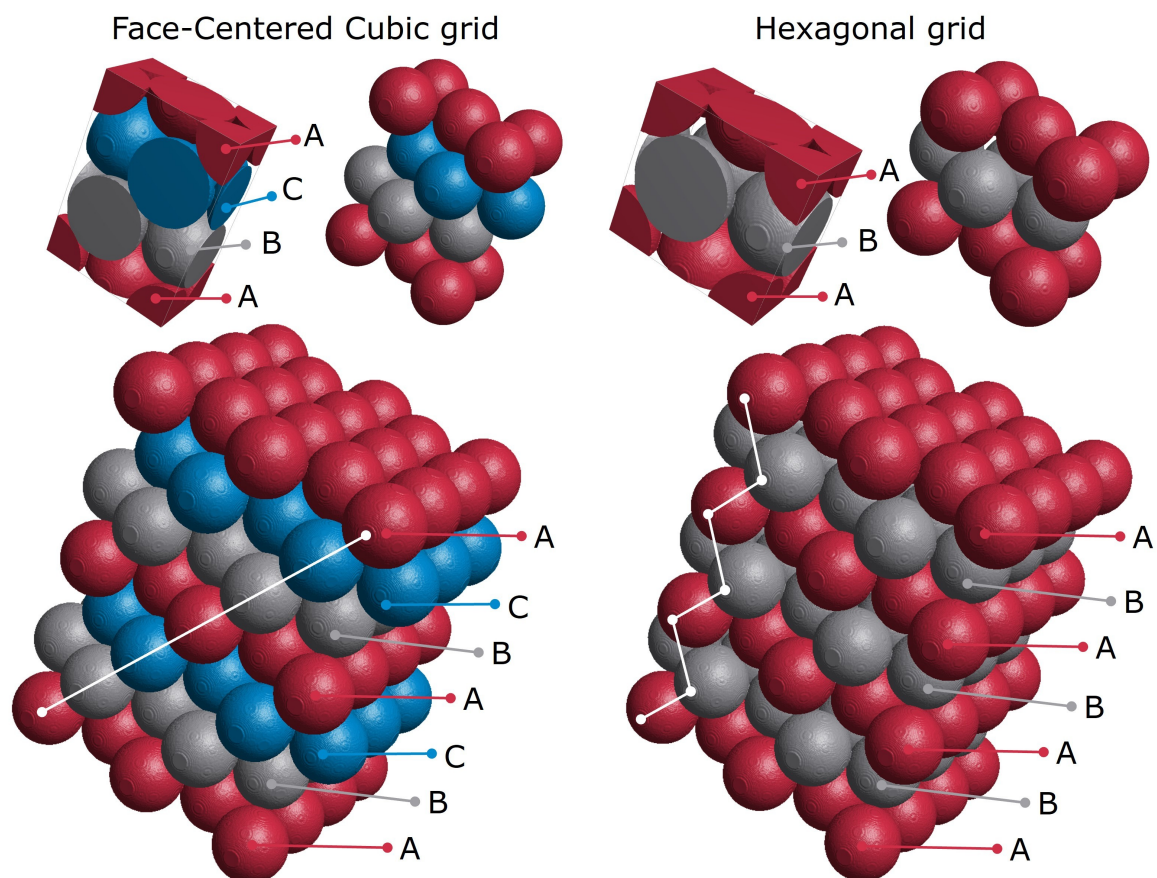


✓ Relationship between the Face-Centered Cubic and Hexagonal lattices

The Face-Centered Cubic and Hexagonal grids are strongly related: both have a packing density of $\frac{1}{3\sqrt{2}}\pi \approx 74.05\%$. In the first figure, $3 \times 3 \times 3$ Face-Centered Cubic unit cells are displayed: a) shows the usual color scheme with different colors for the corner spheres and each of the cube faces. In b), the same structure is shown, but now diagonal layers become visible. In c) only the red layers from b) are shown and the hexagonal structure becomes visible. The **Face-Centered Cubic grid consists of hexagonal layers stacked upon each other** – like the Hexagonal grid.



So, a Face-Centered Cubic is also a Hexagonal grid – what is the difference? It becomes apparent in the next figure.



The Face-Centered Cubic grid consists of three hexagonal layers (A-B-C). The relation from layer to layer is always the same (observe the white line). The Hexagonal grid has two layers (A-B), where the stacking direction changes from layer to layer.

Size of the unit cell

Before the size of the unit cell is set, the **Sphere Diameter** should be entered. It defines the diameter of the spheres in the grid and it is equal for all spheres.

The size of the unit cell can then be determined in two different ways.

✓ Unit Cell Length

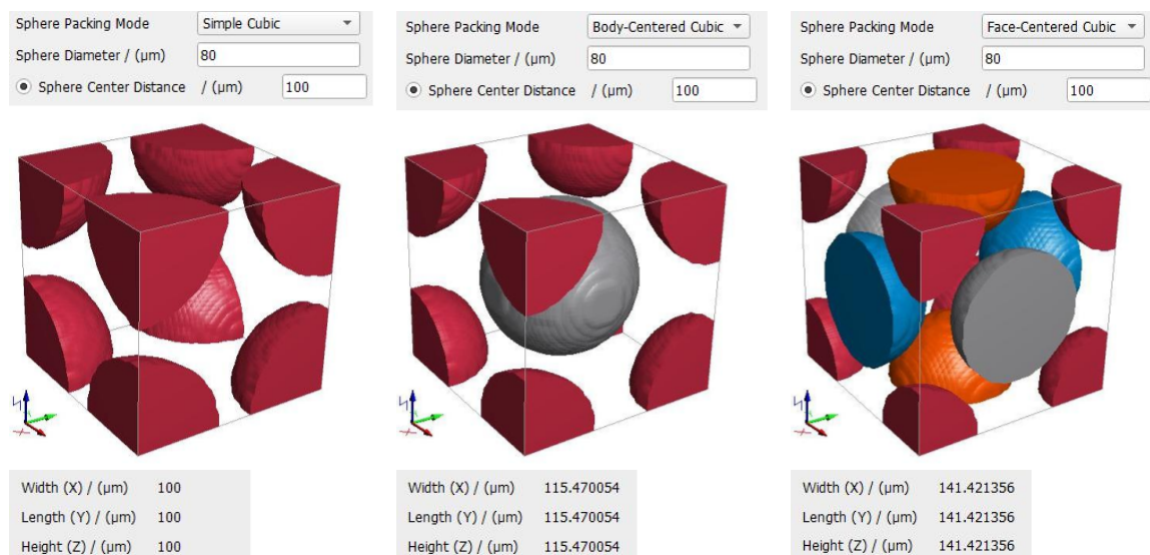
The easiest way is to specify the **Unit Cell Length**, which defines the length of the unit cell in X-direction. For the Simple Cubic, Body-Centered Cubic and Face-Centered Cubic grid types this defines also the length of the unit cell in Y-, and Z-direction, respectively. For the Hexagonal grid, the unit cell is a cuboid, therefore, the unit cell length only gives the length of the unit cell in X-direction. The length in Z-direction is obtained by multiplying the length in X-direction with $\sqrt{8/3}$.



Important! For hexagonal grids, it is not possible to achieve the exact side lengths of the (theoretical) cuboid unit cell with cubic voxels. Therefore, GridGeo approximates the unit cell in the given resolution. This leads to a slightly different unit cell size for different resolutions, and therefore the resulting positions of the spheres will depend on the selected resolution. Furthermore, it is possible that in some cases the spheres may slightly overlap, even for cases where a **Touching Configuration** was selected.

✓ Sphere Center Distance

The other way is to define the **Sphere Center Distance**, which is the distance between neighboring sphere centers in the grid. The resulting unit cell size depends on the chosen **Sphere Packing Mode**.



Checking **Touching Configuration** sets the **Sphere Diameter** equal to the **Sphere Center Distance**, so that the spheres in the lattice touch perfectly.

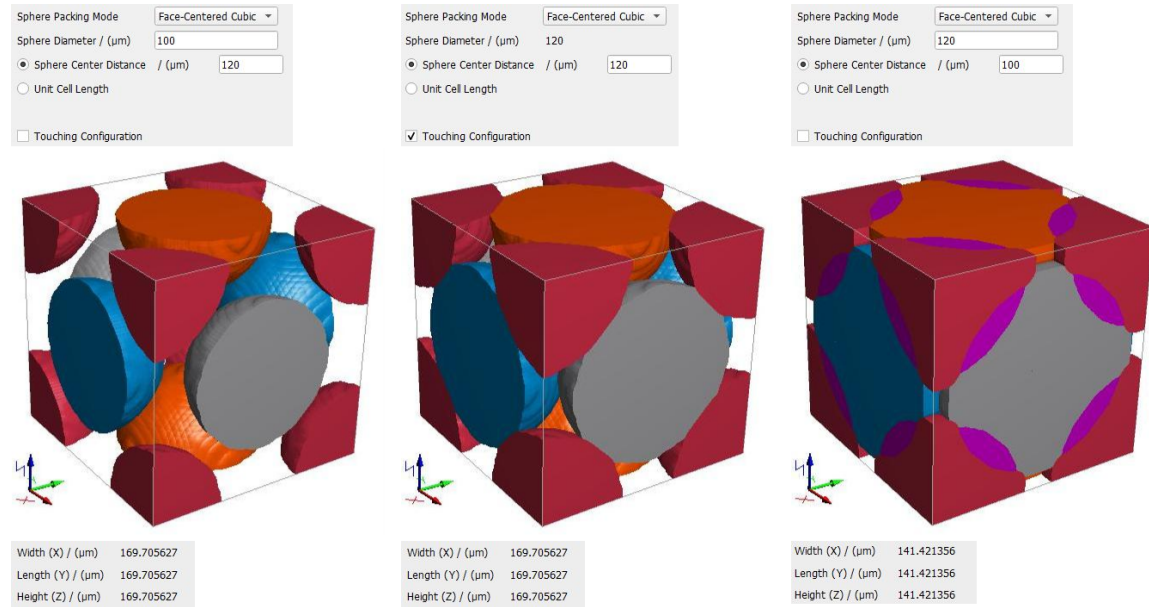
☒ Touching Configuration

The parameters **Sphere Diameter** and **Sphere Center Distance** should always be chosen in combination.

✓ Relation between Sphere Diameter and Sphere Center Distance

In the next figure, their relation is illustrated: Choosing the sphere diameter smaller than the sphere center distance leads to empty space between all spheres in the grid and choosing it larger leads to overlapping spheres.

The minimal distance between spheres in the selected grid occurs when the **Sphere Diameter** is chosen equal to the **Sphere Center Distance**. In this case, the touching configuration is realized: spheres touch and no overlaps occur.



1.1.2 Object Materials

Select Materials

GridGeo – Grid of Spheres

GEODict

Result File Name (*.gdr) μm ▾

Sphere Packing Mode

Sphere Diameter / (μm)

☒ Sphere Center Distance / (μm)

☐ Unit Cell Length

☐ Touching Configuration

☒ Resolve Overlap

☐ Mark Contact Voxels

Domain

Unit Cells X-Direction	1	Voxel per X-Unit Cell	49
Unit Cells Y-Direction	1	NX	49
Unit Cells Z-Direction	1	NY	49
☐ Periodic Domain		NZ	49
Inlet / (μm)	0	Width (X) / (μm)	122.47443
Outlet / (μm)	0	Length (Y) / (μm)	122.47443
Voxel Length / (μm)	2.49947816	Height (Z) / (μm)	122.47443

Corner-Object Material (ID 01)

 x-Object Material (ID 02)

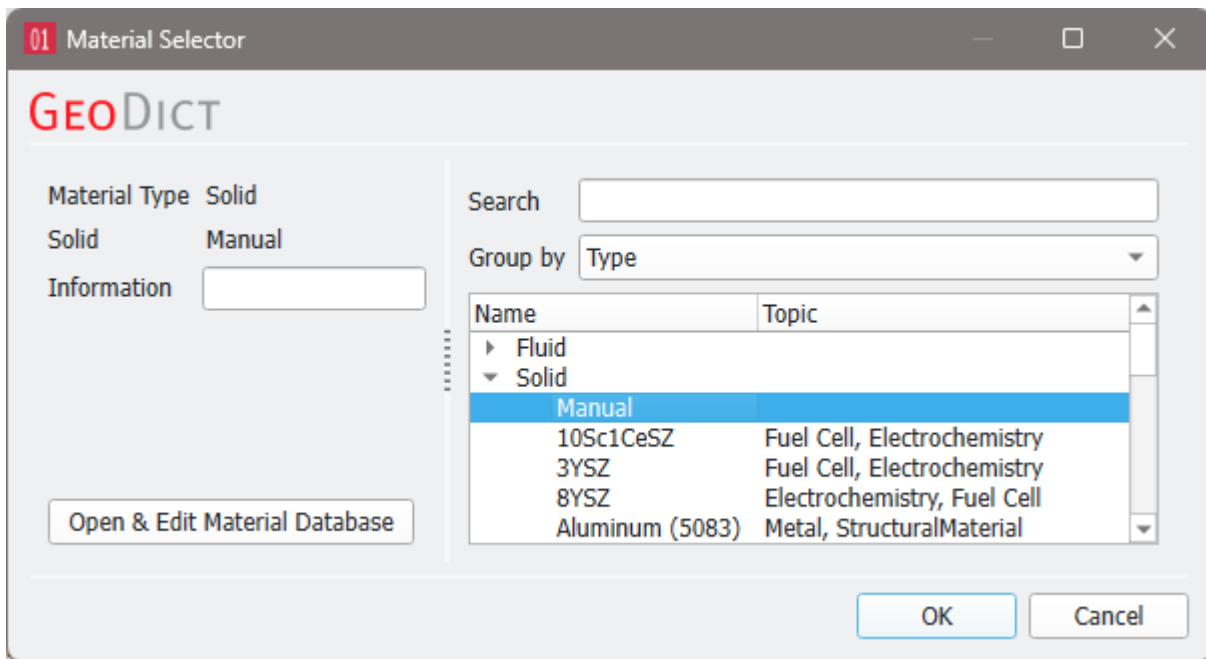
 y-Object Material (ID 03)

 z-Object Material (ID 04)

 Pore / Matrix Material (ID 00)

The materials for the spheres and the pore space in the grid can be chosen according to your needs.

The pull-down menu gives access to selecting the desired material from the GeoDict **Material Database**. When none of the materials available in the database fit the preferred specifications, **Manual** should be chosen. Alternatively, a new material with the desired specifications can be added to the **Material Database** (see the Material Database chapter).

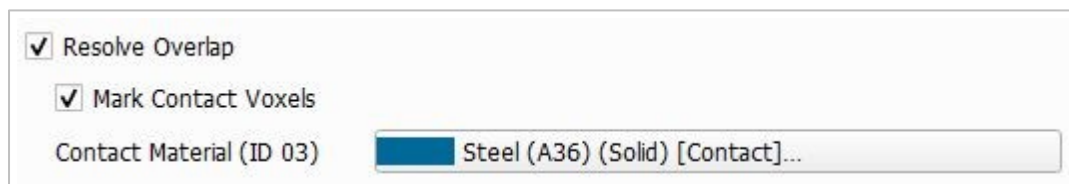


To match realistic material colors for visualization in a certain application, the default material colors can be changed through the **Color & Visibility** tab of the GUI sidebar. For more visualization options, see the Visualization chapter.

Overlap Behavior

In the generated grid, overlap between the spheres might occur, e.g., if the chosen sphere diameter is larger than the sphere center distance. This overlap can be handled in different ways.

By default, **Resolve Overlap** is enabled. With this option, the overlapping regions are assigned to the materials of the spheres which are in contact. This leads to a more realistic structure.



Additionally checking **Mark Contact Voxels** allows to define a separate material for the contact areas. This means, for each overlapping object a one voxel thick layer is reassigned to the **Contact Material**. In this way, even contacting spheres with the same material ID can be clearly distinguished.



Know how! Using **Resolve Overlap** needs more time to compute, therefore we recommend disabling this option for large structures where the information about the overlap is not relevant (e.g., for flow simulations).

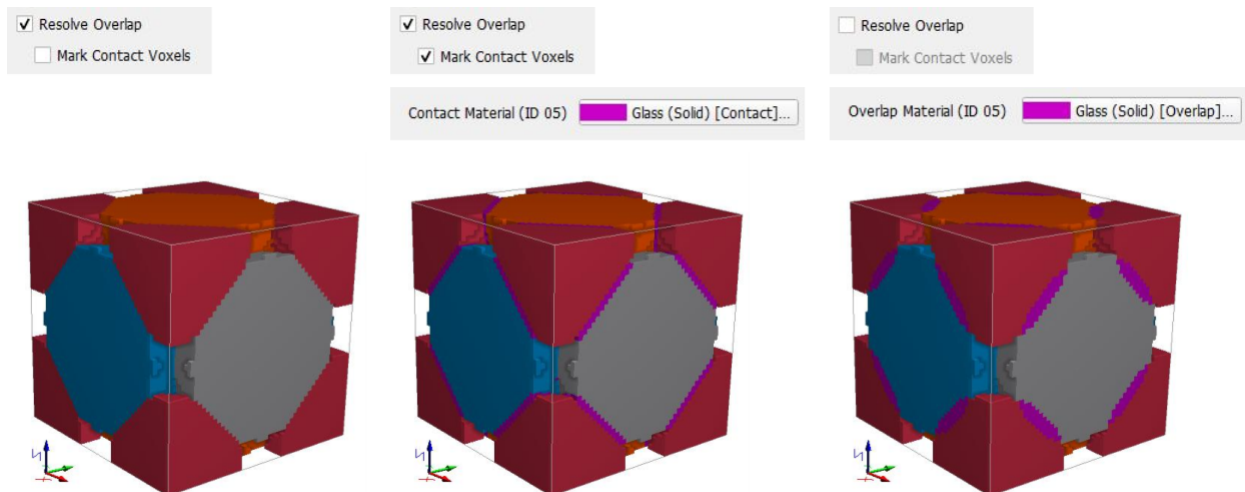
Alternatively, an **Overlap Material** can be selected for the regions where spheres overlap.

☐ Resolve Overlap

☐ Mark Contact Voxels

Overlap Material (ID 03) Steel (A36) (Solid) [Overlap]...

The following example of a face-centered-cubic grid, where the spheres have a diameter of 110 μm and the sphere centers have a distance of 100 μm , illustrates how the different options for the overlap behavior affect the structure.



1.1.3 Domain Panel

In the **Domain** panel you can define the general parameters for the grid.

Domain

Unit Cells X-Direction

Unit Cells Y-Direction

Unit Cells Z-Direction

☐ Periodic Domain

Inlet / (μm)

Outlet / (μm)

Voxel Length / (μm)

Voxel per X-Unit Cell

NX

NY

NZ

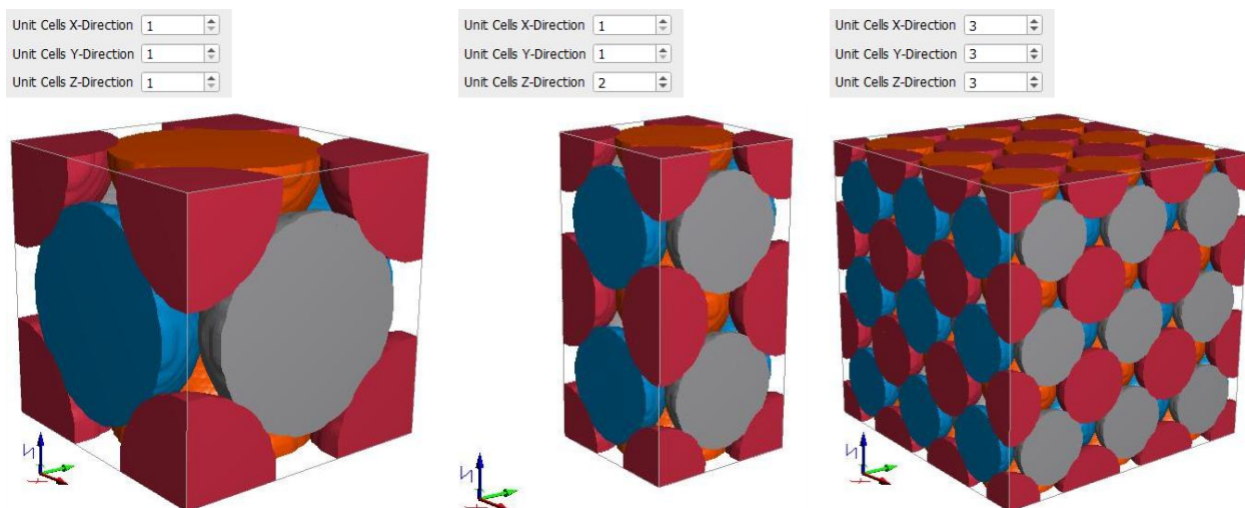
Width (X) / (μm)

Length (Y) / (μm)

Height (Z) / (μm)

Unit Cells X-, Y-, and Z-Direction

The **Unit Cells X-**, **Y-** and **Z-Direction** define the number of repetitions of the unit cell in space. Observe the effect of setting the number of unit cells for the different directions.

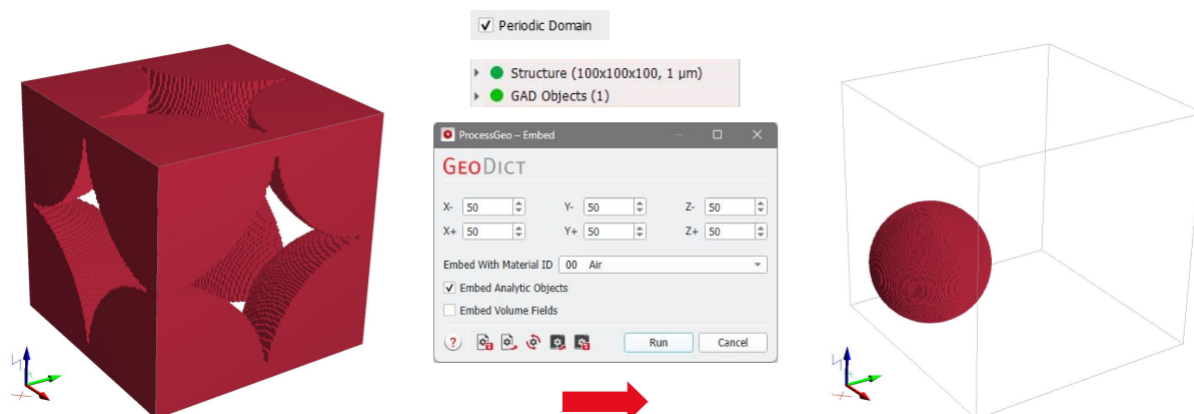


Periodicity of the unit cell

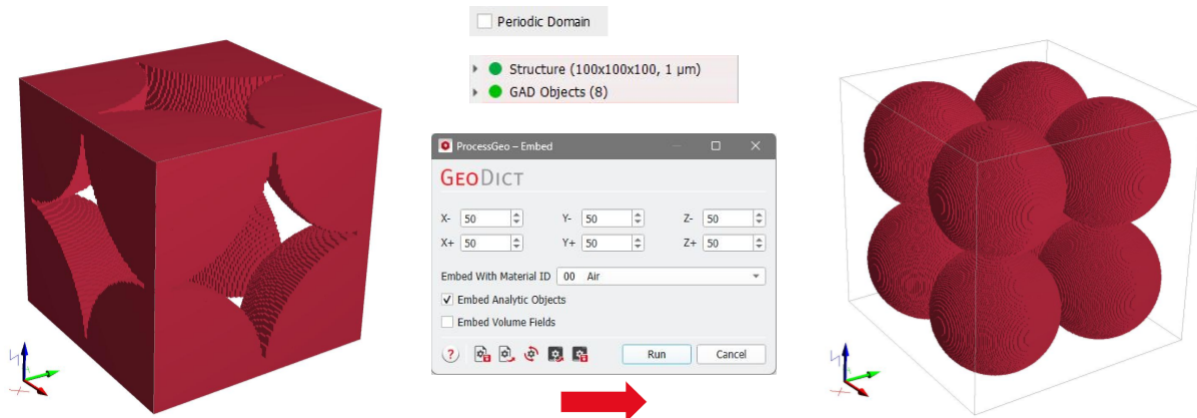
Sphere grids can be generated in a periodic domain in GridGeo when **Periodic Domain** is checked. This means that a sphere cut by the domain boundary will enter the domain periodically on the opposite domain boundary. Hence, if a sphere is cut by the boundary all parts (the sphere is cut into) are visible. If this option is not checked the grid domain is not periodic. This difference is explained in more detail below with the example of a Simple Cubic grid.

When a unit cell of the Simple Cubic grid is generated when **Periodic Domain** is checked, it looks like 8 cut spheres are located at the corners of the unit cell. In reality, there is only one sphere in the unit cell. This sphere is repeated periodically and, therefore, appears again at the opposite sides of the cell.

This can easily be examined by looking at the structure information panel located to the left of the GeoDict GUI: There is only one GAD object in the structure. When embedding the structure with **Model** → **ProcessGeo** → **Crop, Embed & Add Layers** → **Embed** in a larger domain (and choosing Embed Analytic Objects), only that single sphere appears in the domain.



Creating a Simple Cubic Grid without Periodic Domain chosen leads to 8 GAD objects existing in the structure. When this structure is now embedded (**Model** → **ProcessGeo** → **Crop, Embed & Add Layers** → **Embed**), 8 complete spheres appear in the final structure.



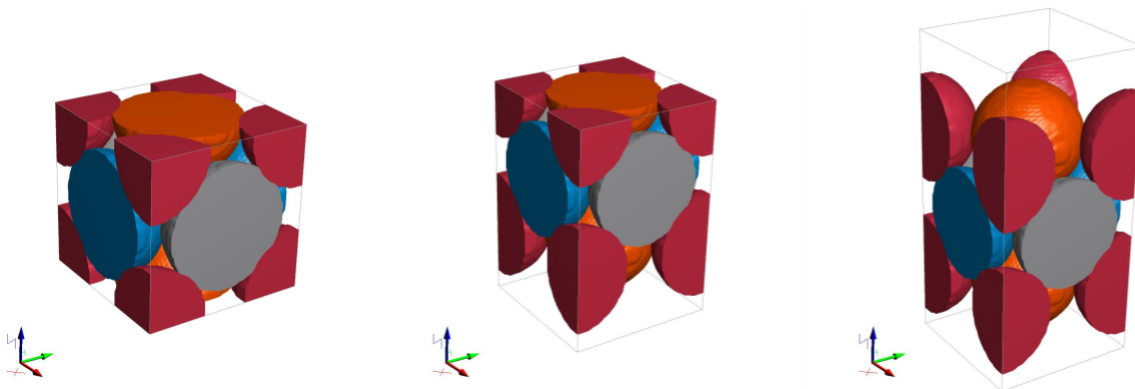
Inlet and Outlet

With the **Inlet** and **Outlet** option, additional space can be added at the bottom and top of the structure (in Z-Direction). The **Inlet** is in **Z-** direction, the **Outlet** is in **Z+** direction. This might be useful for flow simulations.

Inlet / (μm)	0
Outlet / (μm)	0

Inlet / (μm)	60
Outlet / (μm)	0

Inlet / (μm)	60
Outlet / (μm)	80



Cell size and Voxel length

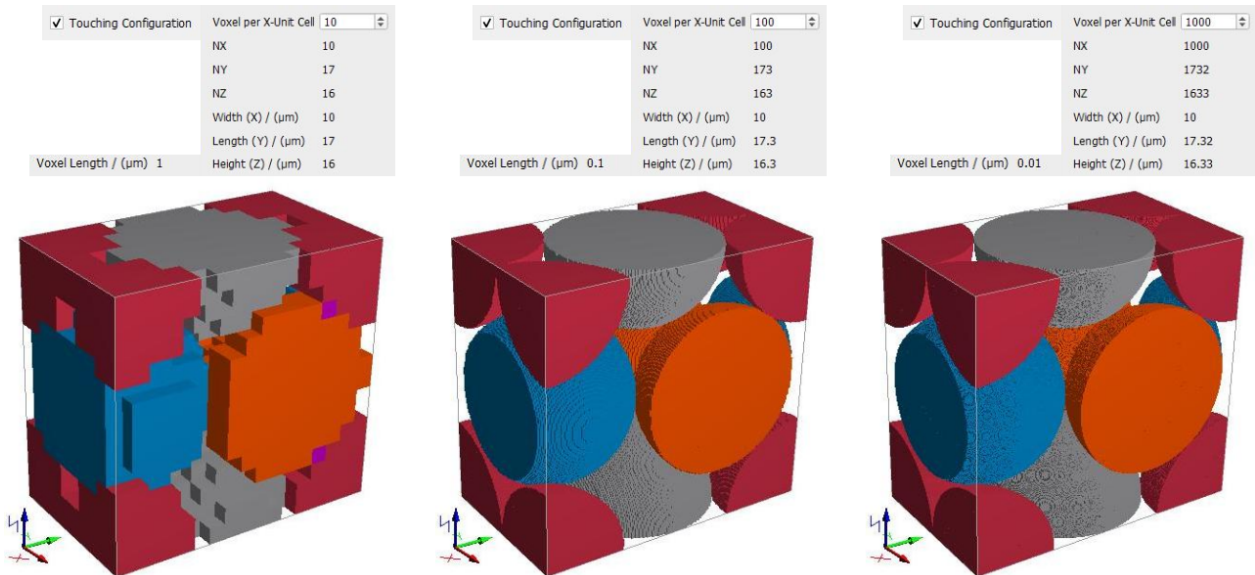
As explained in [Unit Cell Definition](#)^[10], the unit cell size in metric units (**Width (X)**, **Length (Y)**, and **Height (Z)**) depends on the chosen **Sphere Packing Mode**, and the given **Unit Cell Size** or **Sphere Diameter** and **Sphere Center Distance**, respectively.

The number of voxels in the unit cell (**NX**, **NY**, and **NZ**) is computed based on the entered number of **Voxel per X-Unit Cell**. The unit cell of the Simple Cubic, Body-Centered Cubic and Face-Centered Cubic grid types are cubic, therefore, the number of **Voxel per X-Unit Cell** also sets the number of voxels for the other two directions. For the Hexagonal grid the unit cell is a

cuboid and the number of voxels in the Y- and Z-direction are set according to the Length and Height together with the voxel length.

The **Voxel Length** itself is not editable, but computed from the number of **Voxel per X-Unit Cell** and the **Width (X)** of the unit cell. Thus, the number of Voxel per X-Unit Cell also sets the resolution of the structure.

For hexagonal grids, it is not possible to achieve the exact side lengths of the (theoretical) cuboid unit cell with cubic voxels. Therefore, GridGeo approximates the unit cell in the given resolution. This leads to a slightly different unit cell size in each resolution, and therefore the resulting positions of the spheres will depend on the selected resolution. Furthermore, it is possible that in some cases the spheres may slightly overlap, even for cases where a **Touching Configuration** was selected. To evaluate the effect of choosing the number of Voxels per X-Unit Cell on the resolution of the structure, it is important that the 3D-structure mode is set to **Box** (select **View** → **3D Structure Renderer** → **Box**).



1.2 Grid of Parallel Cylinders

The generated **Grid of Parallel Cylinders** is a regular arrangement of cylindrical objects, based on the entered parameters.

The **GridGeo Grid of Cylinders Options** dialog opens when clicking the **Options' Edit...** button in the GridGeo section.

At the top left of the **GridGeo Grid of Cylinders Options** dialog, enter the name for the files containing the generation results in the **Result File Name (*.gdr)** box. Keep the default name, or choose a new name which fits to your current project.

The available units (**m**, **cm**, **mm**, **µm**, **nm**, and **Inch**) are selectable from the drop down menu at the top right of the **GridGeo Grid of Cylinders Options** dialog. When the units are changed, the entered values are adjusted automatically.

GridGeo – Grid of Cylinders

GEO DICT

µm

Result File Name (*.gdr) GridGeoCylinder.gdr

Domain

Width (X) / (µm)	200
Length (Y) / (µm)	200
Height (Z) / (µm)	100
NX	200 (200µm, error: 0µm)
NY	200 (200µm, error: 0µm)
NZ	100 (100µm, error: 0µm)
Voxel Length / (µm)	1

Profile Round Profile

Cylinder Material (ID 01) Glass (Solid)...

Pore / Matrix Material (ID 00) Air...

Diameter / (µm) 20

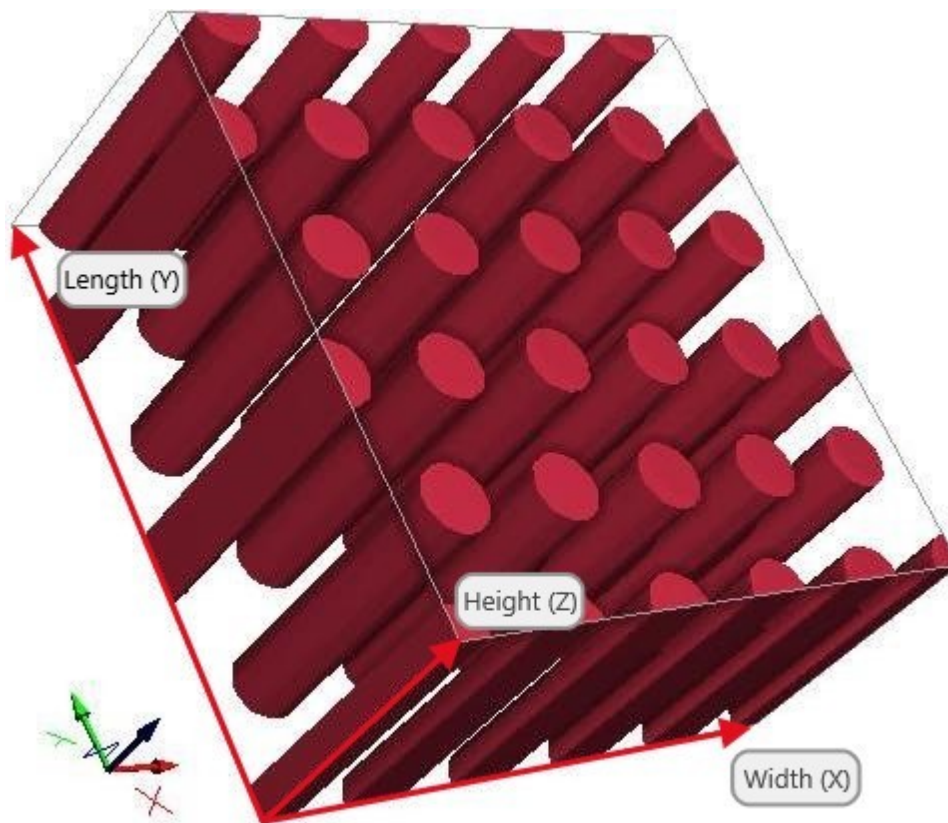
Spacing in X / (µm) 40

Spacing in Y / (µm) 40

Row Shift / (µm) 20

OK Cancel

Domain Settings



Width (X), **Length (Y)**, and **Height (Z)** define the size of the domain in the given directions and selected units. The **Voxel Length** sets the size of a voxel in the selected unit and, therefore, the resolution of the structure. Together with the domain length it will determine the values for the domain size in voxel, which are shown below (**NX**, **NY**, and **NZ**) and cannot be edited. It will also show the achieved domain size in metric units and the error compared to desired domain size (e.g., a width of 50 μm can not be fully resolved with 4 μm voxel length, the error is 2 μm in this case).

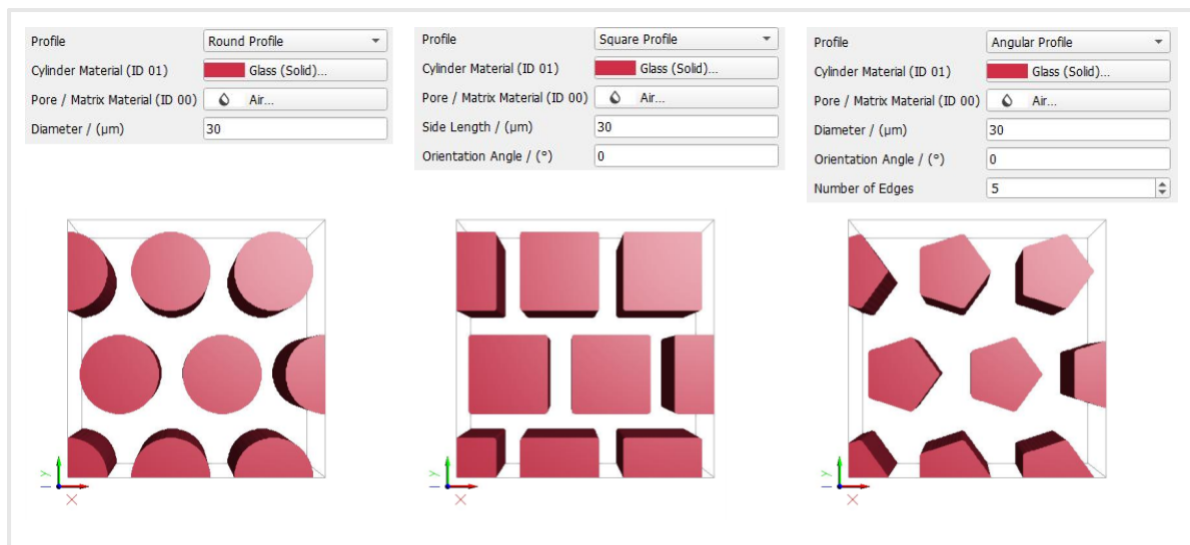


Note! Try to adjust the voxel length or the domain size to minimize the error.

Grid settings

✓ Profile

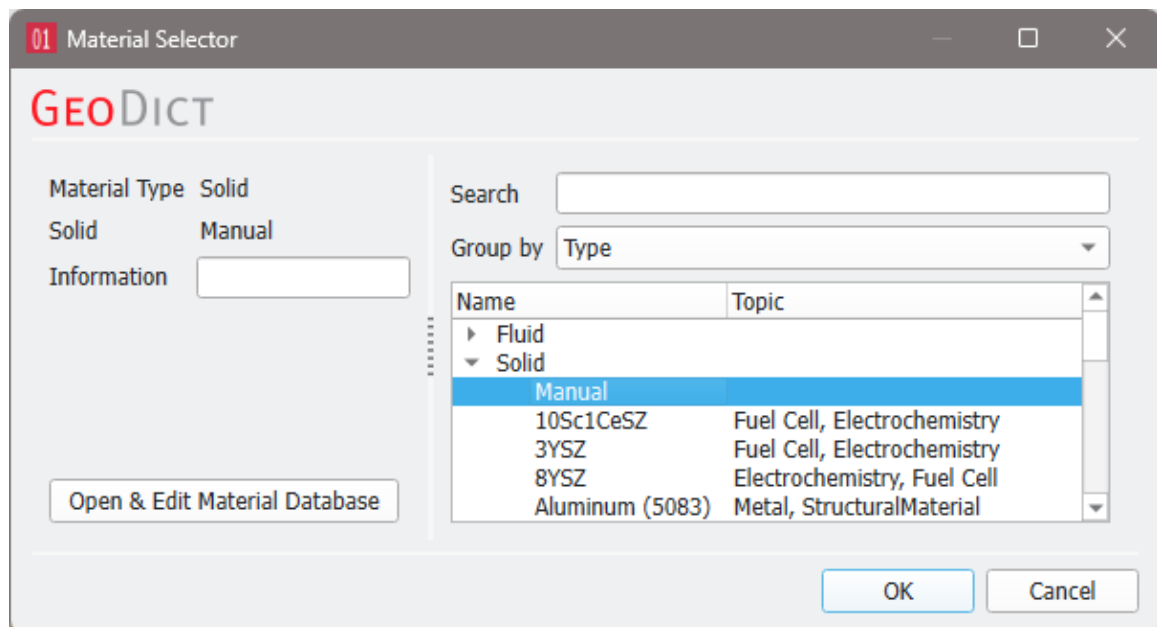
Choose the cylinder **Profile** from the pull-down menu: **Round Profile**, **Square Profile**, or **Angular Profile**.



✓ Cylinder and Pore Material

The **Cylinder Material (ID 01)** and the **Pore / Matrix Material (ID 00)** can be chosen from the GeoDict material database. The cylinders will always be assigned Material ID01, while the pore surrounding them will have Material ID00.

The pull-down menu gives access to selecting the desired material from the GeoDict **Material Database**. When none of the materials available in the database fit the preferred specifications, **Manual** should be chosen. Alternatively, a new material with the desired specifications can be added to the **Material Database** (see the Material Database chapter).



To match realistic material colors for visualization in a certain application, the default material colors can be changed through the **Color & Visibility** tab of the GUI sidebar. For more visualization options, see the Visualization chapter.

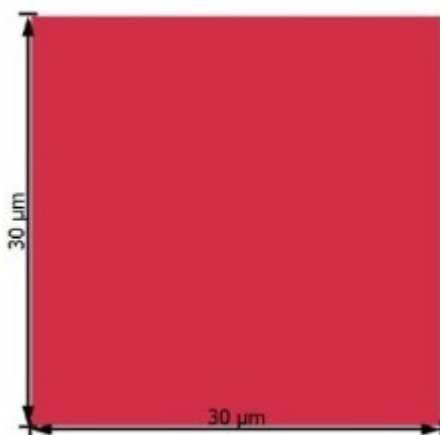
✓ Diameter

Diameter is only available for the **Round Profile** and the **Angular Profile**. For the round profile it sets the diameter of the individual cylinders, which have a circular profile. For the angular profile, it equals the diameter of the circle touching all corners of the profile ([circumscribed circle](#)).



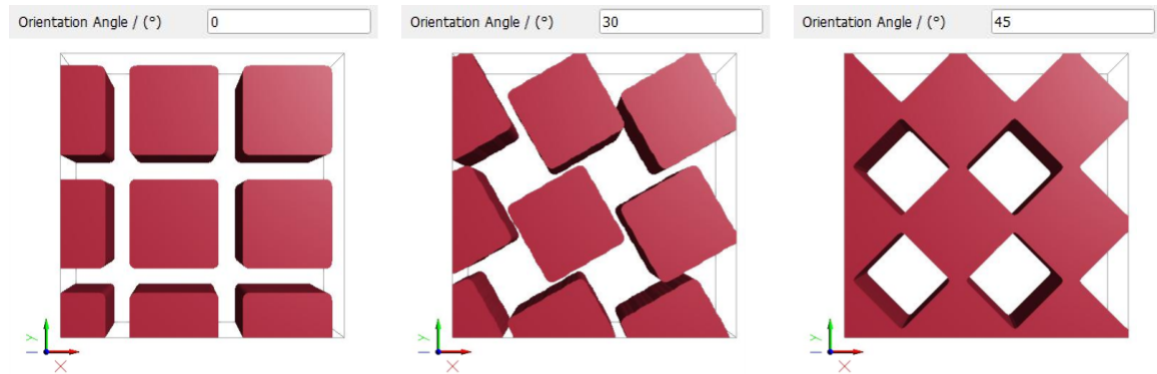
✓ Side Length

Side Length is only available for the **Square Profile** and defines the length of the square in the X-Y-plane.



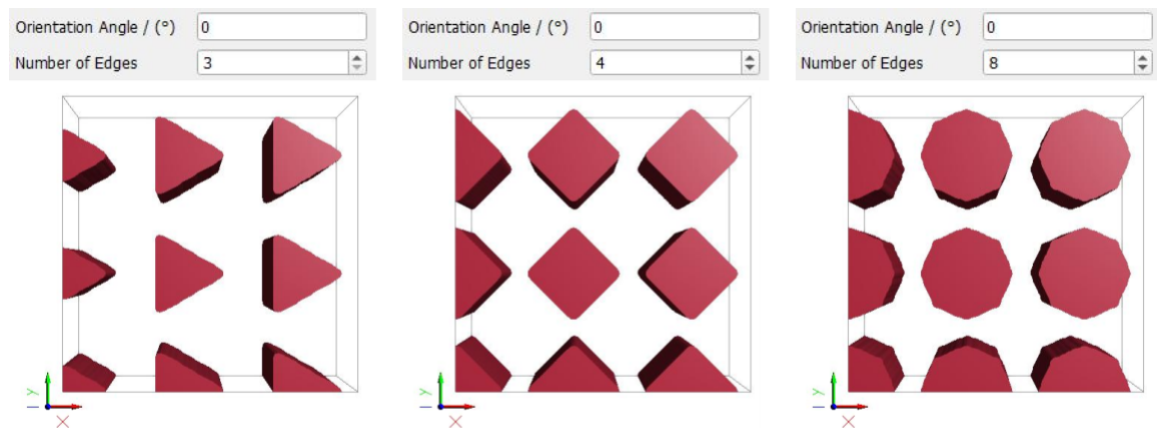
✓ Orientation Angle

The **Orientation Angle** can only be set for the **Square Profile** and the **Angular Profile**. It determines the rotation of the profile in the X-Y-plane. Depending on the combination of parameters, overlapping structures can be generated, as it is shown for the structure with 45° orientation angle.



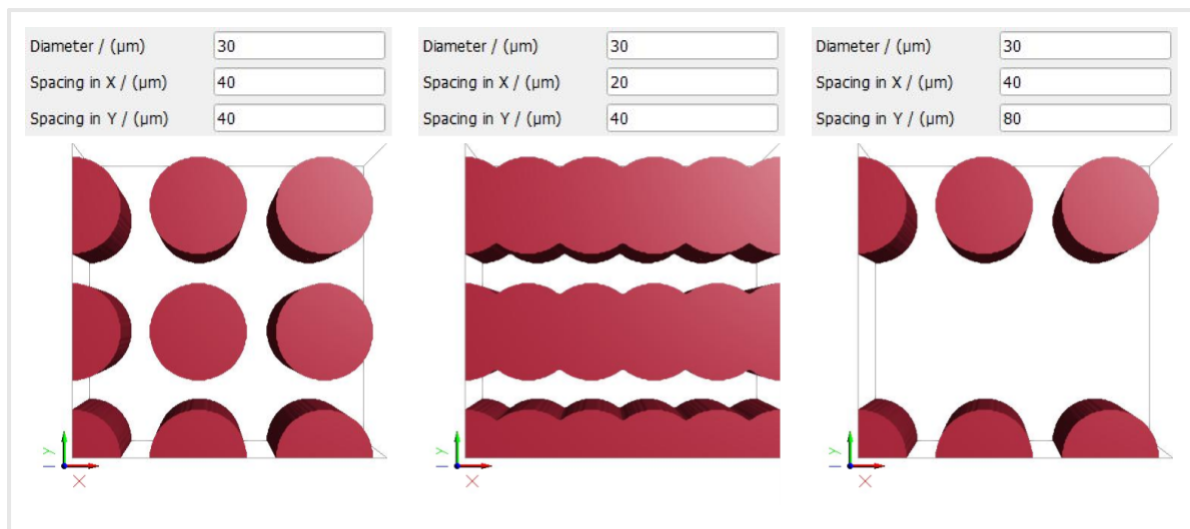
✓ Number of Edges

The **Number of Edges** must be chosen for the **Angular Profile**. The profile will be a polygon with the entered number of edges. Thus the minimal number of edges is 3. The maximum is 10, but this is already quite similar to a circular profile, which can be modeled choosing **Round Profile**.



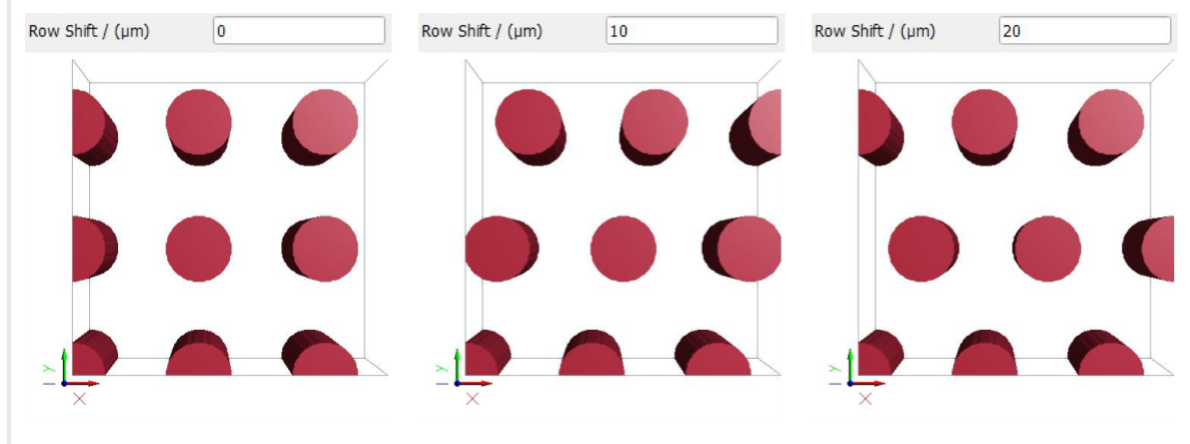
✓ Spacing

Spacing in X and **Spacing in Y** determine the distance between the centers of the cylinders in the given direction. For cylinders with angular profile, the center will be the center of the circumscribed circle.



✓ Row Shift

Row Shift defines the spatial displacement in X-direction between the centers of the cylinders in two consecutive rows (in Y-direction).



1.3 User Defined Grid

The User Defined Grids can be based on an arrangement of objects of any object type available in GeoDict. User Defined Grids are always generated periodically.

The **GridGeo User Defined Grid Options** dialog opens when clicking the **Options' Edit...** button in the GridGeo section.

At the top left of the **GridGeo User Defined Grid Options** dialog, enter the name for the files containing the generation results in the **Result File Name (*.gdr)** box. Keep the default name, or choose a new name which fits to your current project.

The available units (**m**, **cm**, **mm**, **µm**, **nm**, and **Inch**) are selectable from the drop down menu at the top right of the **GridGeo User Defined Grid Options** dialog. When the units are changed, the entered values are adjusted automatically.

The settings are arranged in the two tabs **Grid Options** and **Objects in Unit Cell**.

Tabs of the User Defined Grid dialog

- [Grid Options](#)²⁶
Set the general options for the grid.
- [Objects in Unit Cell](#)³⁴
Define the individual object types of the grid.

1.3.1 Grid Options

Material ID Mode

The **Material ID Mode** pull-down menu at the top allows to select between two modes.

- **Material ID per Object-Type** means that each object defined in the [Objects in Unit Cell](#)³⁴ tab obtains a different **Material ID**.
- **Material ID per Material** means that all objects with the same material (defined in the [Objects in Unit Cell](#)³⁴ tab) receive the same **Material ID**.

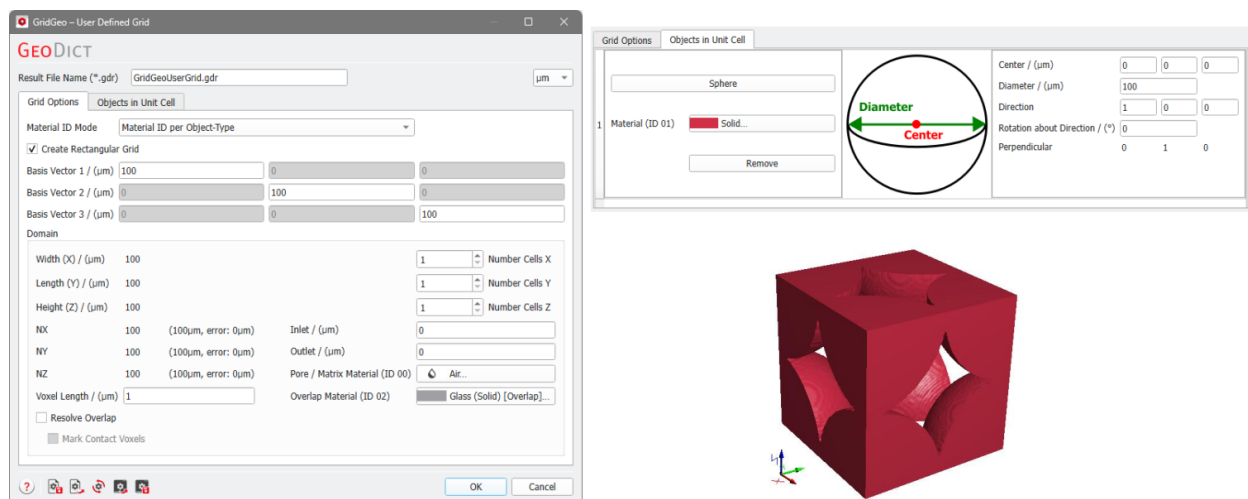
Grid Type

The properties of the grid's unit cell can be completely user-defined. First, decide if you want to **Create a Rectangular Grid**, which means the **Basis Vectors** of the unit cell are orthogonal to each other. Alternatively, if **Create Rectangular Grid** is unchecked, the **Basis Vectors** are defined freely in space. Depending on this choice, the available options in the **Domain** panel differ.

Find detailed explanations for both grid types here:

- [Rectangular Grid](#)²⁷
- [Non-Rectangular Grid](#)³¹

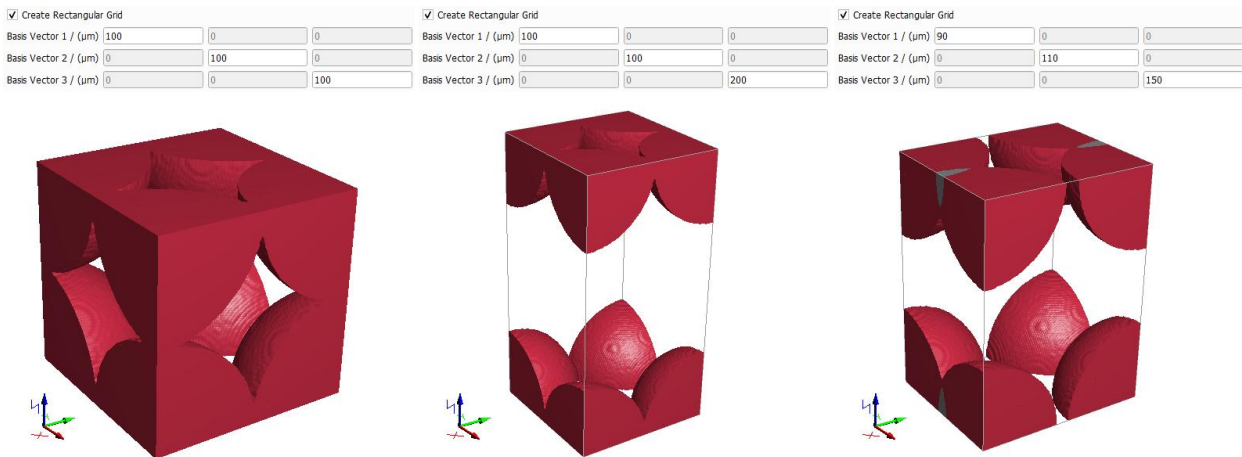
To explain the capabilities of the **User Defined Grid**, a simple grid with only one sphere object is chosen. The basis vectors define a cubic unit cell with a side length of 100 μm , which contains a sphere with its center in the origin and a diameter of 100 μm . This generates a [Simple Cubic grid](#)⁶. Then, various parameters are varied and their effects can be examined.



Grid Options for the Rectangular Grid

Basis Vectors

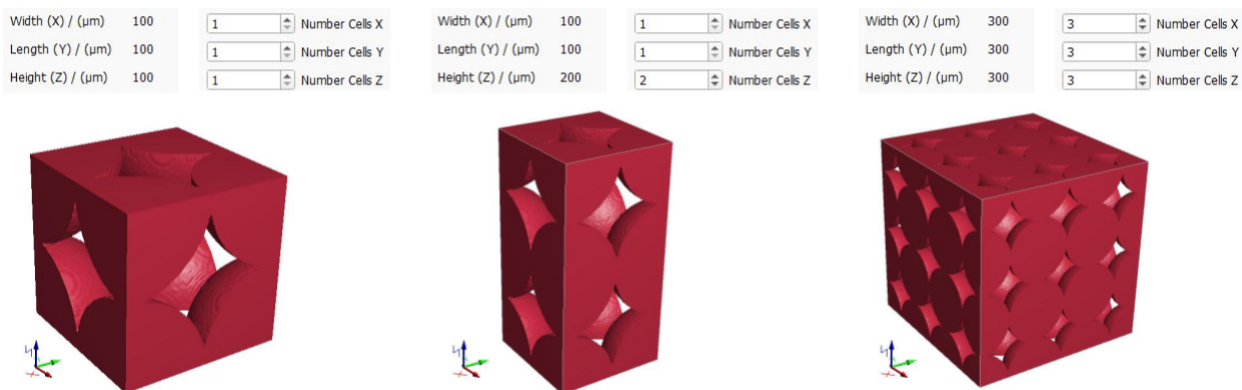
When **Create Rectangular Grid** is checked, the three **Basis Vectors** of the unit cell must be aligned to the X-, Y- and Z-axes. In the first row of the table, **Basis Vector 1** is given which belongs to the X-axis. **Basis Vector 2** (in the second row) belongs to the Y-axis, and **Basis Vector 3** (third row) belongs to the Z-axis. Thus, only the component of the corresponding direction of each vector can be edited. In the periodic grid, the basis vectors define the size and shape of the unit cell and the relation from unit cell to unit cell. The effect of changing the basis vectors is shown below – the shape of the unit cell can be an arbitrary cuboid.



Domain

Cell Number and Size

For Rectangular Grids, the **Number Cells X**, **Y**, and **Z** must be given. It sets the number of unit cells in the corresponding direction in the domain. As the basis vectors are aligned to the axes, their value determines the size of one unit cell. The size of the generated grid in metric units (**Width (X)**, **Length (Y)**, and **Height (Z)**) is computed based on the Cell Number and cannot be edited.

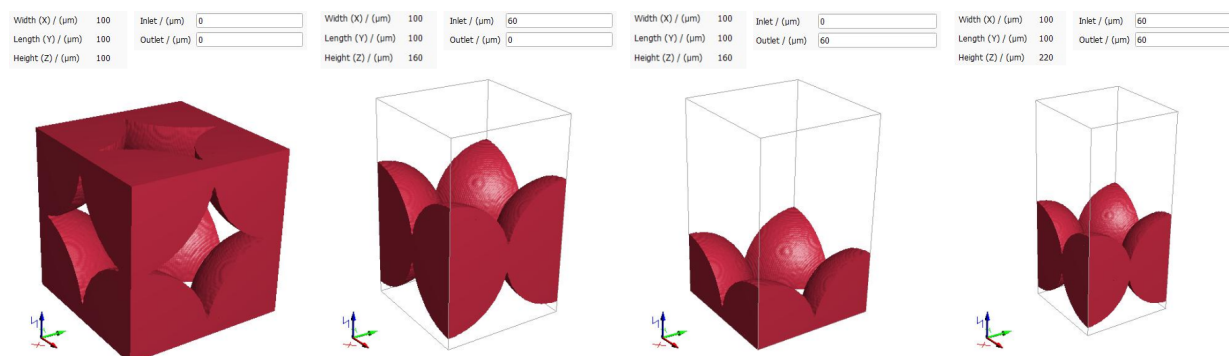


Inlet and Outlet

The parameters **Inlet** and **Outlet** add empty space to the domain at the bottom or at the top of the domain (in Z-direction). The **Inlet** is in **Z-** direction, the **Outlet** is in **Z+** direction. When generating one unit cell without **Inlet** and **Outlet** (Setting both values to 0), the structure is repeated periodically and the objects penetrating the border of the domain reappear at the opposite side. When either an **Inlet** or an **Outlet** is used (by choosing a value larger than 0), the structure is not periodic in Z-direction anymore so the objects will not reappear from the other side. In this example, the object in the unit cell is a sphere centered in the origin.

Therefore, it is not completely contained in the domain when the **Inlet** is set to zero, while the **Outlet** is set to a larger value.

The size of the inlet and outlet will be added to the **Height (Z)** of the domain and affects the number of voxels in Z-direction (**NZ**).



Voxel Length and Number

The **Voxel Length** sets the size of a voxel in the selected unit and, therefore, the resolution of the structure. Together with the domain length (**Width (X)**, **Length (Y)**, and **Height (Z)**) it will determine the values for the domain size in voxel, which are shown below (**NX**, **NY**, and **NZ**) and cannot be edited. It will also show the achieved domain size in metric units and the error compared to desired domain size (e.g., a width of 50 μm can not be fully resolved with 4 μm voxel length, the error is 2 μm in this case).

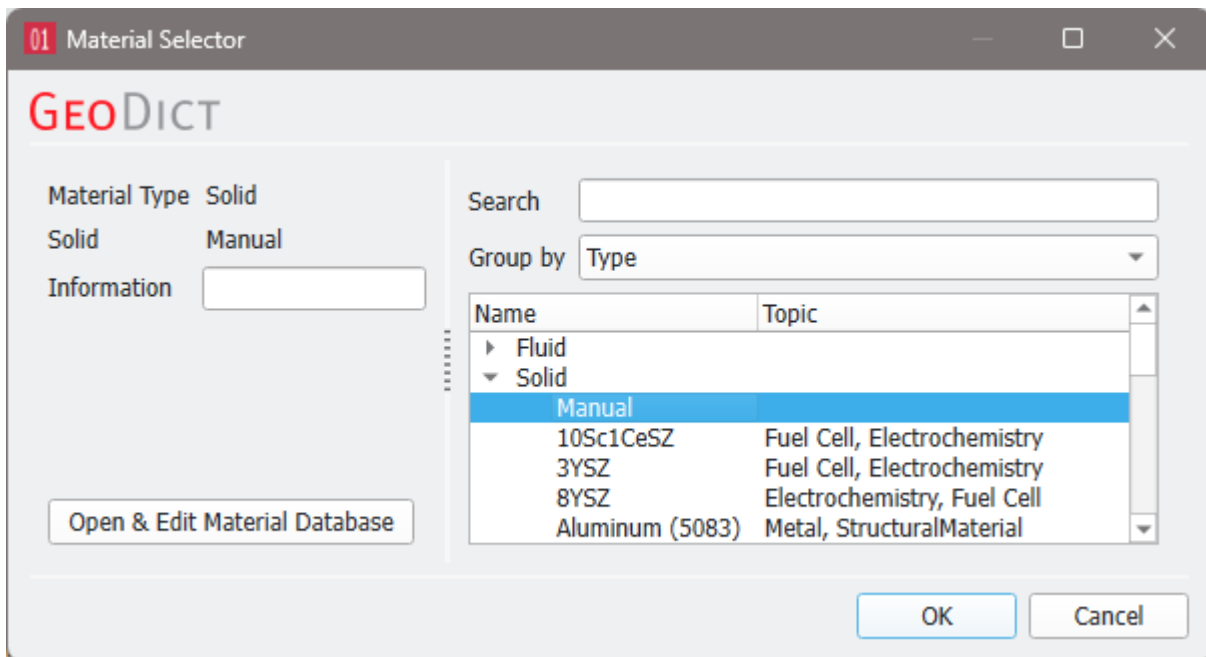


Note! Try to adjust the voxel length or the domain size to minimize the error.

Select Pore Material

The material for the **Pore / Matrix Material (ID 00)** in the grid can be chosen in the **Domain panel**. The material(s) of the object(s) are set in the [Objects in Unit Cell](#) ³⁴ tab.

The pull-down menu gives access to selecting the desired material from the GeoDict **Material Database**. When none of the materials available in the database fit the preferred specifications, **Manual** should be chosen. Alternatively, a new material with the desired specifications can be added to the **Material Database** (see the Material Database chapter).

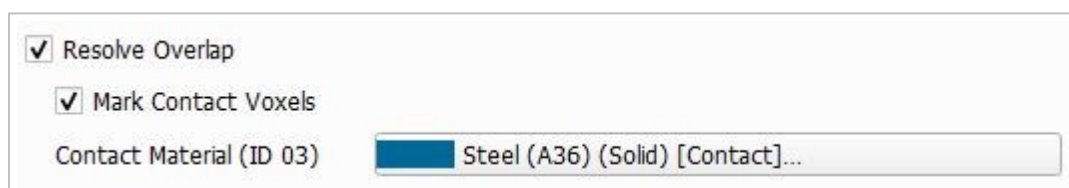


To match realistic material colors for visualization in a certain application, the default material colors can be changed through the **Color & Visibility** tab of the GUI sidebar. For more visualization options, see the Visualization chapter.

Overlap Behavior

In the generated grid, overlap between the objects might occur. This overlap can be handled in different ways.

By default, **Resolve Overlap** is enabled. With this option, the overlapping regions are assigned to the materials of the objects which are in contact. This leads to a more realistic structure.



Additionally checking **Mark Contact Voxels** allows to define a separate material for the contact areas. This means, for each overlapping object a one voxel thick layer is reassigned to the **Contact Material**. In this way, even contacting objects with the same material ID can be clearly distinguished.



Know how! Using **Resolve Overlap** needs more time to compute, therefore we recommend disabling this option for large structures where the information about the overlap is not relevant (e.g., for flow simulations).

Alternatively, an **Overlap Material** can be selected for the regions where objects overlap.

☐ Resolve Overlap

☐ Mark Contact Voxels

Overlap Material (ID 03)

Steel (A36) (Solid) [Overlap]...

Grid Options for the Non-Rectangular Grid

Basis Vectors

When **Create Rectangular Grid** is not checked, the three **Basis Vectors** can be defined freely. In the first row of the table, **Basis Vector 1** is defined which belongs to the X-axis. **Basis Vector 2** (in the second row) belongs to the Y-axis, and **Basis Vector 3** (third row) belongs to the Z-axis. The first column contains the X-component, the Y-component is in the second column, and in the third column the Z-component is entered.



Important! The basis vectors must be linearly independent to span a volume in space, so an error message appears if this is not the case.

☐ Create Rectangular Grid

Basis Vector 1 / (μm)	100	0	0
Basis Vector 2 / (μm)	100	0	0
Basis Vector 3 / (μm)	0	0	100

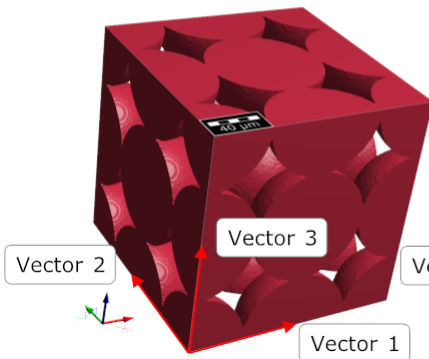


Domain

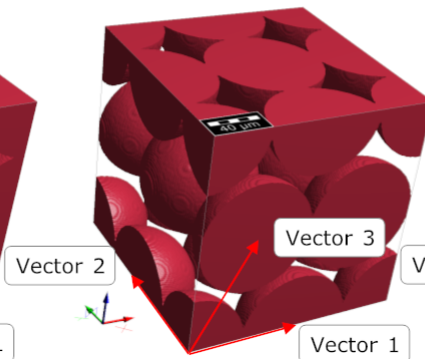
The domain options now differ from those available in the rectangular case. Since the unit cell might be non-orthogonal or rotated with respect to the GeoDict coordinate system, the domain containing the structure can no longer be described by numbers of unit cells in the coordinate directions. Instead, the size of the domain must be entered directly.

As it happened for the [Rectangular Grid](#)²⁷, the basis vectors define the size and shape of the unit cell and therefore the relation between succeeding unit cells. The effect of using non-orthogonal basis vectors is illustrated in the following figure by changing only one vector (Basis Vector 3). The domain size is set equally in each dimension to 200 μm .

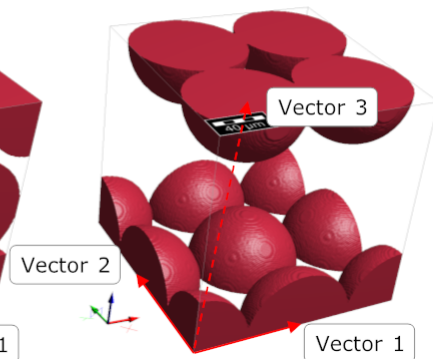
Basis Vector 1 / (μm)	100	0	0
Basis Vector 2 / (μm)	0	100	0
Basis Vector 3 / (μm)	0	0	100



Basis Vector 1 / (μm)	100	0	0
Basis Vector 2 / (μm)	0	100	0
Basis Vector 3 / (μm)	50	0	100



Basis Vector 1 / (μm)	100	0	0
Basis Vector 2 / (μm)	0	100	0
Basis Vector 3 / (μm)	50	50	200

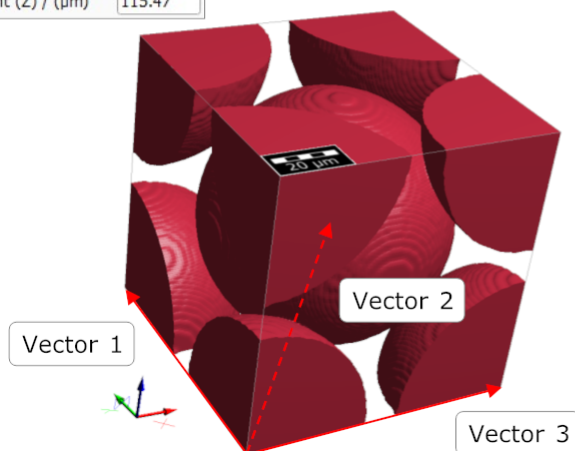


With the use of non-orthogonal basis vectors, the Body-Centered Cubic and Face-Centered Cubic grids can be generated with only one sphere per unit cell.

Lattices with this property are called Bravais lattices. Find out more about them [here](#).

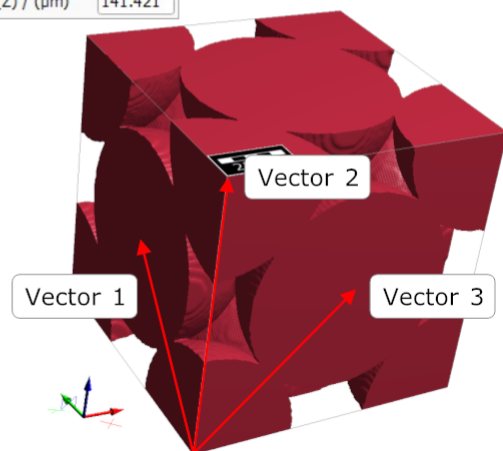
Basis Vector 1 / (μm)	0	115.47	0
Basis Vector 2 / (μm)	57.735	57.735	57.735
Basis Vector 3 / (μm)	115.47	0	0

Width (X) / (μm)	115.47
Length (Y) / (μm)	115.47
Height (Z) / (μm)	115.47



Basis Vector 1 / (μm)	0	70.7107	70.7107
Basis Vector 2 / (μm)	0	0	141.421
Basis Vector 3 / (μm)	70.7107	0	70.7107

Width (X) / (μm)	141.421
Length (Y) / (μm)	141.421
Height (Z) / (μm)	141.421



Voxel Length and Number

The **Voxel Length** sets the size of a voxel in the selected unit and, therefore, the resolution of the structure. Together with the domain length (**Width (X)**, **Length (Y)**, and **Height (Z)**) it will determine the values for the domain size in voxel, which are shown below (**NX**, **NY**, and **NZ**) and cannot be edited. It will also show the achieved domain size in metric units and the error compared to desired domain size (e.g., a width of 50 μm can not be fully resolved with 4 μm voxel length, the error is 2 μm in this case).

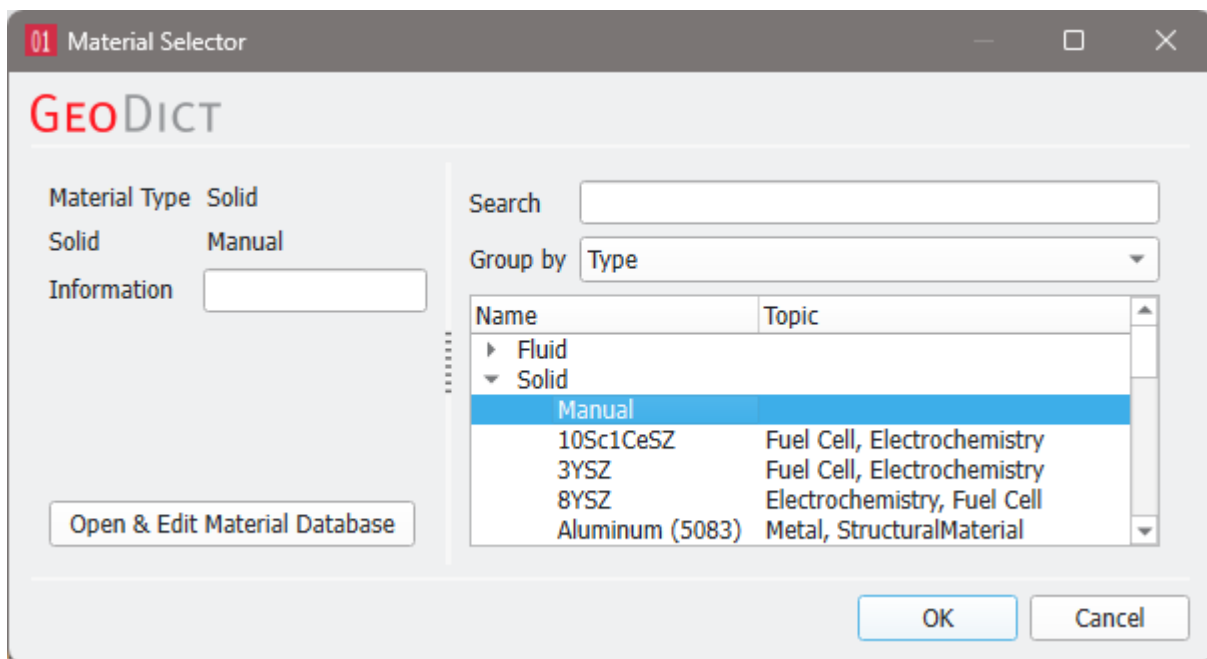


Note! Try to adjust the voxel length or the domain size to minimize the error.

Select Pore Material

The material for the **Pore / Matrix Material (ID 00)** in the grid can be chosen in the **Domain panel**. The material(s) of the object(s) are set in the [Objects in Unit Cell](#)³⁴ tab.

The pull-down menu gives access to selecting the desired material from the GeoDict **Material Database**. When none of the materials available in the database fit the preferred specifications, **Manual** should be chosen. Alternatively, a new material with the desired specifications can be added to the **Material Database** (see the Material Database chapter).

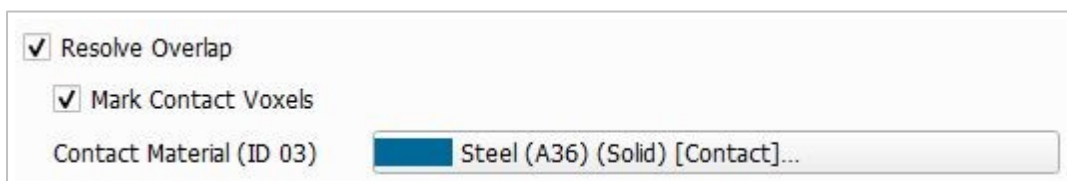


To match realistic material colors for visualization in a certain application, the default material colors can be changed through the **Color & Visibility** tab of the GUI sidebar. For more visualization options, see the Visualization chapter.

Overlap Behavior

In the generated grid, overlap between the objects might occur. This overlap can be handled in different ways.

By default, **Resolve Overlap** is enabled. With this option, the overlapping regions are assigned to the materials of the objects which are in contact. This leads to a more realistic structure.



Additionally checking **Mark Contact Voxels** allows to define a separate material for the contact areas. This means, for each overlapping object a one voxel thick layer is reassigned to

the **Contact Material**. In this way, even contacting objects with the same material ID can be clearly distinguished.



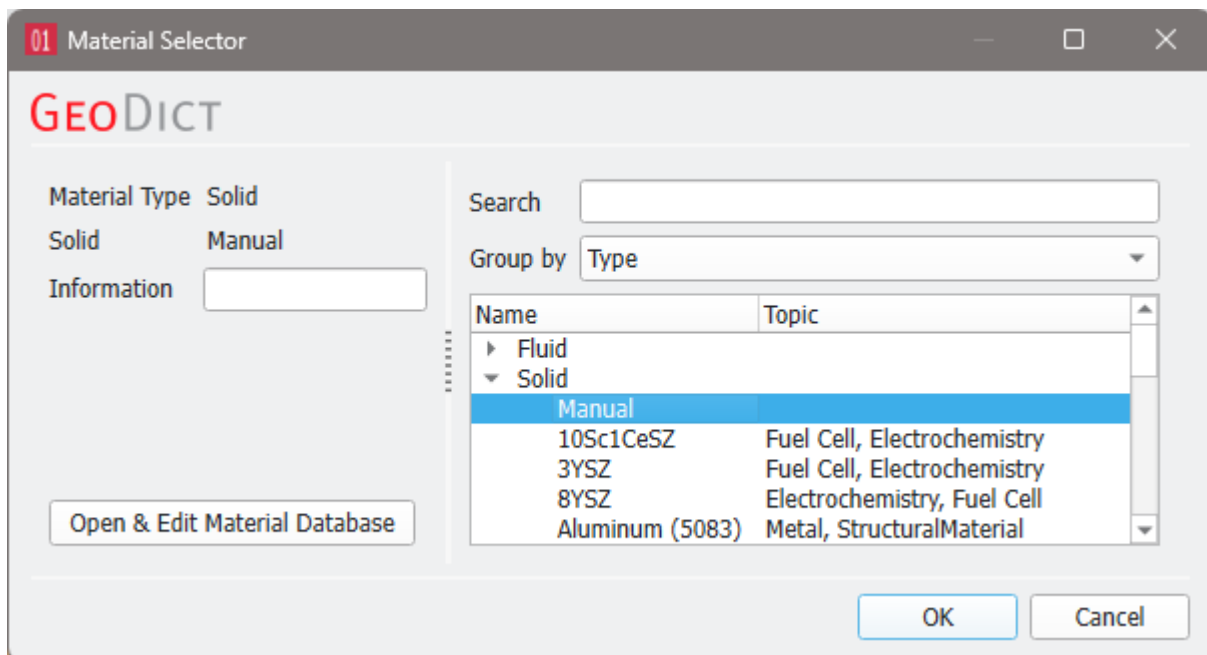
Know how! Using **Resolve Overlap** needs more time to compute, therefore we recommend disabling this option for large structures where the information about the overlap is not relevant (e.g., for flow simulations).

Alternatively, an **Overlap Material** can be selected for the regions where objects overlap.

1.3.2 Objects in Unit Cell

In the **Objects in Unit Cell** tab, the different objects appearing in the grid can be defined. At the bottom, choose the **Object Type** and click **Add** to define further parameters. With **Remove**, an object can be deleted from the selection. The available **Object Types** are the same as in GadGeo (find detailed explanation there). Observe the **Material ID** of each object, which depends on the selection of the [Material Mode](#)²⁶. Change the material, if necessary, by clicking on it and choosing a new material from the Material Selector.

The pull-down menu gives access to selecting the desired material from the GeoDict **Material Database**. When none of the materials available in the database fit the preferred specifications, **Manual** should be chosen. Alternatively, a new material with the desired specifications can be added to the **Material Database** (see the Material Database chapter).



To match realistic material colors for visualization in a certain application, the default material colors can be changed through the **Color & Visibility** tab of the GUI sidebar. For more

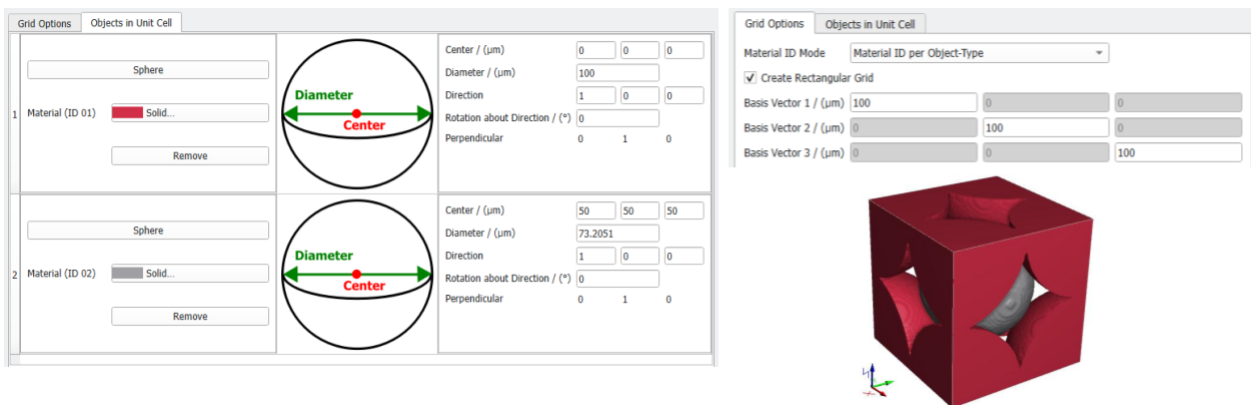
visualization options, see the Visualization chapter.



Important! Objects in Unit Cell and **Basis Vectors** must always be considered in combination.

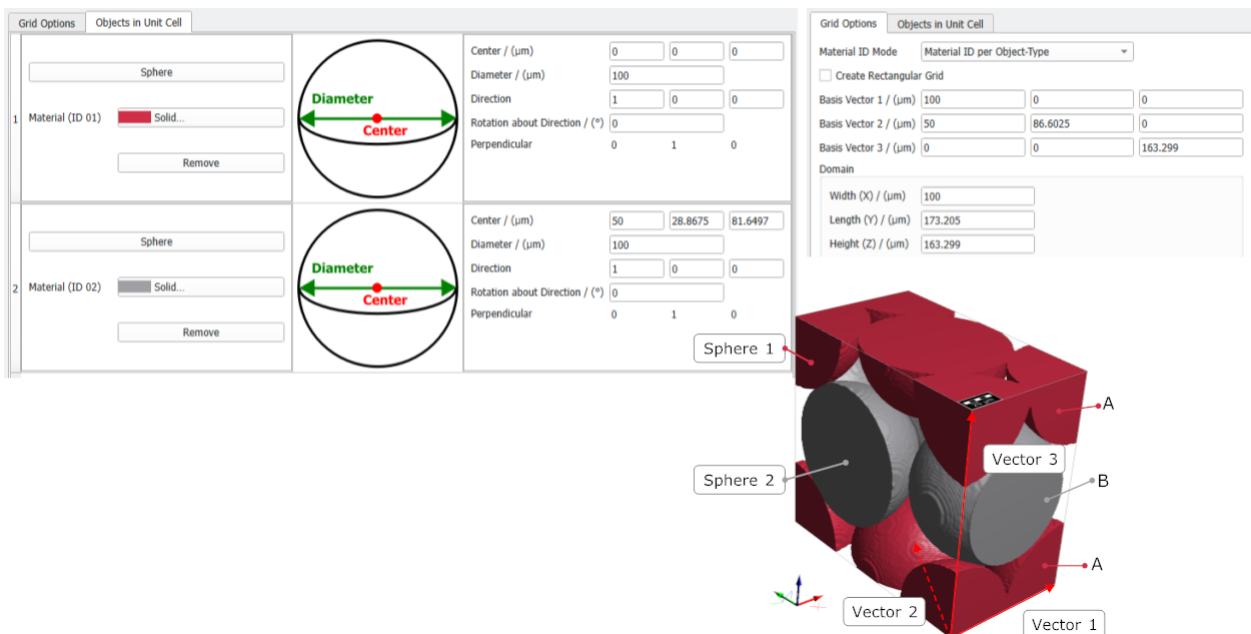
Example 1

The first example is a [Simple Cubic Grid](#) with a smaller sphere in the middle, which can be generated in a rectangular grid.



Example 2

The next example is a HCP (hexagonal close-packed) grid, which can be generated with two sphere objects in a non-orthogonal grid.



In contrast to the Simple Cubic, Body-Centered Cubic and Face-Centered Cubic lattices, a Hexagonal lattice cannot be generated with only one sphere and three basis vectors. The reason is, that a hexagonal lattice is not a Bravais lattice (https://en.wikipedia.org/wiki/Bravais_lattice). The relation from layer A to layer B is different from the relation of layer B to the next layer A (see also the [Relation between FCC and Hexagonal](#) ).

1.4 Perforated Foil

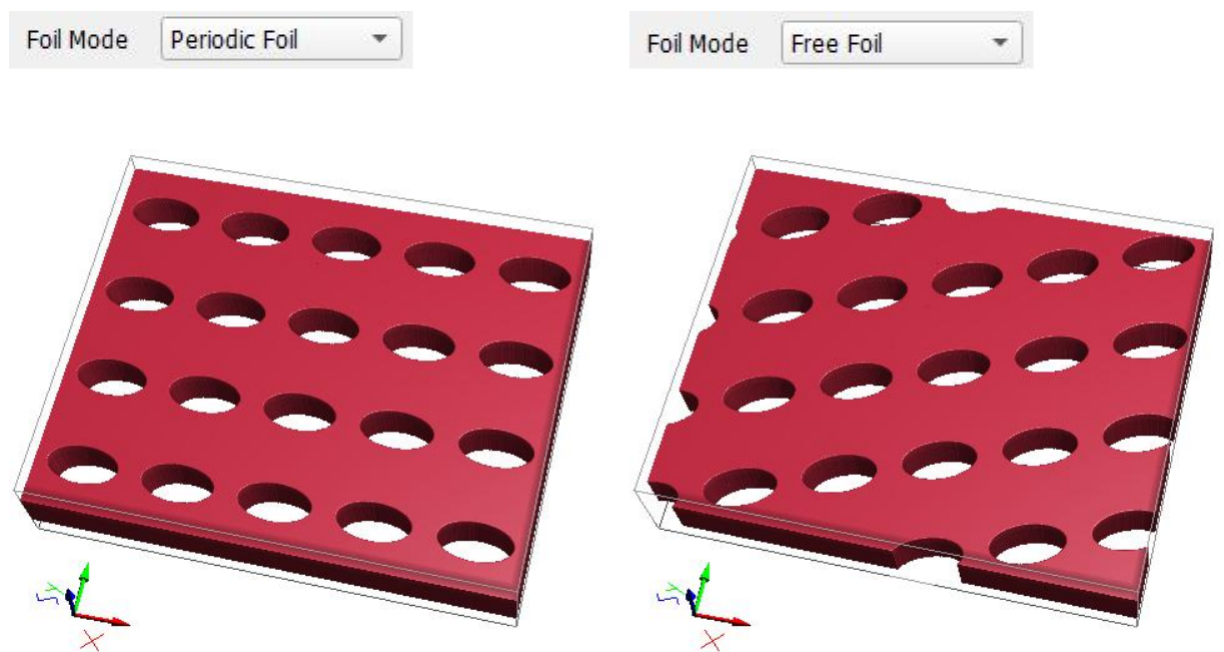
Select **Perforated Foils** to create flat sheets with differently shaped holes.

The **GridGeo Perforated Foil Options** dialog opens when clicking the **Options' Edit...** button in the GridGeo section.

At the top left of the **GridGeo Perforated Foil Options** dialog, enter the name for the files containing the generation results in the **Result File Name (*.gdr)** box. Keep the default name, or choose a new name which fits to your current project.

The available units (**m**, **cm**, **mm**, **μm**, **nm**, and **Inch**) are selectable from the drop down menu at the top right of the **GridGeo Perforated Foil Options** dialog. When the units are changed, the entered values are adjusted automatically.

As **Foil Mode** either [Periodic Foil](#)³⁸ or [Free Foil](#)⁴³ can be chosen to be generated in GridGeo and the selection changes some of the available parameters.



The Perforated Foil command

- [Periodic Foil](#)³⁸
Periodic Foils fit in a rectangular grid and can therefore be composed of multiple unit cells (which must be specified).
- [Free Foil](#)⁴³
Skewed grids can be generated as Free Foils. Rectangular unit cells may be complicated to determine (or may not exist at all), so instead of a desired number of unit cells the overall size of the domain must be set.

1.4.1 Periodic Foil

GridGeo – Perforated Foil

GEODICT

Result File Name (*.gdr) μm

Foil Mode Periodic Foil

Unit Cells X-Dir. Unit Cells Y-Dir.

Pore / Matrix Material (ID 00) Air... ☒ Curved Hole Walls

Material (ID 01) Steel (A36) (Solid) [Foil]...

Width (X) / (μm) Hole Top Width (X) / (μm)

Length (Y) / (μm) Hole Top Length (Y) / (μm)

Height (Z) / (μm) Hole Bottom Width (X) / (μm)

Inlet / (μm) Hole Bottom Length (Y) / (μm)

Outlet / (μm) Hole Shape

NX / (Voxel) ☐ Square ☒ Round

NY / (Voxel)

NZ / (Voxel)

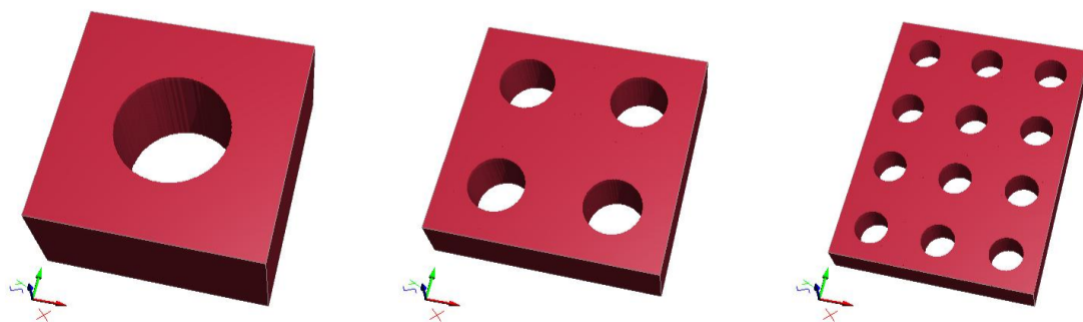
Voxel Length / (μm)

? OK Cancel

✓ Unit Cells

Periodic Foils are composed of one or multiple **Unit Cells**. One-unit cell consists of a flat piece of foil with one hole, which can be repeated periodically by setting the number of **Unit Cells X-Dir.** and **Unit Cells Y-Dir.** to the desired values. In the figure below, periodic foils consisting of one, four or twelve-unit cells are shown.

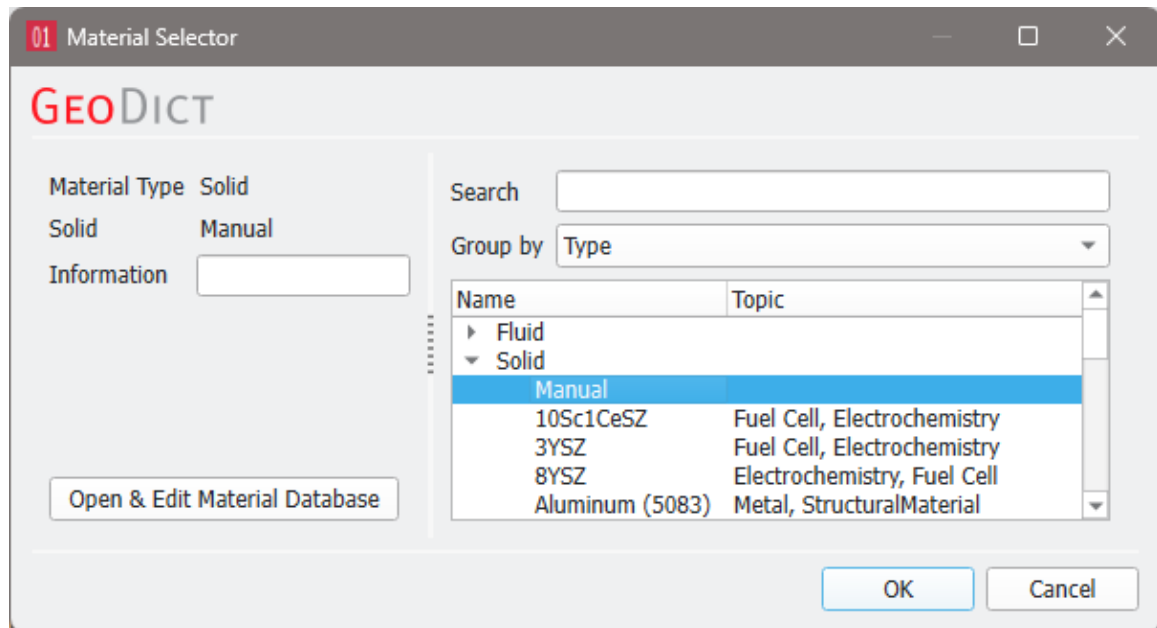
Unit Cells X-Dir. 1	Unit Cells X-Dir. 2	Unit Cells X-Dir. 3
Unit Cells Y-Dir. 1	Unit Cells Y-Dir. 2	Unit Cells Y-Dir. 4



✓ Materials

The materials of the foil and the medium surrounding it can be chosen from the GeoDict material database by clicking the buttons **Pore / Matrix Material (ID 00)** and **Material (ID 01)**.

The pull-down menu gives access to selecting the desired material from the GeoDict **Material Database**. When none of the materials available in the database fit the preferred specifications, **Manual** should be chosen. Alternatively, a new material with the desired specifications can be added to the **Material Database** (see the Material Database chapter).



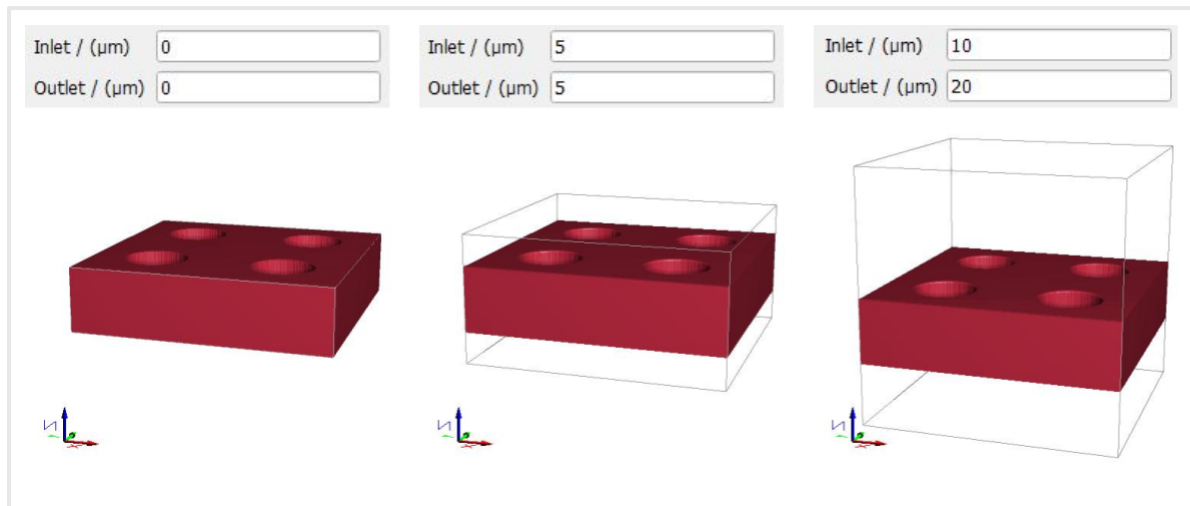
To match realistic material colors for visualization in a certain application, the default material colors can be changed through the **Color & Visibility** tab of the GUI sidebar. For more visualization options, see the Visualization chapter.

✓ Size in the Chosen Unit

The size of created structure in the chosen unit is displayed as **Width (X)**, **Length (Y)**, and **Height (Z)** and cannot be edited, but is affected by the **Unit Cells** and the **Hole Spacing**.

✓ Inlet and Outlet

Inlet and **Outlet** define the height of the empty area above and below the foil. The **Inlet** is in **Z-** direction, the **Outlet** is in **Z+** direction. These parameters might be of interest for flow simulations on the foils, or when embedding them in other structures.

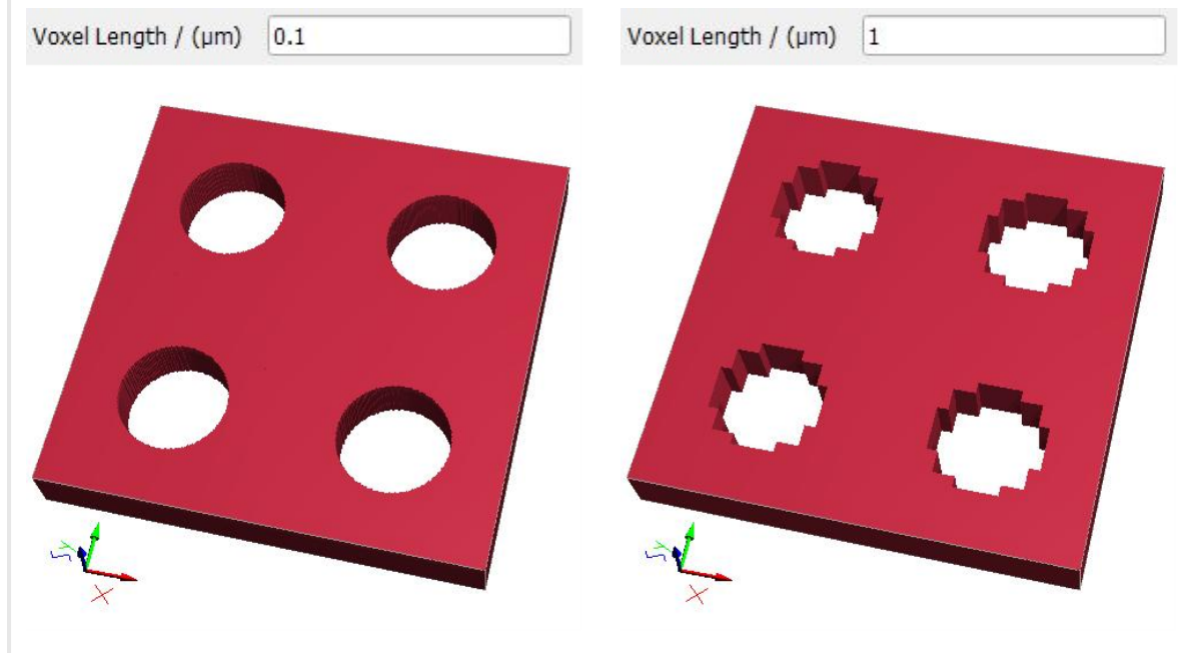


✓ Size in Number of Voxels

The size of the created structure in voxels (**NX**, **NY**, and **NZ**) can also not be edited, but is determined by the size in units (**Width (X)**, **Length (Y)**, and **Height (Z)**) and the chosen **Voxel Length**.

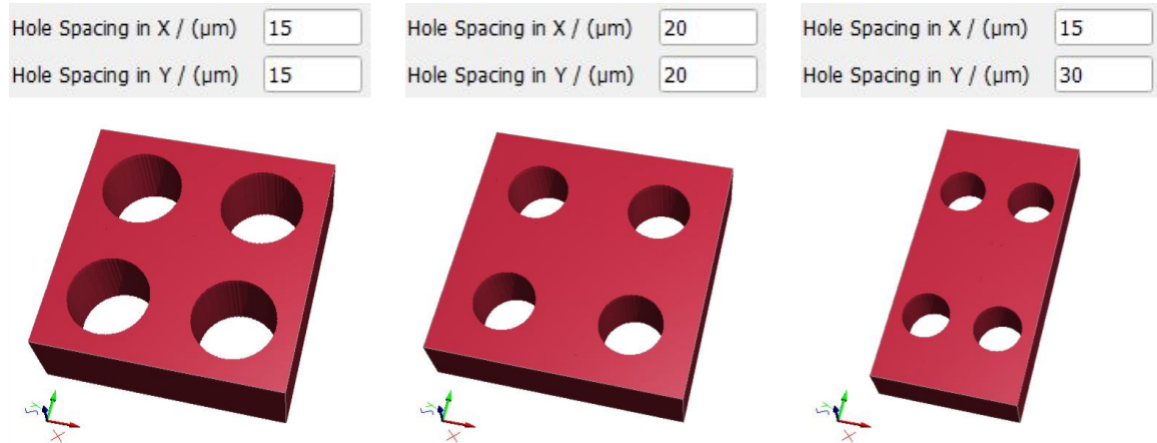
✓ Voxel Length

The **Voxel Length** determines the size of a voxel in the selected length unit and therefore the resolution of the structure. To evaluate the effect of choosing the number of Voxels per X-Unit Cell on the resolution of the structure, it is important that the 3D-structure mode is set to **Box** (select **View** → **3D Structure Renderer** → **Box**).



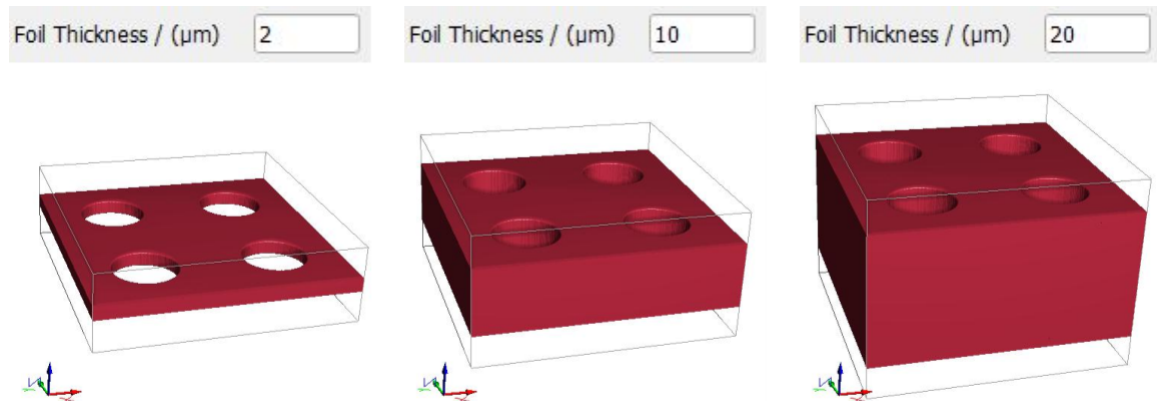
✓ Hole Spacing

The parameters **Hole Spacing in X** and **Hole Spacing in Y** define the distance between subsequent hole centers, as shown in the figure below. Choosing a higher hole spacing value will increase the structure size.



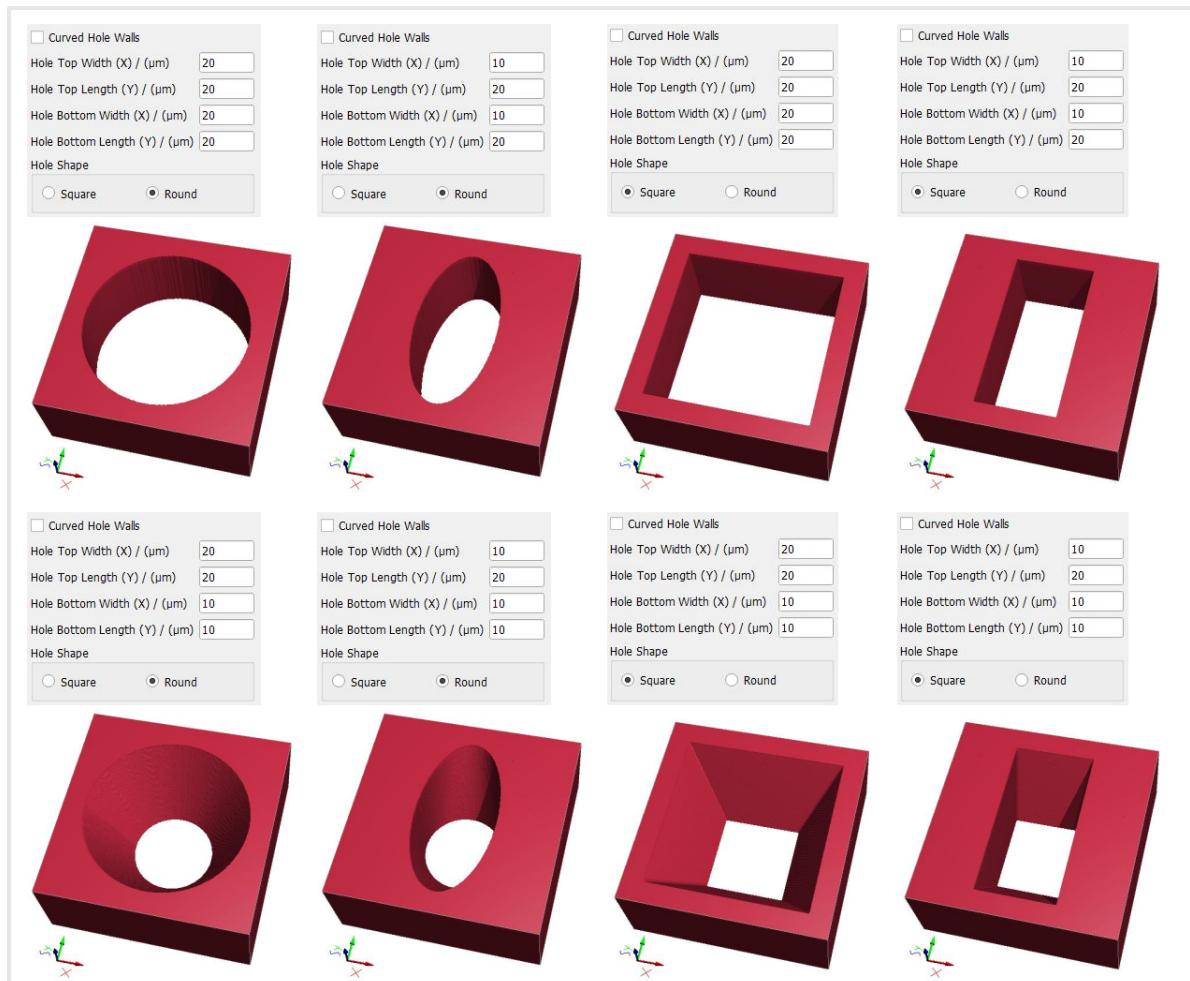
✓ Foil Thickness

The **Foil Thickness** determines the height of the foil which influences the **Height (Z)** of the generated structure.

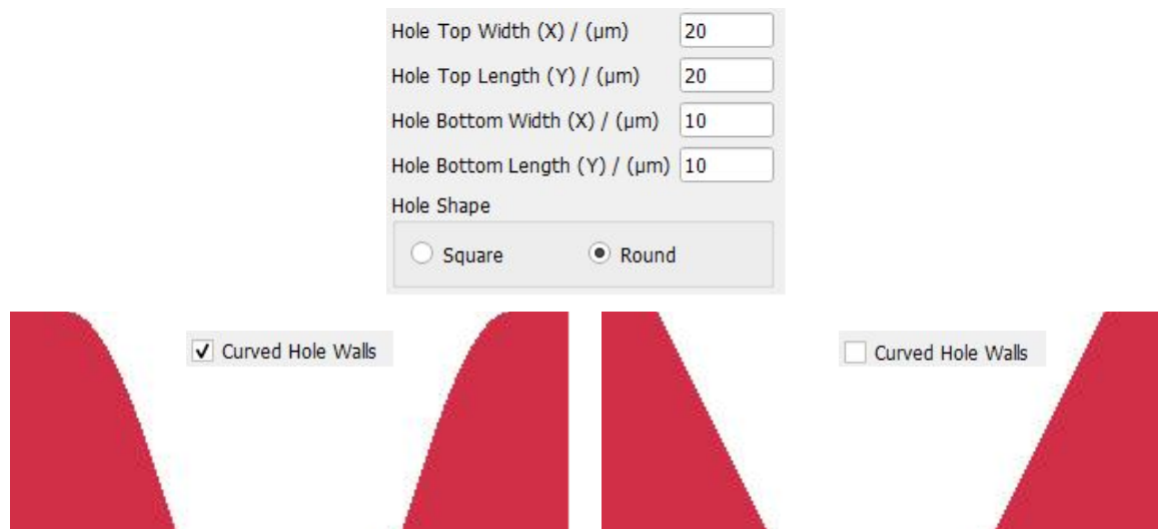


✓ Hole Defining Parameters

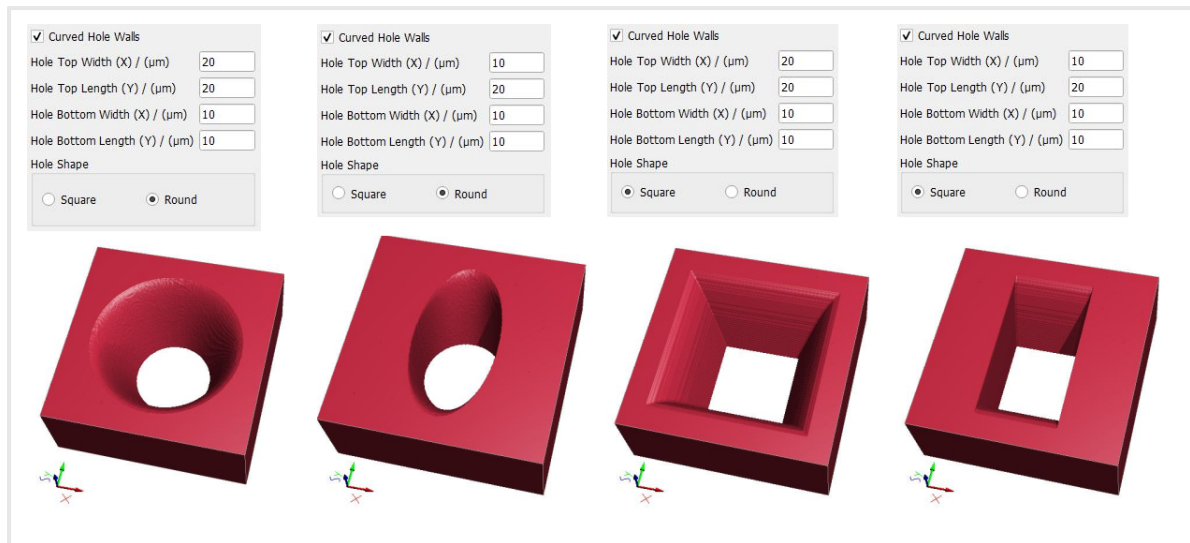
The parameters defining the hole shape are explained in combination in the following figures. The main shape of the holes can be defined by selecting **Round** or **Square** for the **Hole Shape**. The hole dimensions at the top and bottom of the foil can be determined by setting **Hole Top Width (X)**, **Hole Top Length (Y)**, **Hole Bottom Width (X)** and **Hole Bottom Length (Y)**. With these options, a large variety of hole shapes (e.g., straight or conical holes) is possible.



Furthermore, the hole walls can be chosen to be curved (**Curved Hole Walls**). This option only has an effect if the hole has different sizes at the top and bottom.



Below, find the examples from above, where the top and bottom of the hole have different size, but with **Curved Hole Walls**.



1.4.2 Free Foil

The Perforated Foil Options dialog changes in some details when choosing **Free Foil** instead of **Periodic Foil**. The option to select several unit cells is no longer available, instead the **Width (X)** and **Length (Y)** of the foil must be chosen directly. The options to select the **Row Shift** and the **Rotation Angle** are added. In most cases, the foil cannot be repeated periodically. The center of the first hole is in the origin of the domain.

GridGeo – Perforated Foil

GEOdict

Result File Name (*.gdr) μm ▾

Foil Mode ▾

Pore / Matrix Material (ID 00)

Material (ID 01)

Width (X) / (μm)

Length (Y) / (μm)

Height (Z) / (μm)

Inlet / (μm)

Outlet / (μm)

NX / (Voxel)

NY / (Voxel)

NZ / (Voxel)

Voxel Length / (μm)

Hole Spacing in X / (μm)

Hole Spacing in Y / (μm)

Foil Thickness / (μm)

Row Shift / (μm)

Rotation Angle / (°)

☒ Curved Hole Walls

Hole Top Width (X) / (μm)

Hole Top Length (Y) / (μm)

Hole Bottom Width (X) / (μm)

Hole Bottom Length (Y) / (μm)

Hole Shape

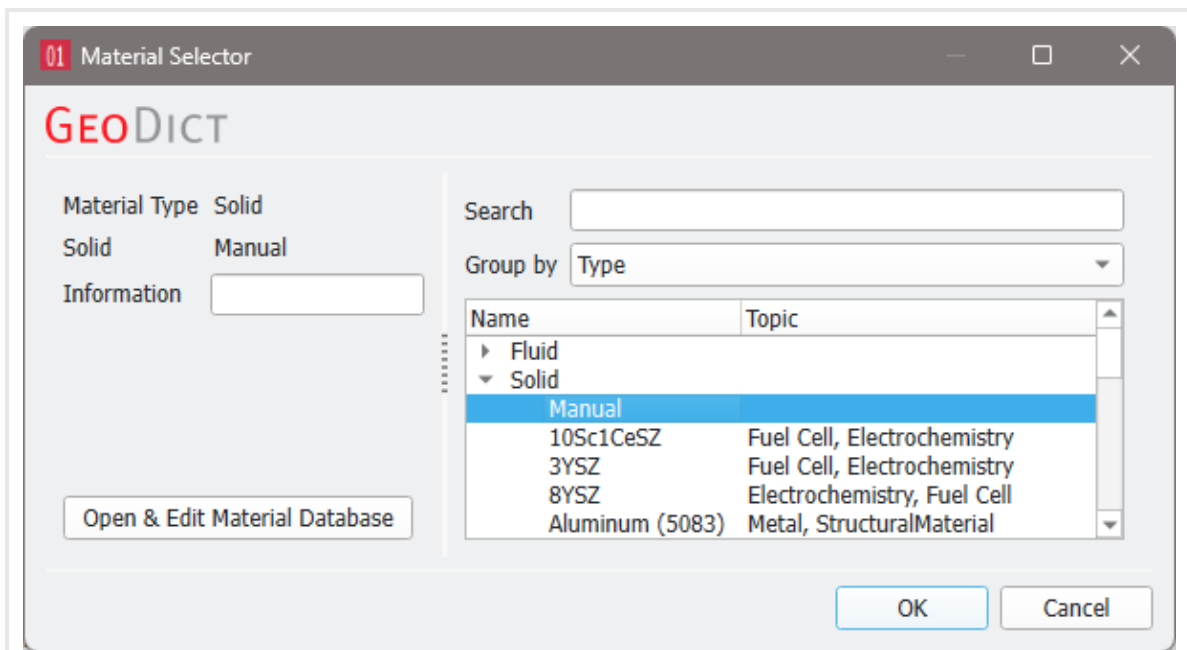
☐ Square ☒ Round

? OK Cancel

✓ Materials

The materials of the foil and the medium surrounding it can be chosen from the GeoDict material database by clicking the buttons **Pore / Matrix Material (ID 00)** and **Material (ID 01)**.

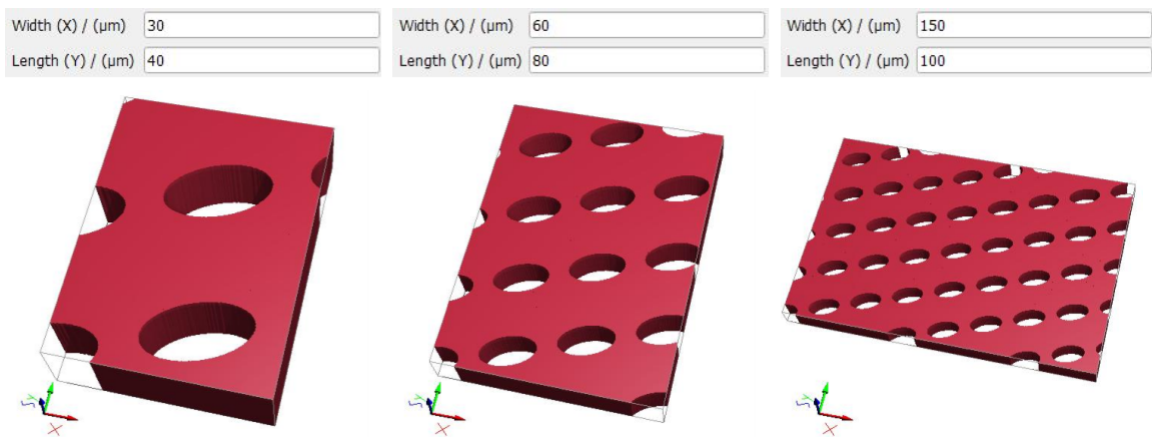
The pull-down menu gives access to selecting the desired material from the GeoDict **Material Database**. When none of the materials available in the database fit the preferred specifications, **Manual** should be chosen. Alternatively, a new material with the desired specifications can be added to the **Material Database** (see the Material Database chapter).



To match realistic material colors for visualization in a certain application, the default material colors can be changed through the **Color & Visibility** tab of the GUI sidebar. For more visualization options, see the Visualization chapter.

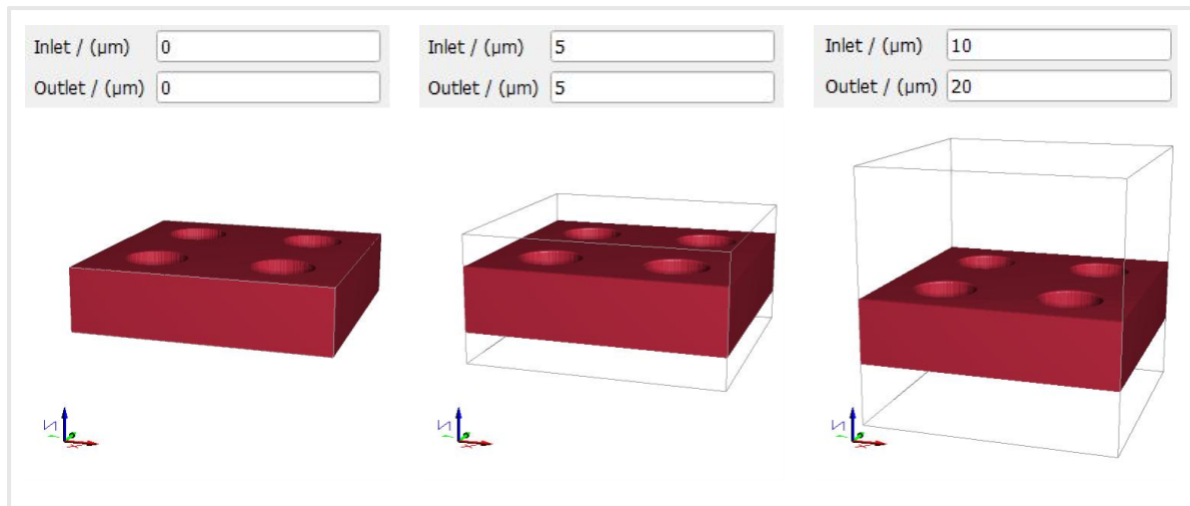
✓ Size in the Chosen Unit

Selecting the **Width (X)** and **Length (Y)** defines the dimension of the domain. The **Height (Z)** cannot be edited, because it is determined by the Foil Thickness and the Inlet and Outlet.



✓ Inlet and Outlet

Inlet and **Outlet** define the height of the empty area above and below the foil. The **Inlet** is in **Z-** direction, the **Outlet** is in **Z+** direction. These parameters might be of interest for flow simulations on the foils, or when embedding them in other structures.

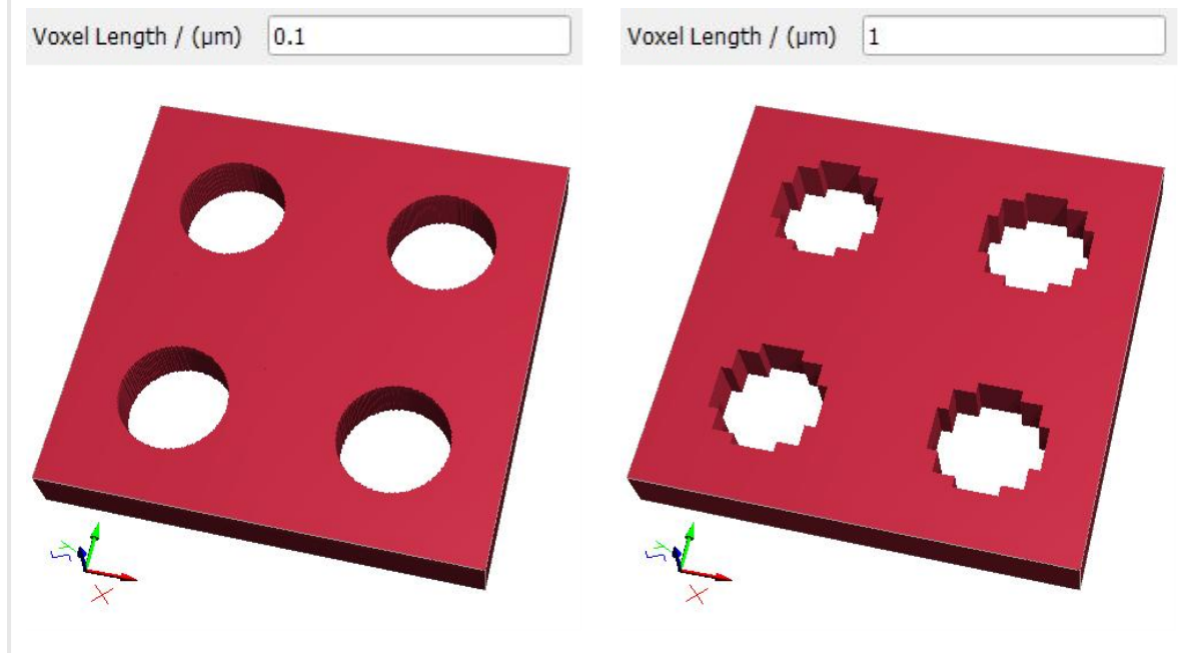


✓ Size in Number of Voxels

The size of the created structure in voxels (**NX**, **NY**, and **NZ**) can also not be edited, but is determined by the size in units (**Width (X)**, **Length (Y)**, and **Height (Z)**) and the chosen **Voxel Length**.

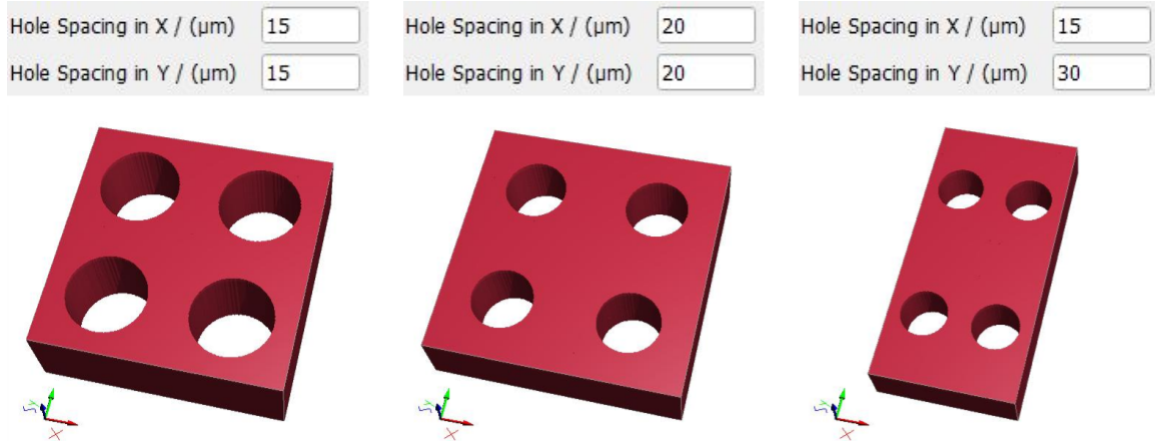
✓ Voxel Length

The **Voxel Length** determines the size of a voxel in the selected length unit and therefore the resolution of the structure. To evaluate the effect of choosing the number of Voxels per X-Unit Cell on the resolution of the structure, it is important that the 3D-structure mode is set to **Box** (select **View** → **3D Structure Renderer** → **Box**).



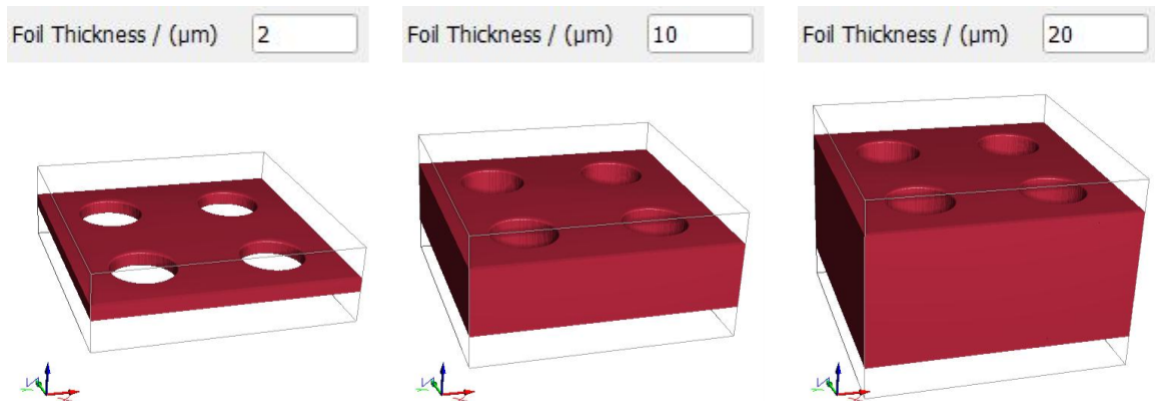
✓ Hole Spacing

The parameters **Hole Spacing in X** and **Hole Spacing in Y** define the distance between subsequent hole centers, as shown in the figure below. Choosing a higher hole spacing value will increase the structure size.



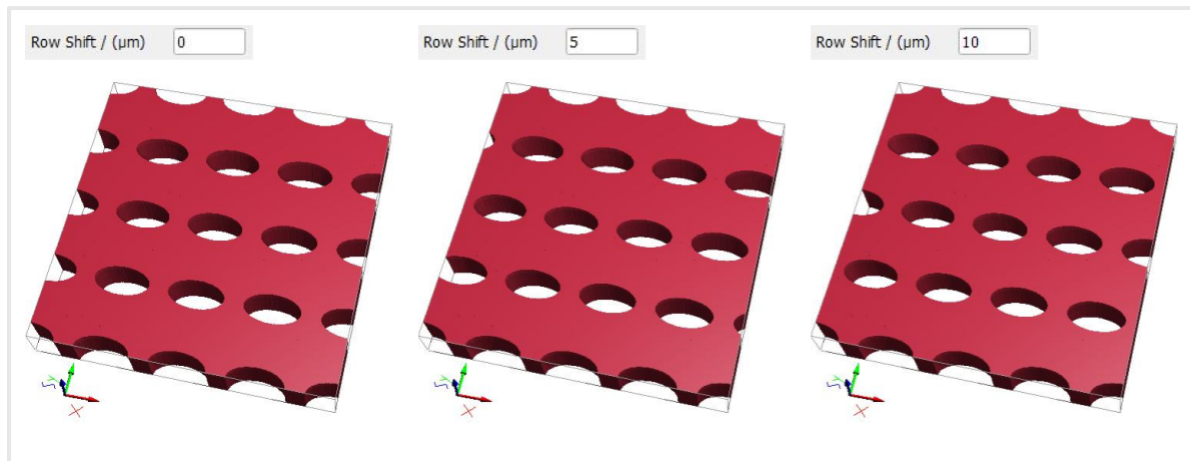
✓ Foil Thickness

The **Foil Thickness** determines the height of the foil which influences the **Height (Z)** of the generated structure.



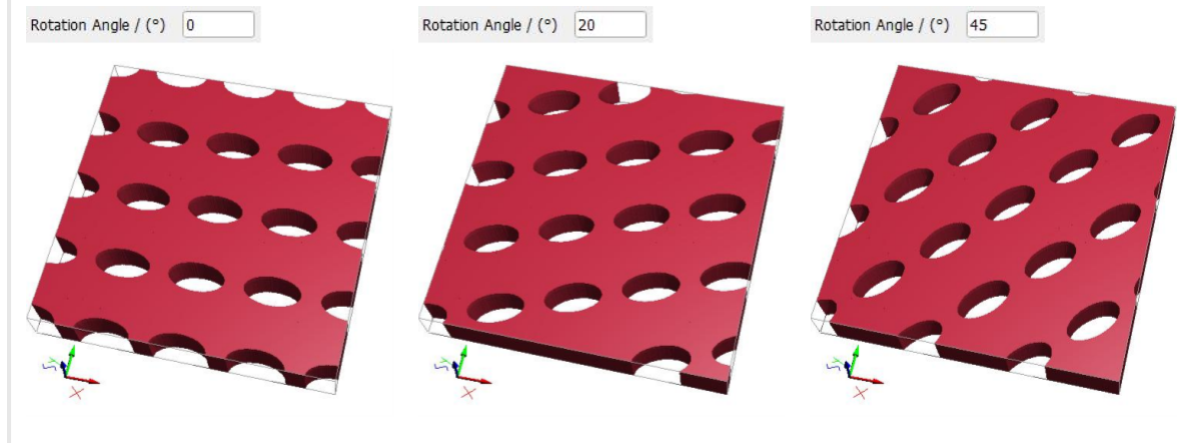
✓ Row Shift

The **Row Shift** defines the distance by which subsequent rows are shifted in X-direction.



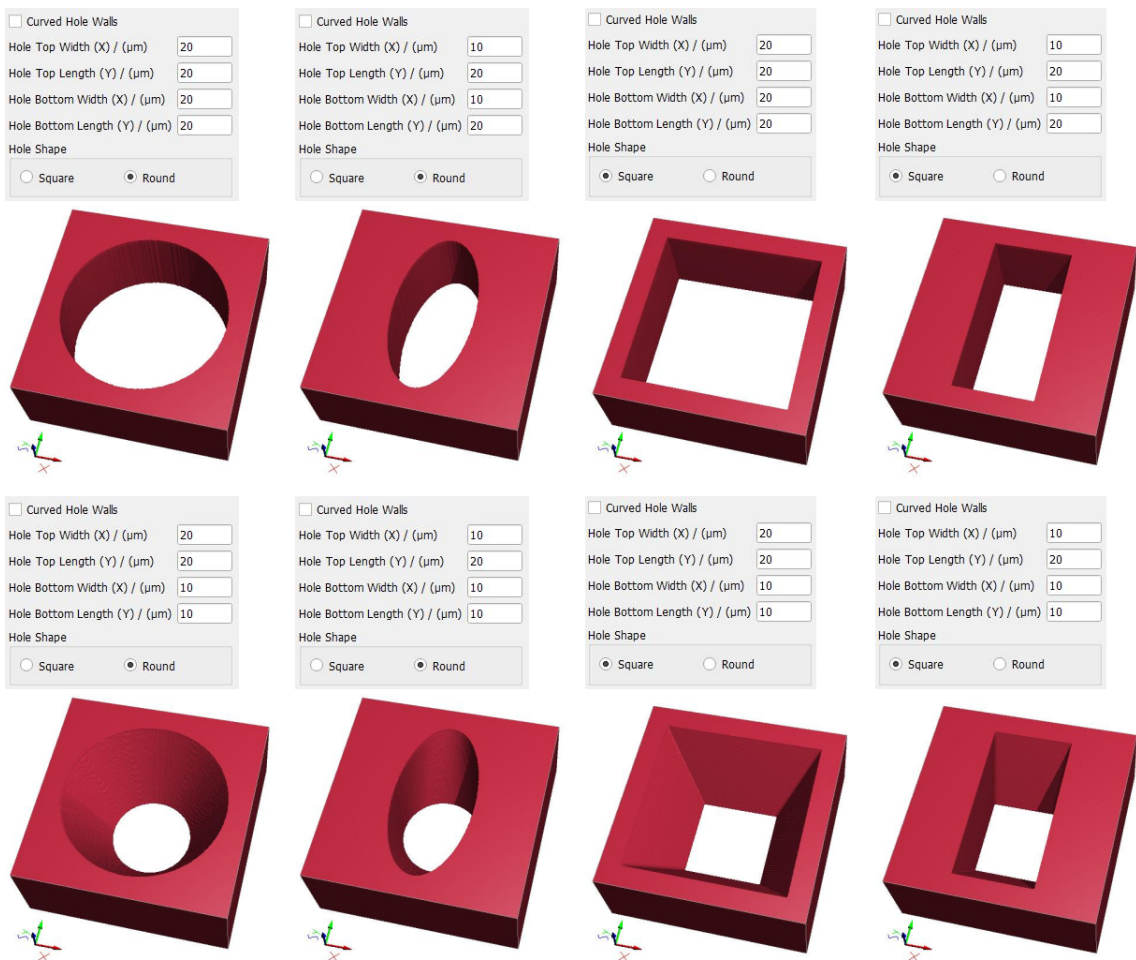
✓ Rotation Angle

The **Rotation Angle** is the angle in degrees by which the whole lattice is rotated around the Z-axes of the domain.

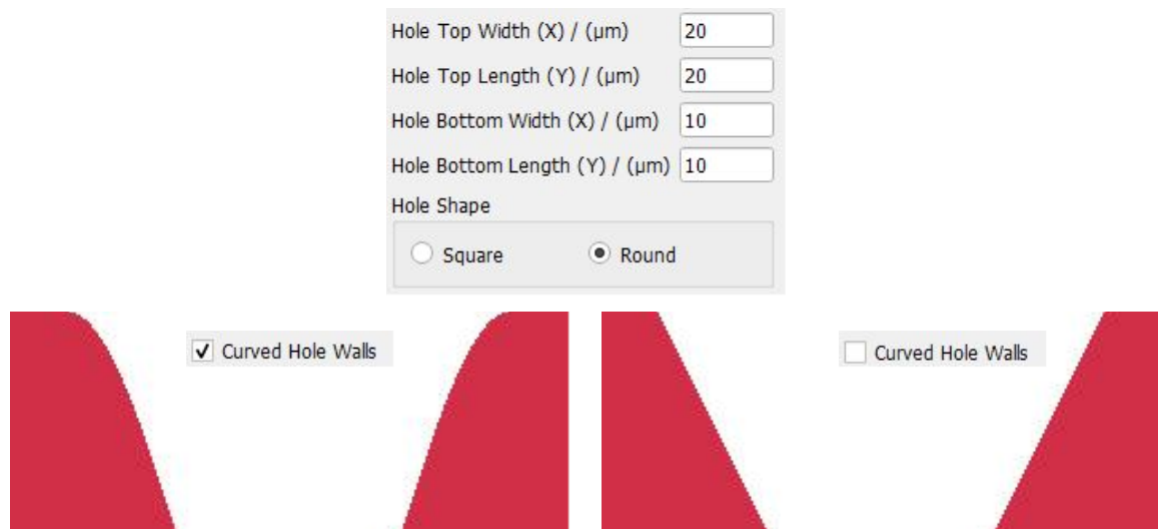


✓ Hole Defining Parameters

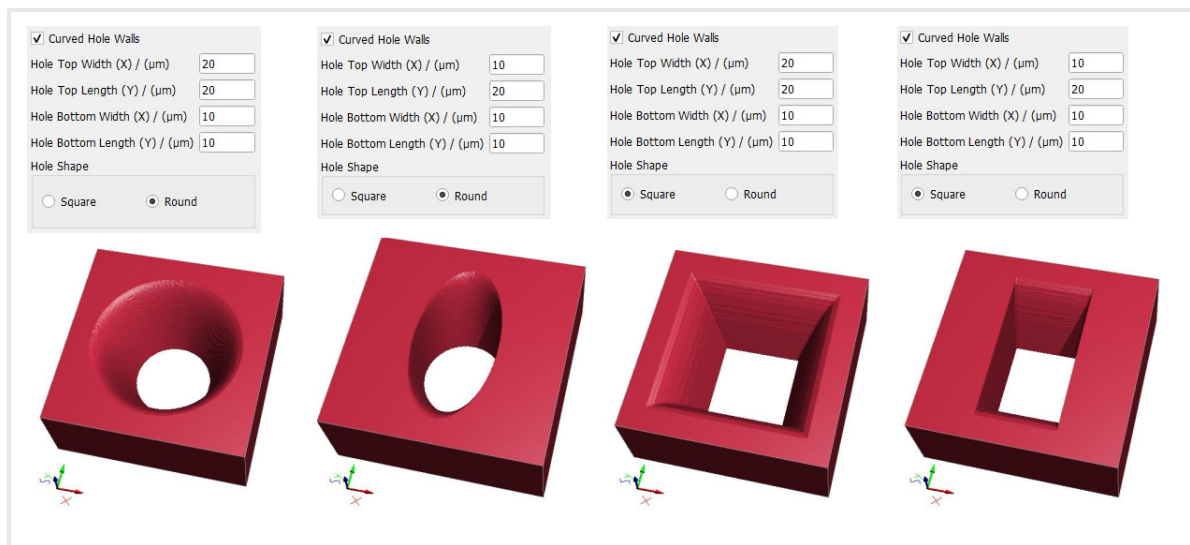
The parameters defining the hole shape are explained in combination in the following figures. The main shape of the holes can be defined by selecting **Round** or **Square** for the **Hole Shape**. The hole dimensions at the top and bottom of the foil can be determined by setting **Hole Top Width (X)**, **Hole Top Length (Y)**, **Hole Bottom Width (X)** and **Hole Bottom Length (Y)**. With these options, a large variety of hole shapes (e.g., straight or conical holes) is possible.



Furthermore, the hole walls can be chosen to be curved (**Curved Hole Walls**). This option only has an effect if the hole has different sizes at the top and bottom.

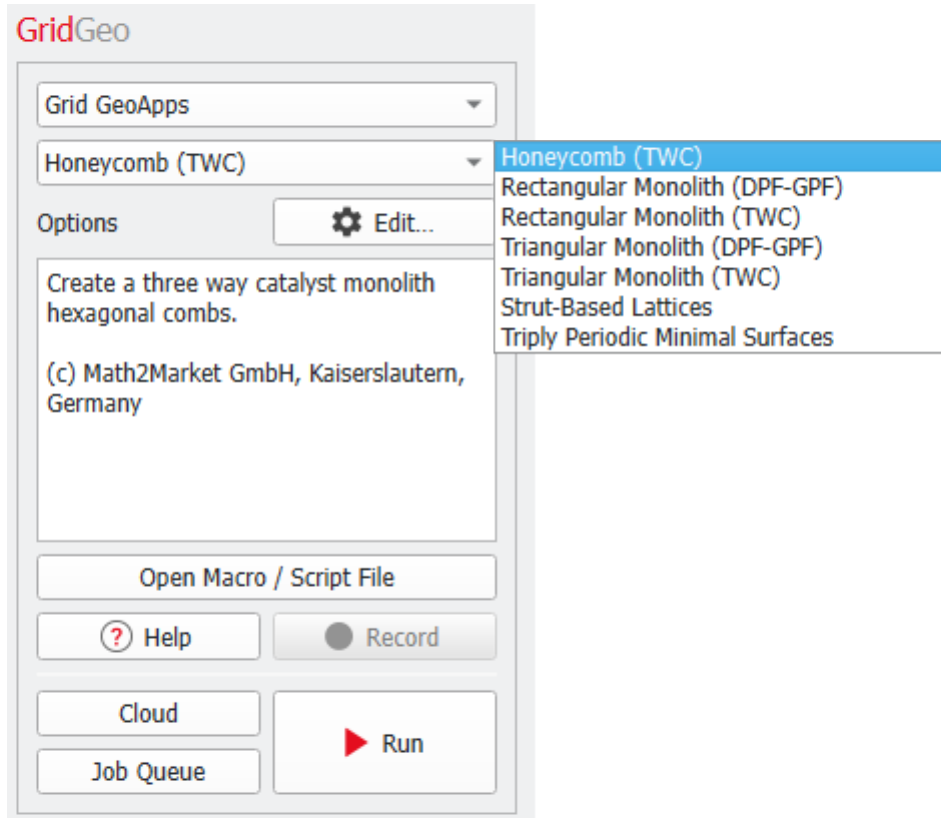


Below, find the examples from above, where the top and bottom of the hole have different size, but with **Curved Hole Walls**.



1.5 Grid GeoApps

In GridGeo, additional generator scripts for periodic structures of interest in several fields of application are available under **Grid GeoApps**.



Change the generation parameters by choosing one of these predefined generator scripts and clicking the **Options' Edit...** button. With **Run** in the GridGeo section, the microstructure is generated.

The GridGeo Apps

- [Honeycomb \(TWC\)](#)^[52]
Create a three-way catalyst monolith with hexagonal combs.
- [Rectangular Monolith \(DPF-GPF\)](#)^[53]
Create a diesel particulate filter / gasoline particulate filter with rectangular combs, which are partly closed.
- [Rectangular Monolith \(TWC\)](#)^[54]
Create a three-way catalyst monolith with rectangular combs with open channels
- [Triangular Monolith \(DPF-GPF\)](#)^[55]
Create a diesel particulate filter / gasoline particulate filter with triangular combs, which are partly closed.
- [Triangular Monolith \(TWC\)](#)^[57]
Create a three-way catalyst monolith with triangular combs with open channels.
- [Strut-Based Lattices](#)^[58]

The GridGeo Apps

They are constructed from nodes on the edges or vertices of the unit cell connected via straight beams.

- [Triply Periodic Minimal Surfaces \(TPMS\)](#) ⁷¹

They are mathematically created surfaces which are not self-intersecting or enfolded. They can be packed together in a periodic 3D pattern, locally minimizing the surface area for a given boundary resulting in a mean curvature of zero.

1.5.1 Honeycomb (TWC)

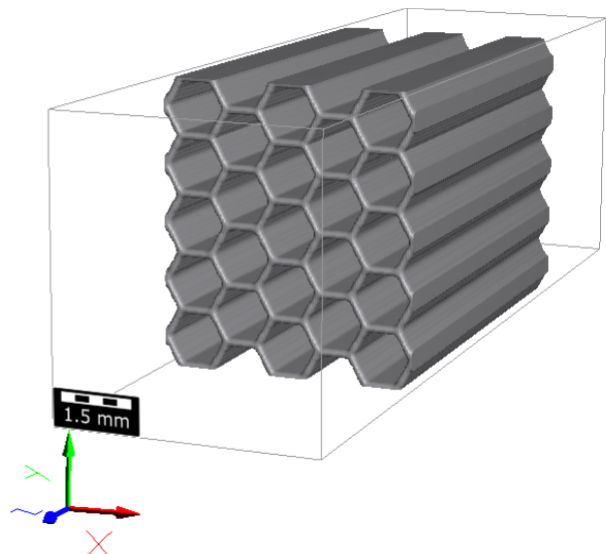
The **Honeycomb (TWC)** app generates a three-way catalyst monolith with hexagonal combs.



Modules needed to run this GeoApp:

GridGeo

Clicking **Edit** opens the **Honeycomb (TWC) Parameters** dialog.



Define the following parameters:

- **Result File Name**,
- the **Voxel Length**,
- the **Filter Length** in Z-Direction without inflow and outflow region,
- the **Number of Unit Cells** in X- and Y-direction,
- the **Wall Thickness**,
- the **Inlet**, defining an inflow region,
- the **Outlet**, defining the outflow region,

- the **Channel Side Length**, for the hexahedron sides,
- and the **Unit Cell Offset in X-Direction** defining the cell positions in X-direction.

Close the dialog with **OK** and then click **Run** to create the honeycomb.

1.5.2 Rectangular Monolith (DPF-GPF)

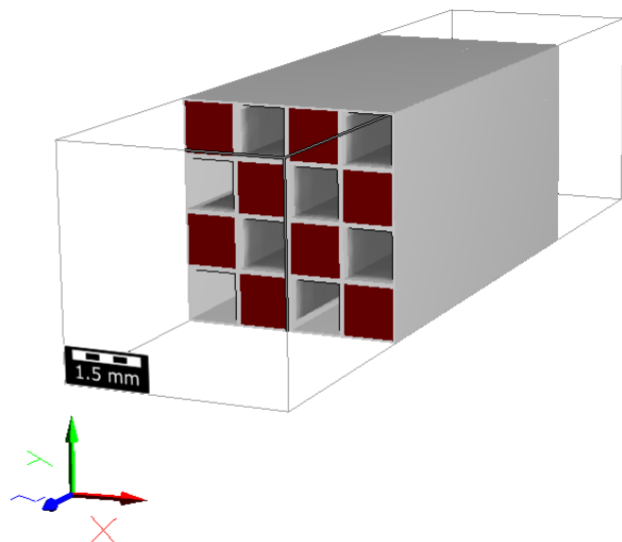
The **Rectangular Monolith (DPF-GPF)** app generates a Diesel Particulate Filter / Gasoline Particulate Filter consisting of rectangular combs. Every channels is plugged on one end in an alternating pattern.



Modules needed to run this GeoApp:

GridGeo

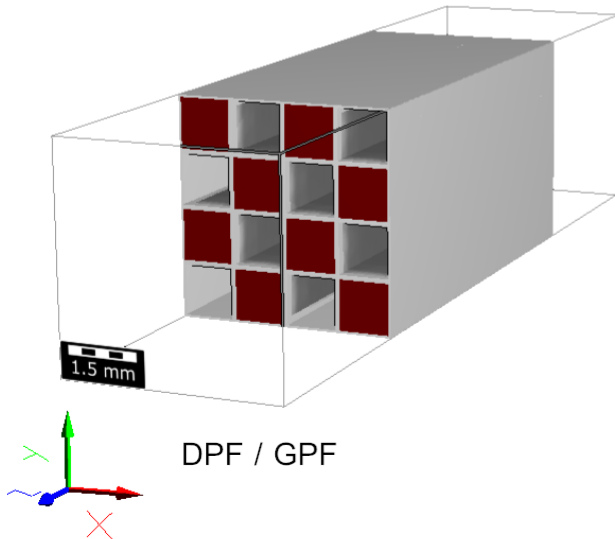
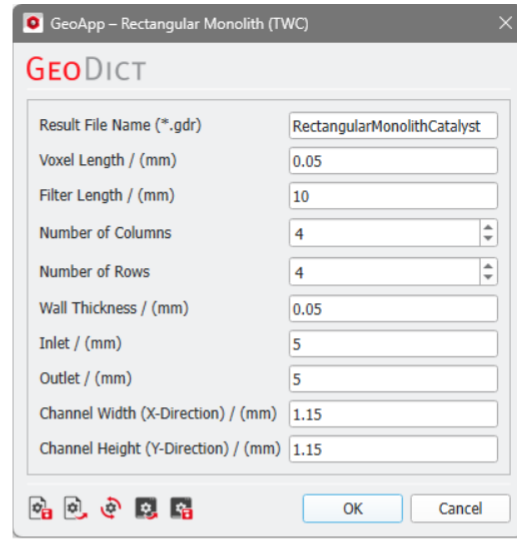
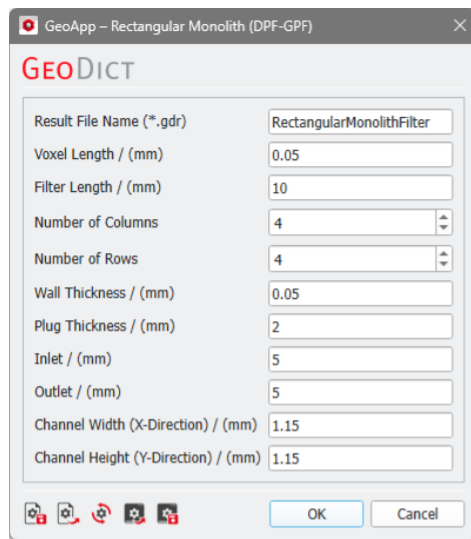
Clicking **Edit...** opens the **Rectangular Monolith (DPF-GPF) Parameters** dialog.



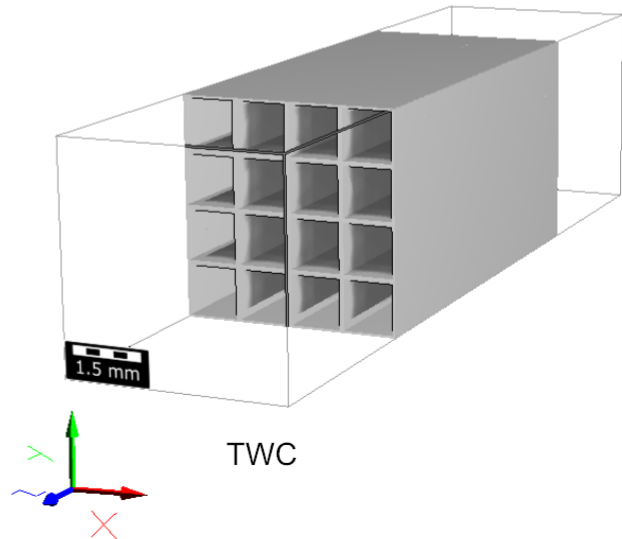
Define the **Result File Name**, the **Voxel Length**, the **Filter Length**, the **Number of Columns** and **Rows**, the **Wall Thickness**, the **Inlet** length, the **Outlet** length, the **Channel Width** and **Height**.

Close the dialog with **OK** and then click **Run** to create the rectangular monolith.

The structure generated using the **Rectangular Monolith (DPF-GPF)** app is identical to that of the **Rectangular Monolith (TWC)** app, except that the former has every channel sealed on one end to create a wall-flow configuration, while the latter keeps all channels open to form a flow-through structure.



DPF / GPF



TWC

1.5.3 Rectangular Monolith (TWC)

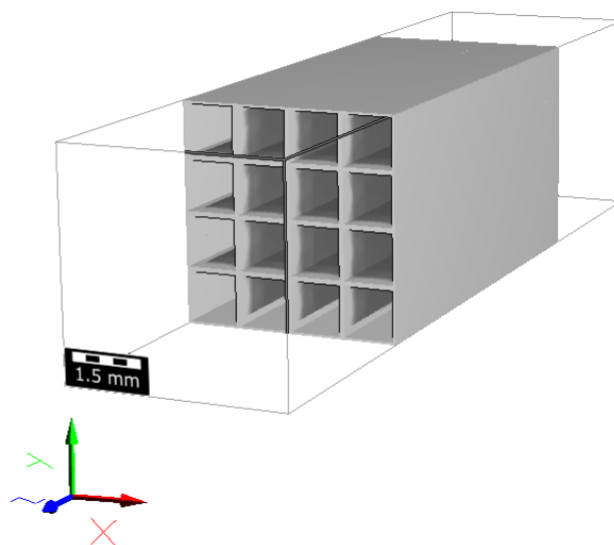
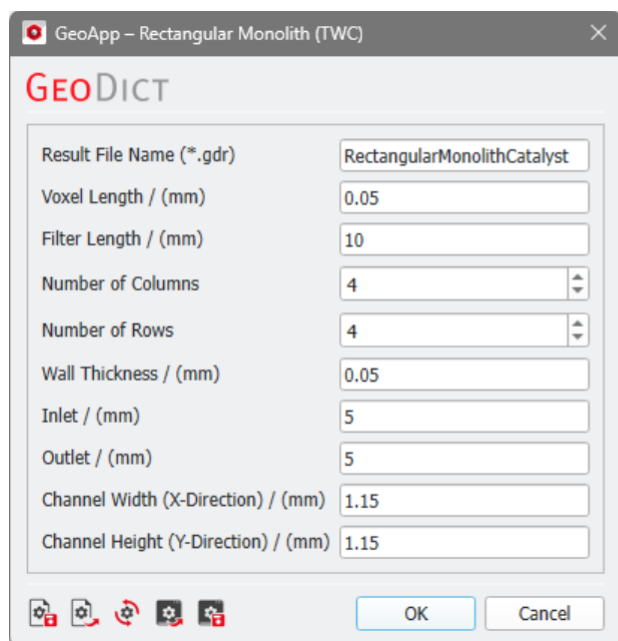
The **Rectangular Monolith (TWC)** app generates a three-way catalyst consisting of rectangular combs with open channels.



Modules needed to run this GeoApp:

GridGeo

Clicking **Edit...** opens the **Rectangular Monolith (TWC) Parameters** dialog.



Define the **Result File Name**, the **Voxel Length**, the **Filter Length**, the **Number of Columns** and **Rows**, the **Wall Thickness**, the **Inlet** length, the **Outlet** length, the **Channel Width** and **Height**.

Close the dialog with **OK** and then click **Run** to create the rectangular monolith.

Compare the structures generated with the **Rectangular Monolith (DPF-GPF)** and the **Rectangular Monolith (TWC)** app in the Rectangular Monolith (DPF-GPF) section.

1.5.4 Triangular Monolith (DPF-GPF)

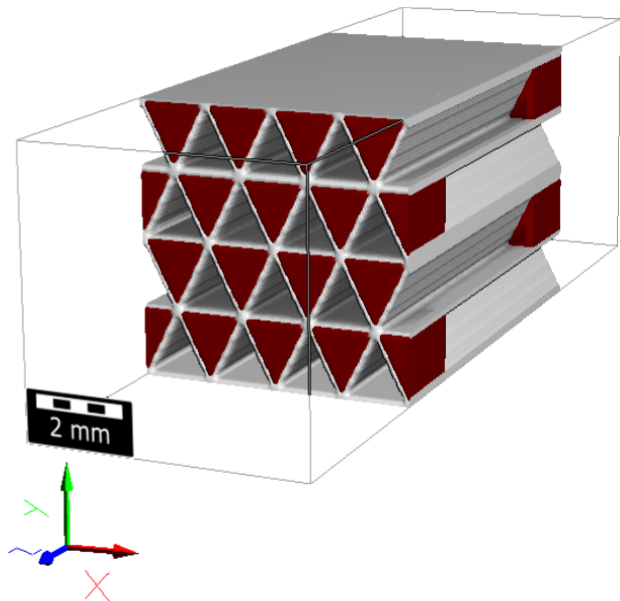
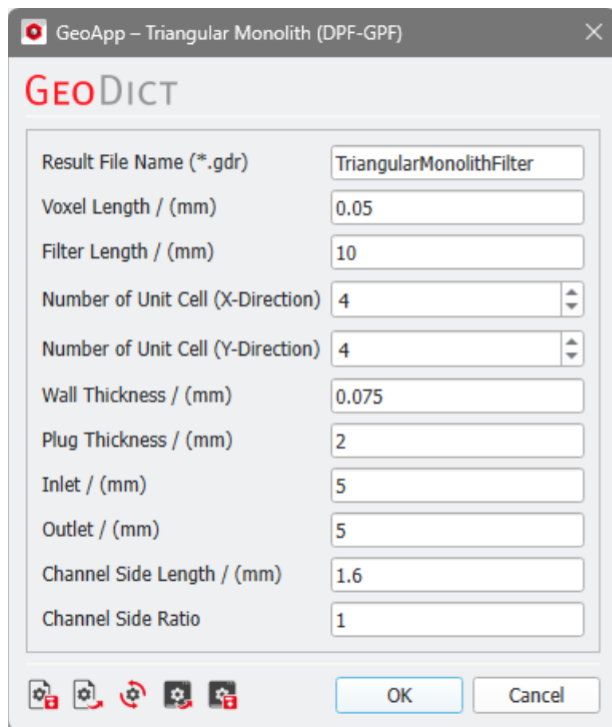
The **Triangular Monolith (DPF-GPF)** app generates a Diesel Particulate Filter / Gasoline Particulate Filter consisting of triangular combs. Every channels is plugged on one end in an alternating pattern.



Modules needed to run this GeoApp:

GridGeo

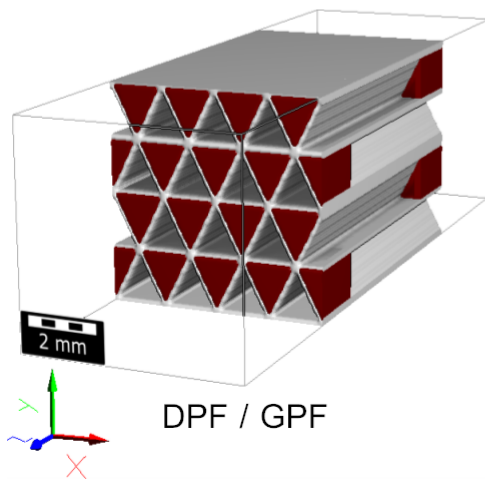
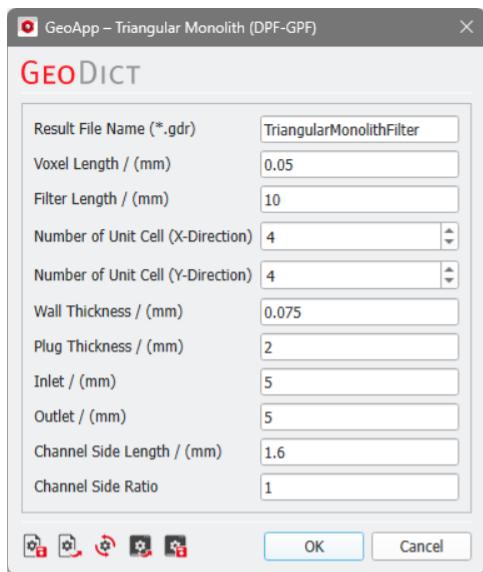
Clicking **Edit** opens the **Triangular Monolith(DPF-GPF) Parameters** dialog.



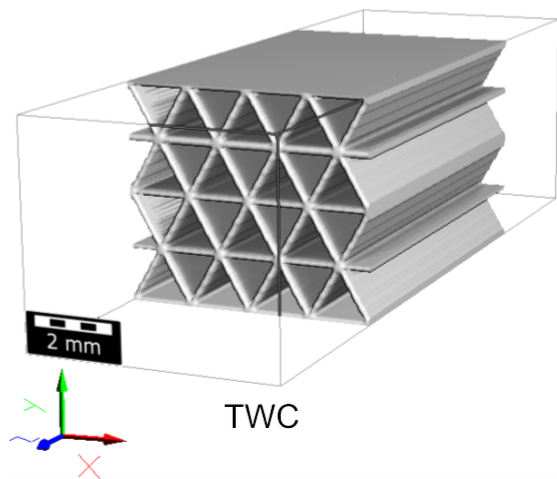
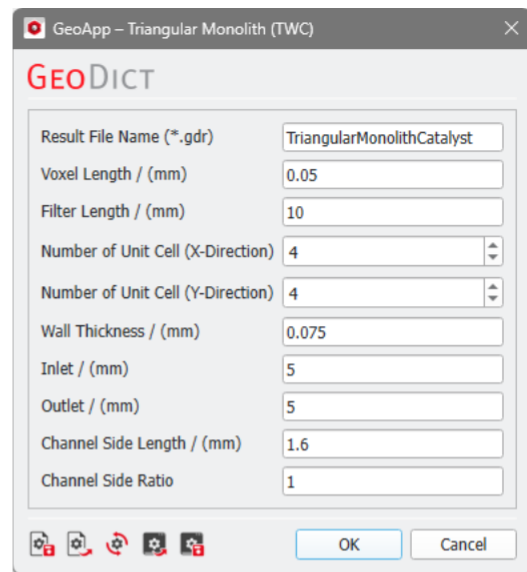
Define the **Result File Name**, the **Voxel Length**, the **Filter Length**, the **Number of Unit Cells** in X- and Y-direction, the **Wall Thickness**, the **Plug Thickness**, the **Inlet** length, the **Outlet** length, the **Channel Side Length** and **Channel Side Ratio**.

Close the dialog with **OK** and then click **Run** to create the triangular monolith.

The structure generated using the **Triangular Monolith (DPF-GPF)** app is identical to that of the **Triangular Monolith (TWC)** app, except that the former has every channel sealed on one end to create a wall-flow configuration, while the latter keeps all channels open to form a flow-through structure.



DPF / GPF



TWC

1.5.5 Triangular Monolith (TWC)

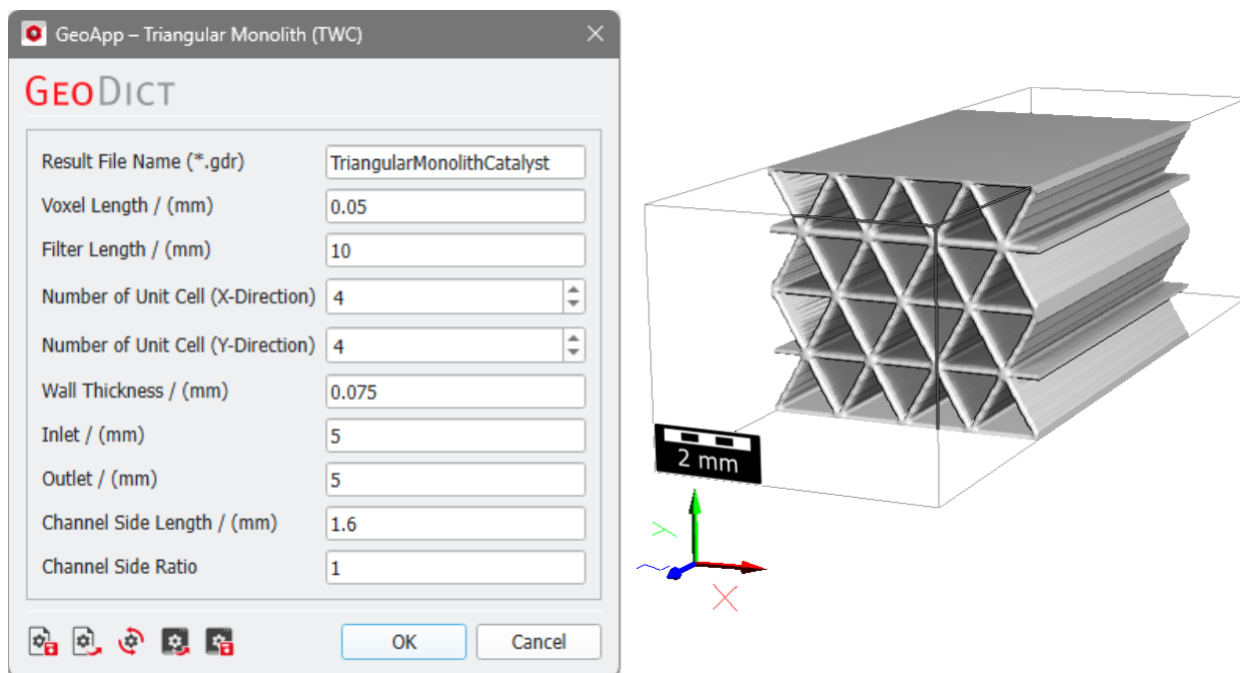
The **Triangular Monolith (TWC)** app generates a three-way catalyst consisting of triangular combs with open channels.



Modules needed to run this GeoApp:

GridGeo

Clicking **Edit** opens the **Triangular Monolith (TWC) Parameters** dialog.



Define the **Result File Name**, the **Voxel Length**, the **Filter Length**, the **Number of Unit Cells** in X- and Y-direction, the **Wall Thickness**, the **Plug Thickness**, the **Inlet** length, the **Outlet** length, the **Channel Side Length** and **Channel Side Ratio**.

Close the dialog with **OK** and then click **Run** to create the triangular monolith.

Compare the structures generated with the **Rectangular Monolith (DPF-GPF)** and the **Rectangular Monolith (TWC)** app in the Triangular Monolith (DPF-GPF) section.

1.5.6 Strut-Based Lattices

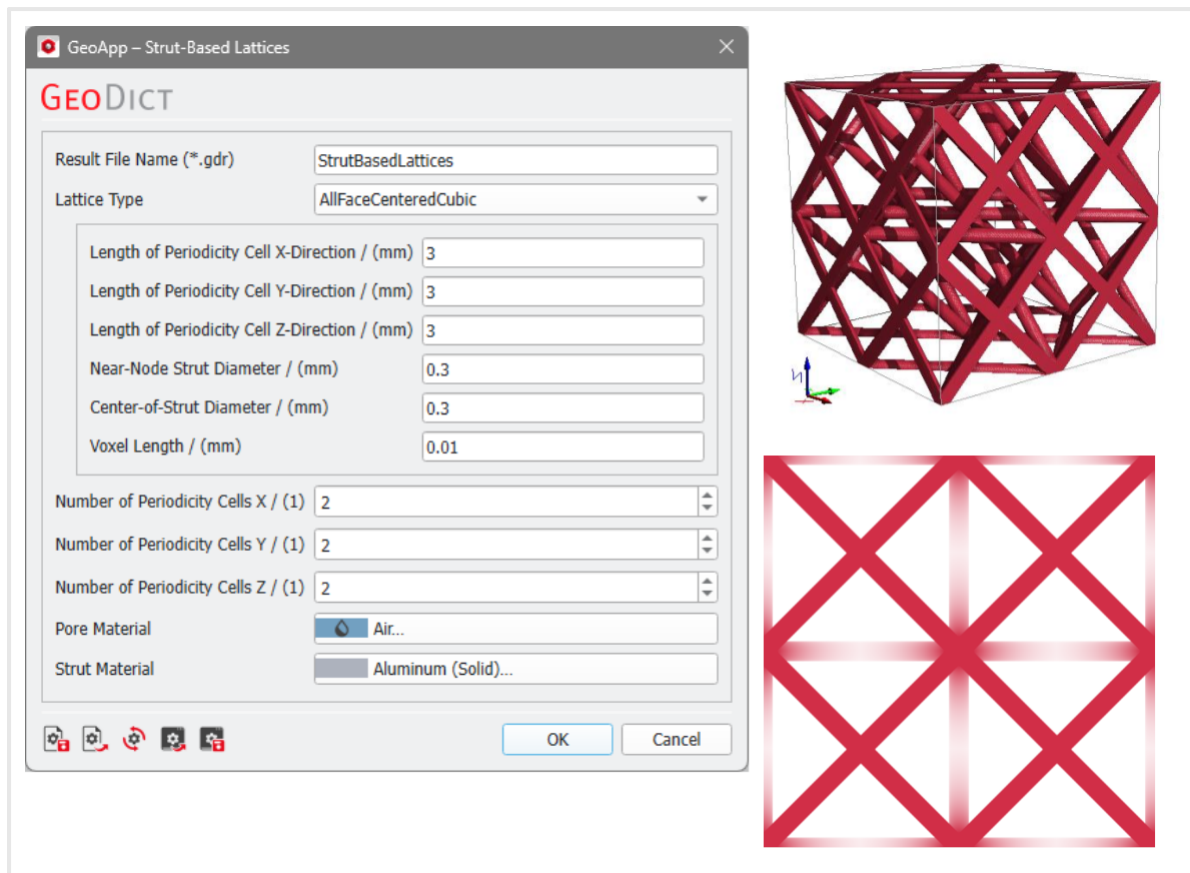
In the following, the resulting structures of all **Lattice Types** are shown in both 3D-Rendering and 2D Cross Section View in X-direction together with the default settings for each lattice type.



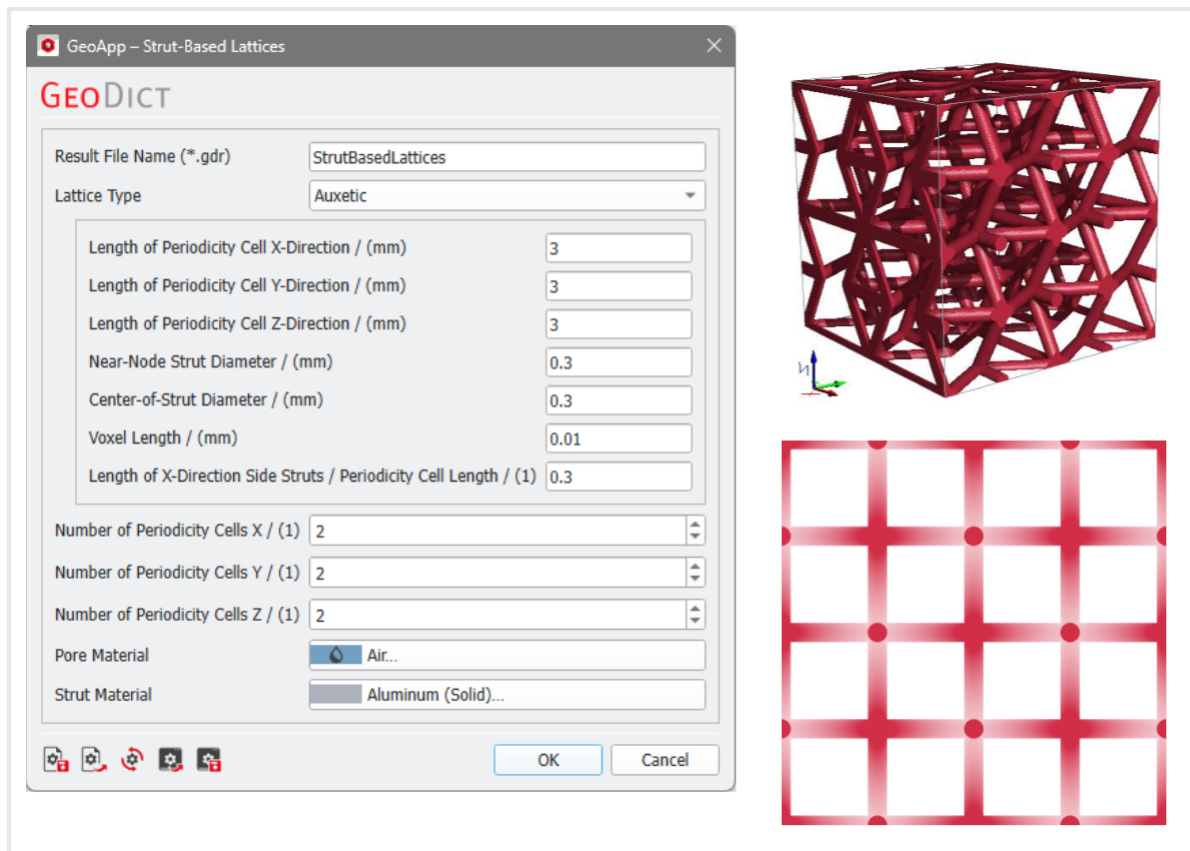
Modules needed to run this GeoApp:

GridGeo

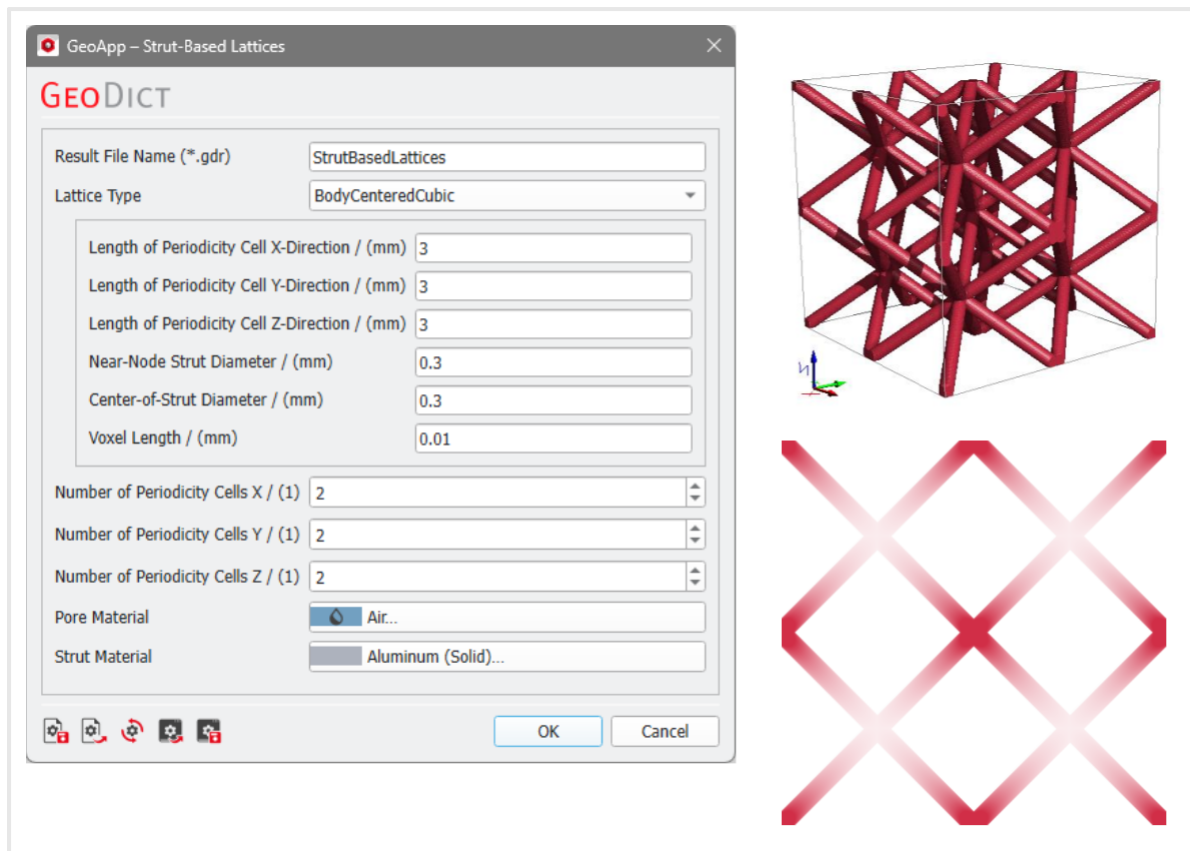
✓ All-Face-Centered-Cubic-(AFCC)



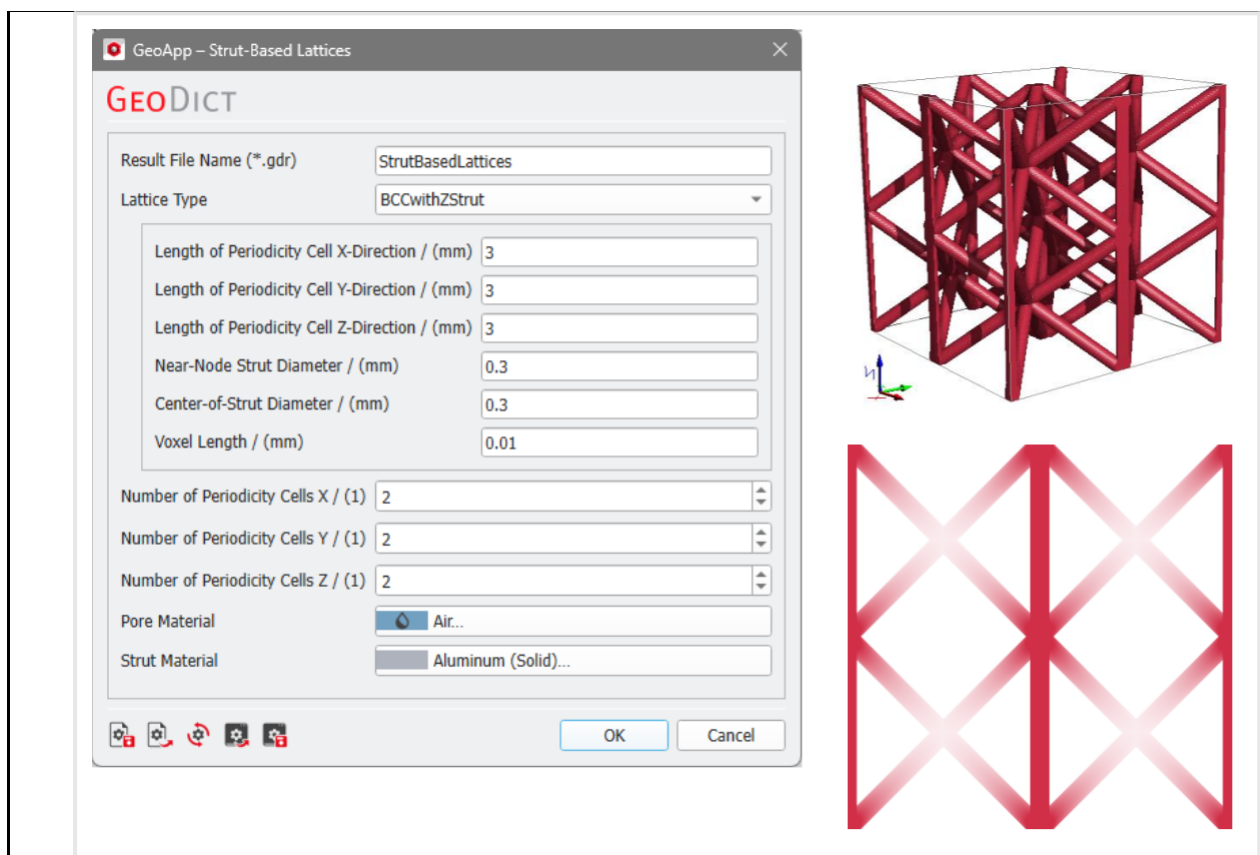
✓ Auxetic



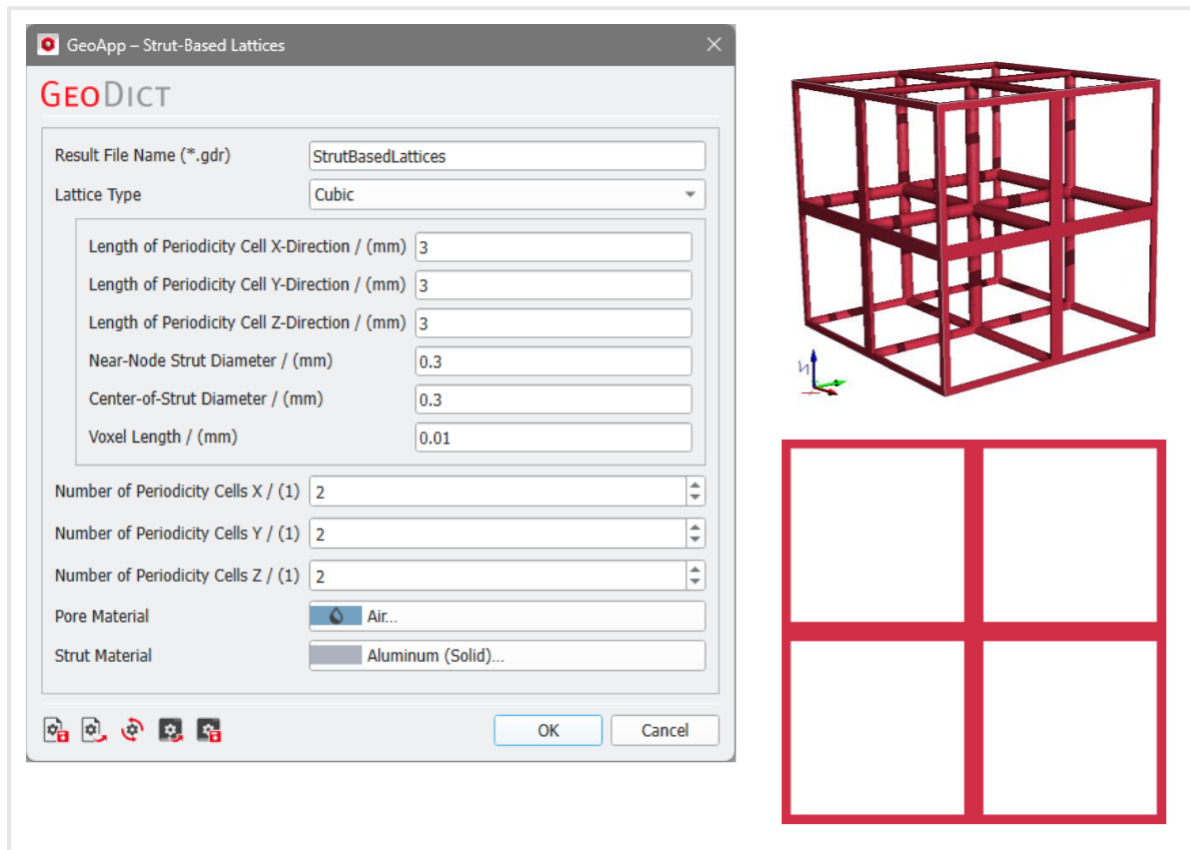
✓ Body-Centered-Cubic-(BCC)



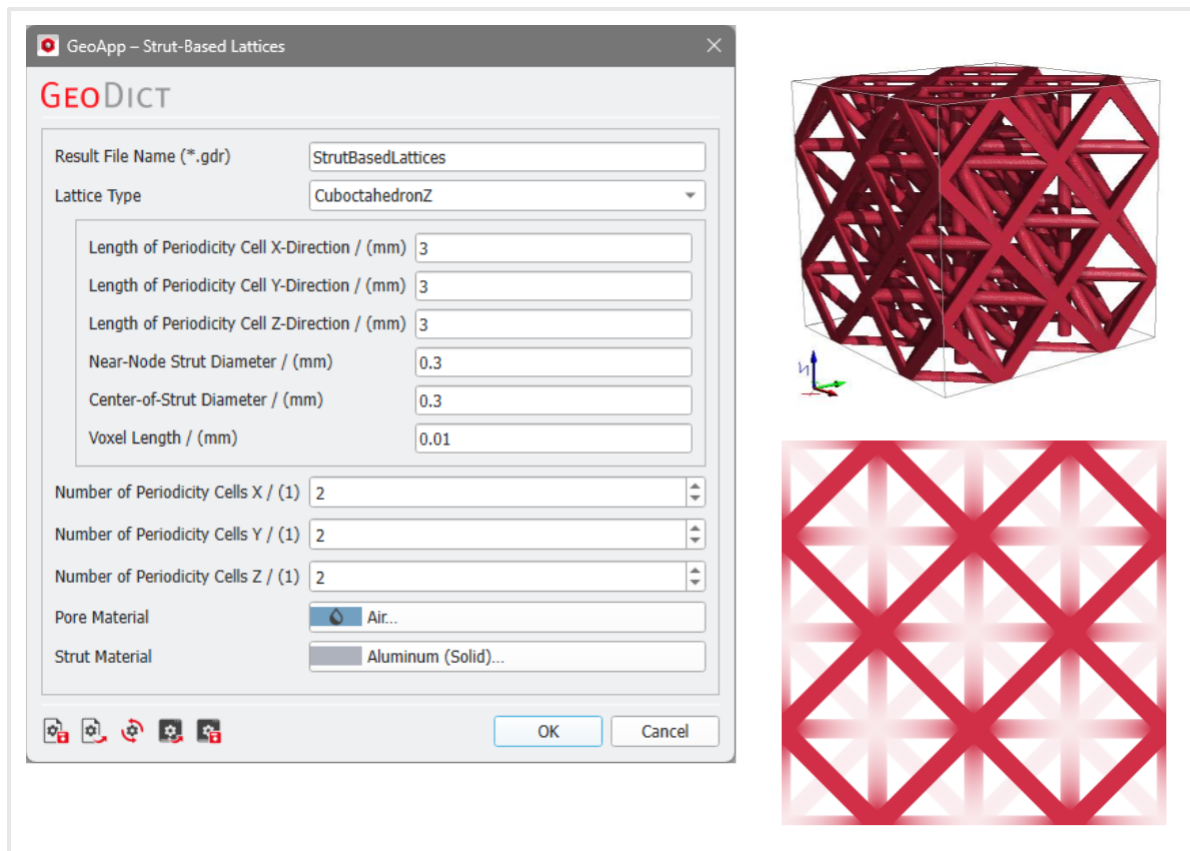
✓ BCC-with-Z-Strut-(BCCZ)



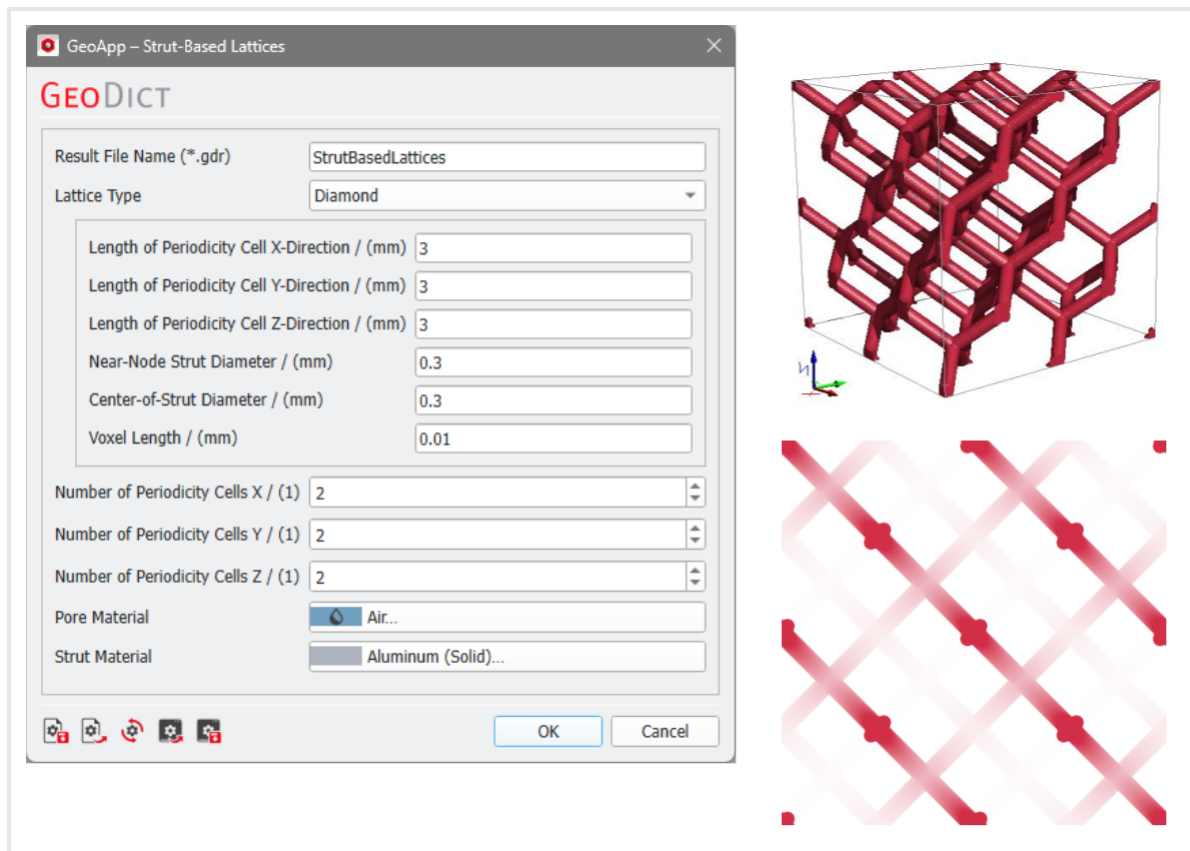
✓Cubic



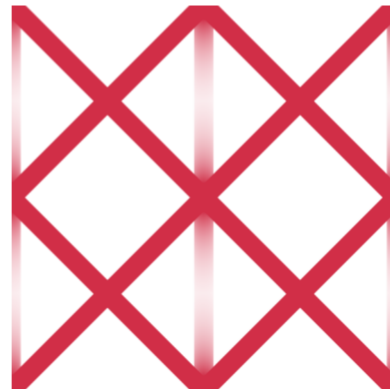
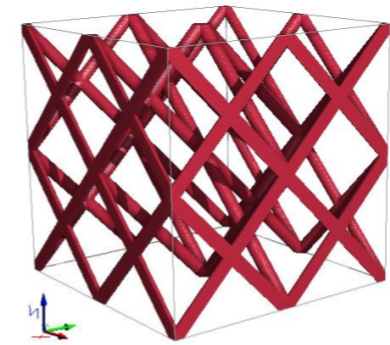
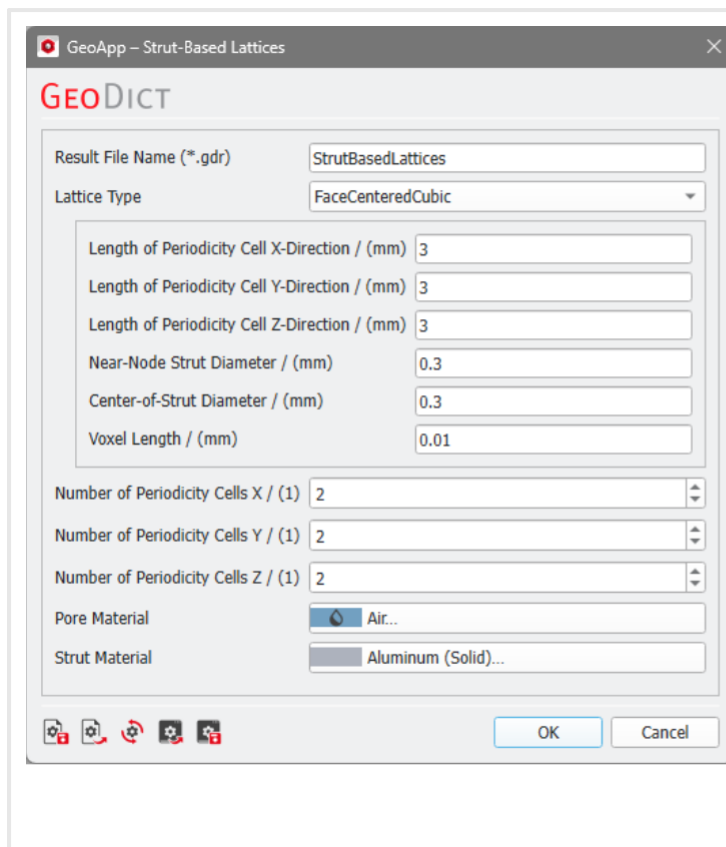
✓Cuboctahedron-Z



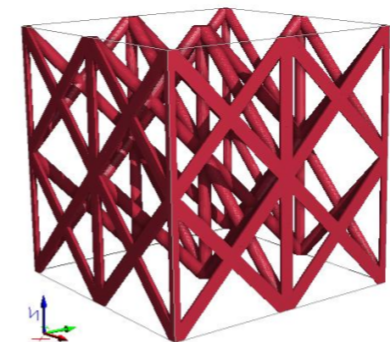
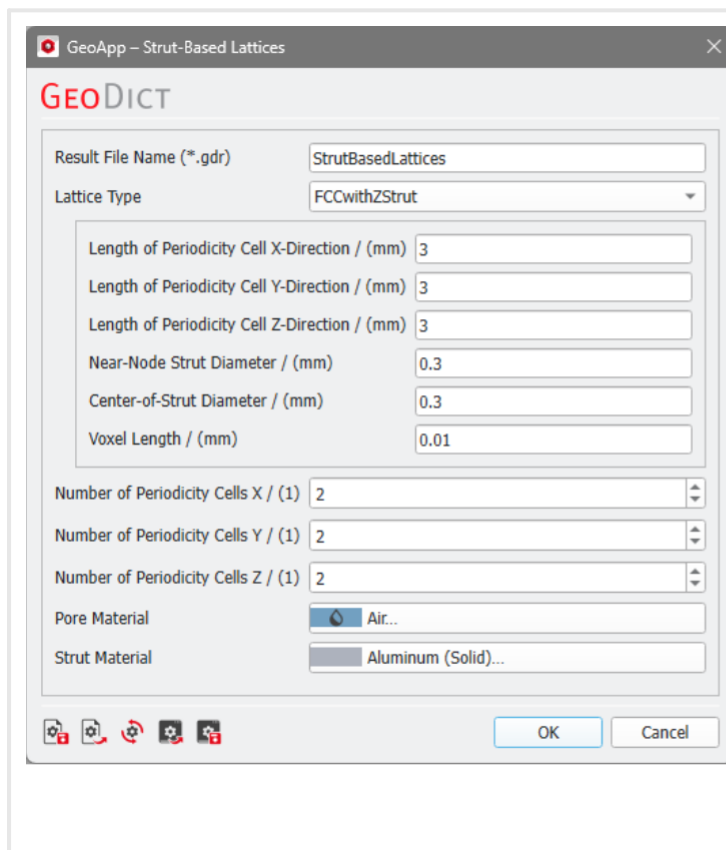
✓Diamond-(Penta-Mode)



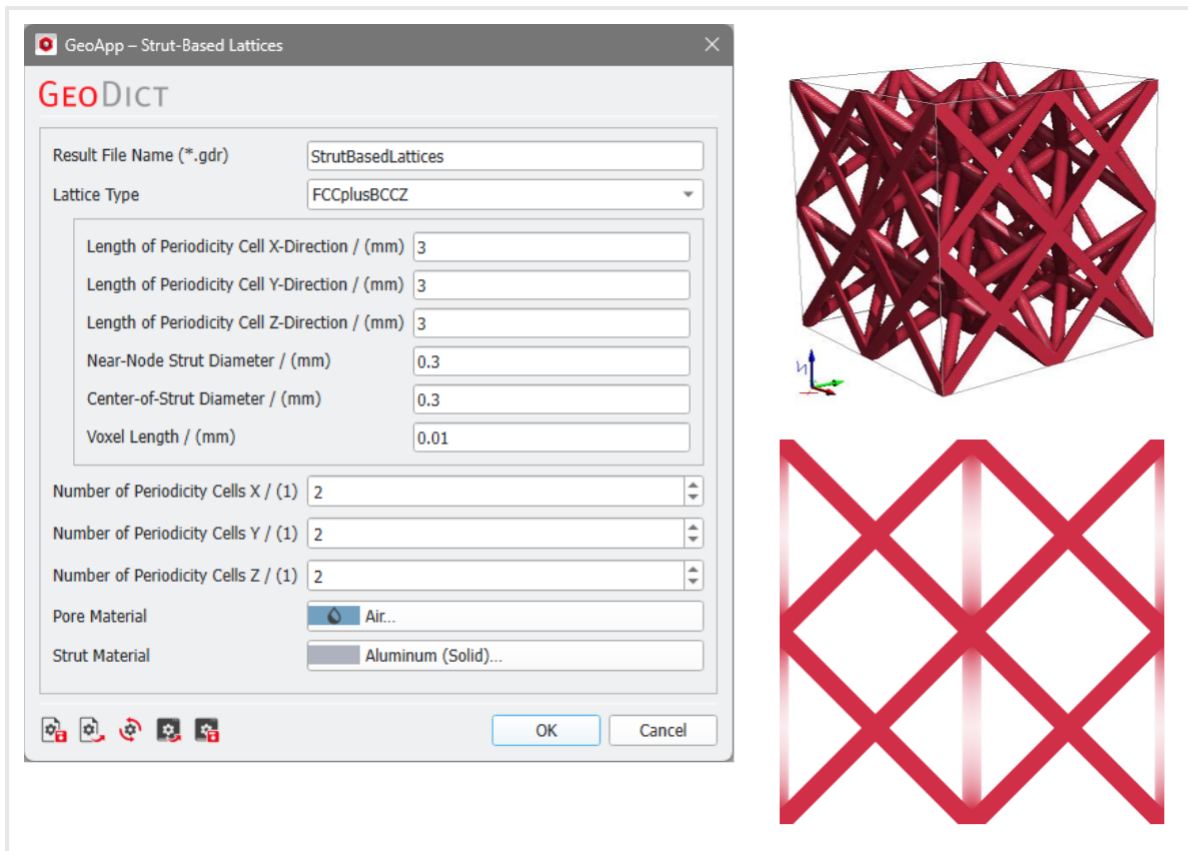
✓ Face-Centered-Cubic-(FCC)



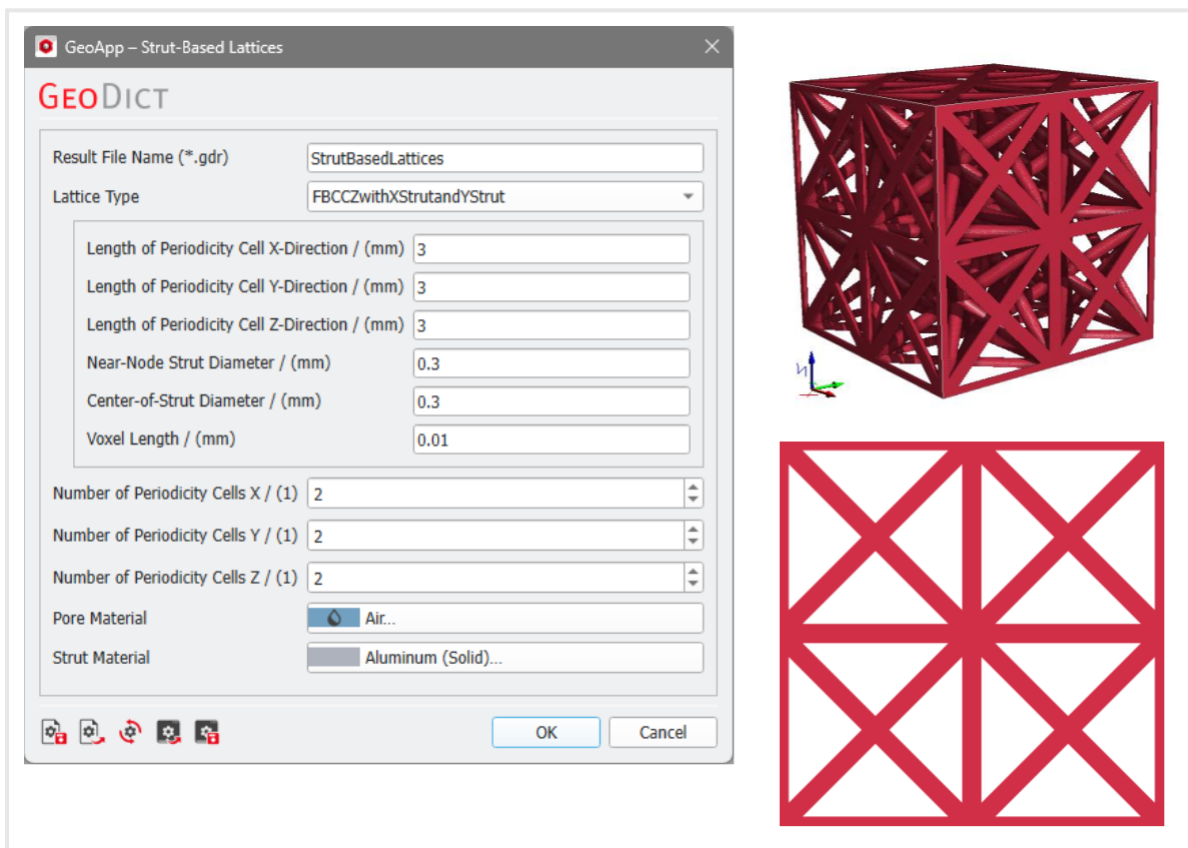
✓FCC-with-Z-Strut-(FCCZ)



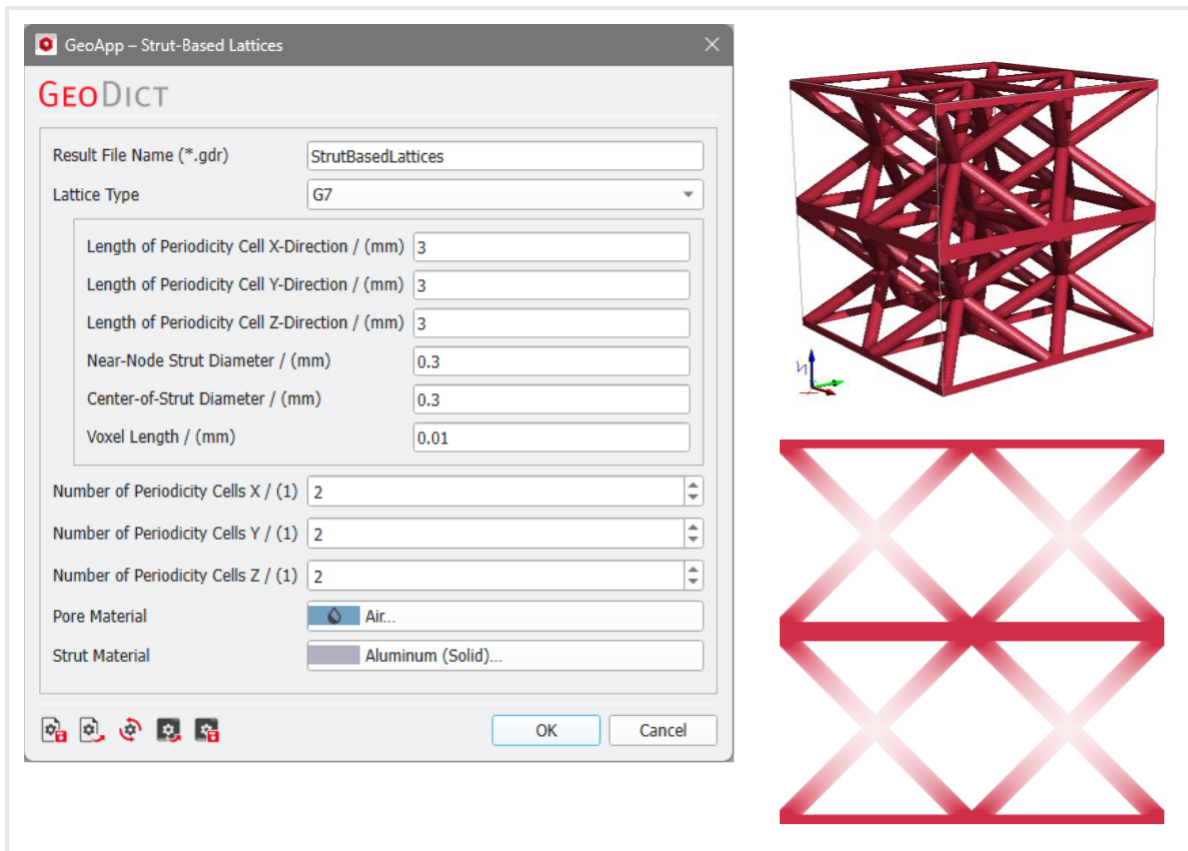
✓FCC-plus-BCCZ-(FBCCZ)



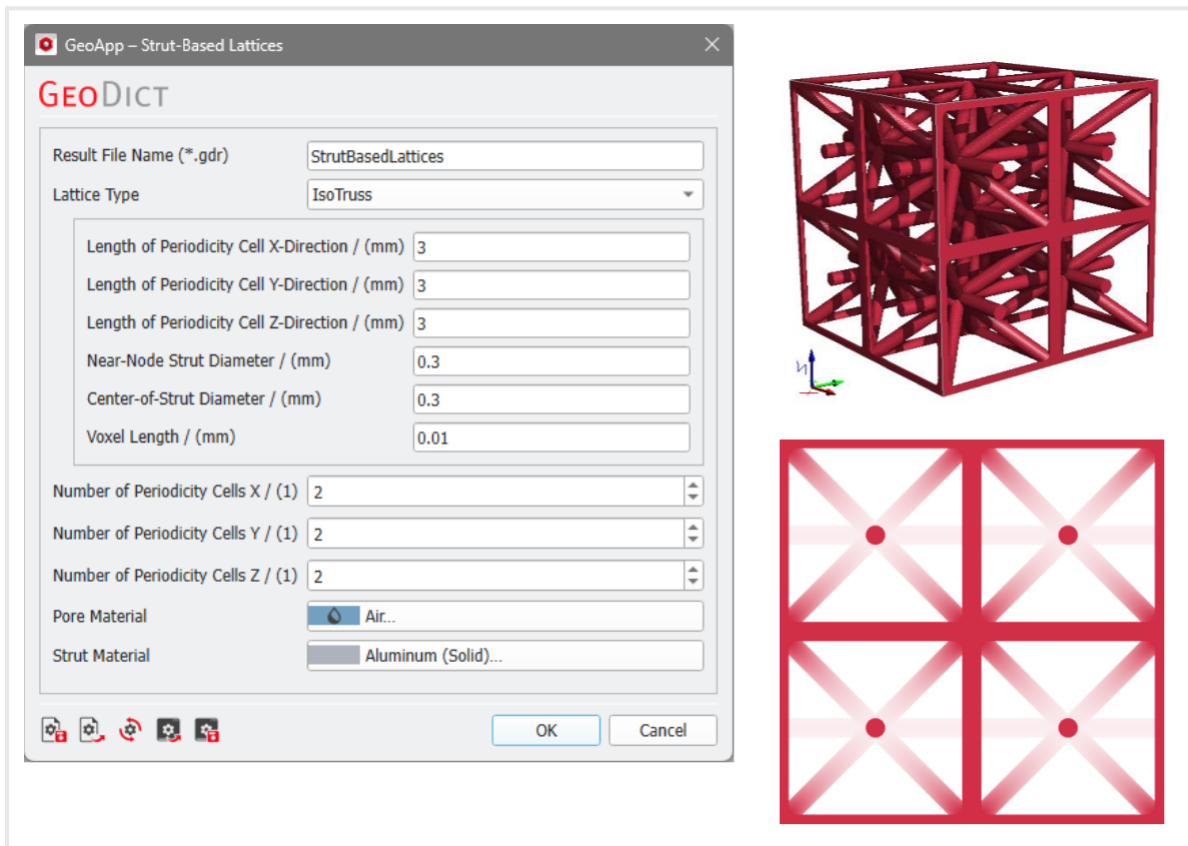
✓FBCCZ-with-X-Strut-and-Y-Strut-(FBCCXYZ)



✓G7



✓Iso-Truss



✓ Kelvin

GeoApp – Strut-Based Lattices

GEODICT

Result File Name (*.gdr)

Lattice Type

Length of Periodicity Cell X-Direction / (mm)

Length of Periodicity Cell Y-Direction / (mm)

Length of Periodicity Cell Z-Direction / (mm)

Near-Node Strut Diameter / (mm)

Center-of-Strut Diameter / (mm)

Voxel Length / (mm)

Diamond Side Length / Periodicity Cell Length / (1)

Number of Periodicity Cells X / (1)

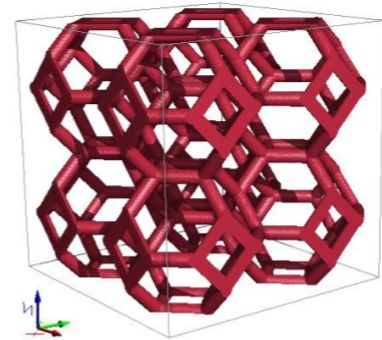
Number of Periodicity Cells Y / (1)

Number of Periodicity Cells Z / (1)

Pore Material

Strut Material

OK Cancel



✓ Octahedron

GeoApp – Strut-Based Lattices

GEODICT

Result File Name (*.gdr)

Lattice Type

Length of Periodicity Cell X-Direction / (mm)

Length of Periodicity Cell Y-Direction / (mm)

Length of Periodicity Cell Z-Direction / (mm)

Near-Node Strut Diameter / (mm)

Center-of-Strut Diameter / (mm)

Voxel Length / (mm)

Number of Periodicity Cells X / (1)

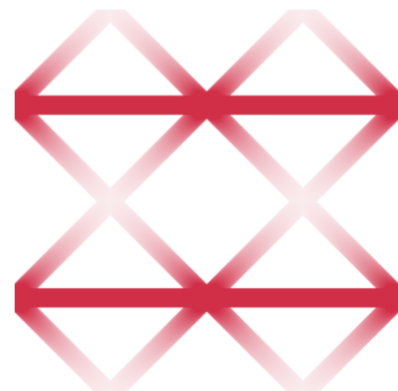
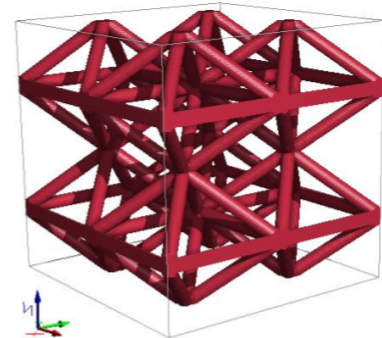
Number of Periodicity Cells Y / (1)

Number of Periodicity Cells Z / (1)

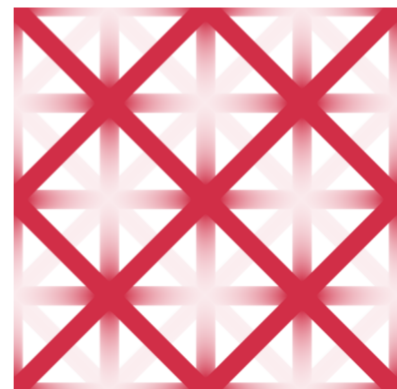
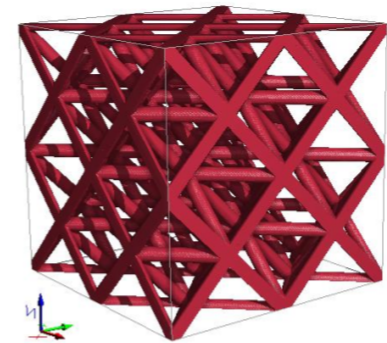
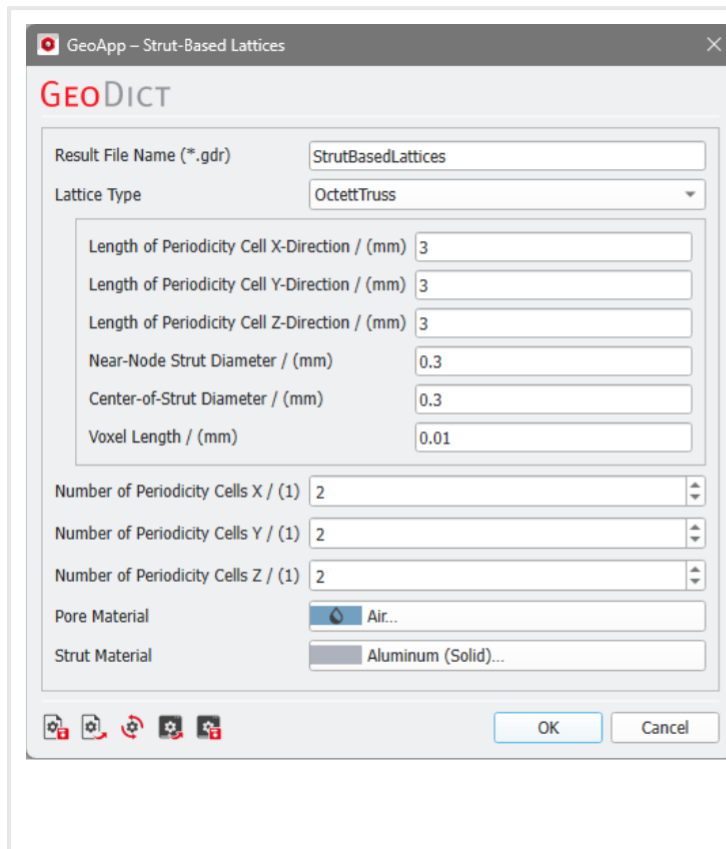
Pore Material

Strut Material

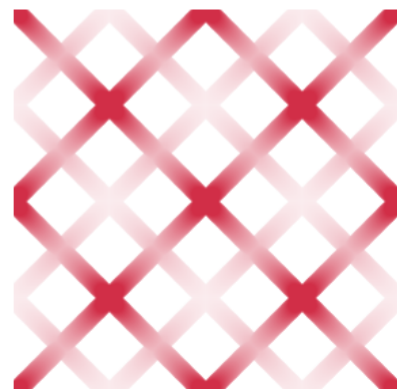
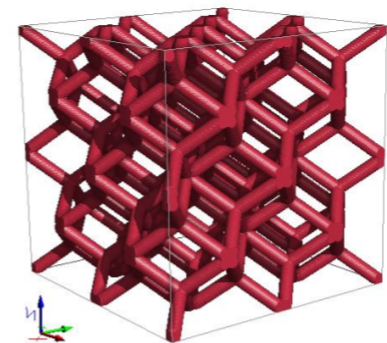
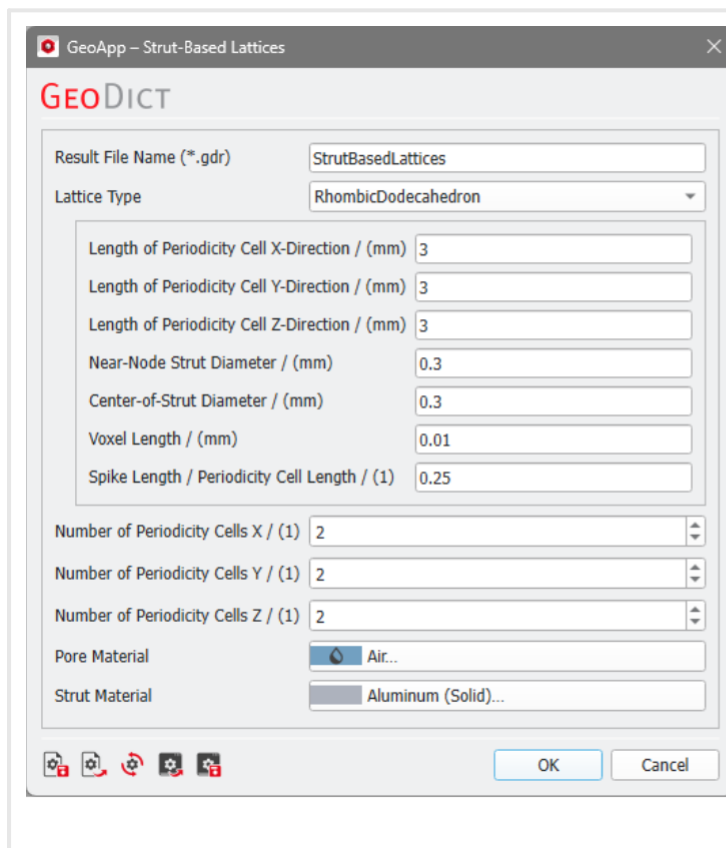
OK Cancel



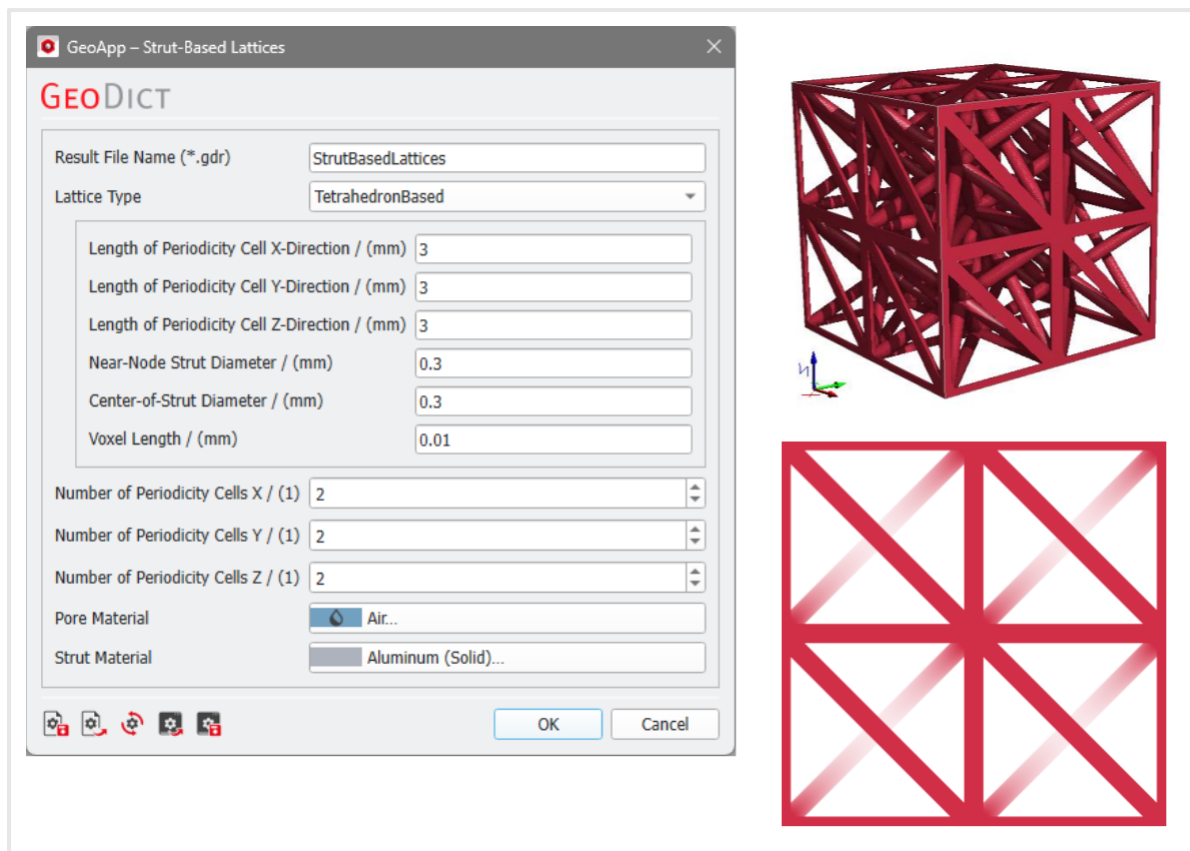
✓ Octett-Truss



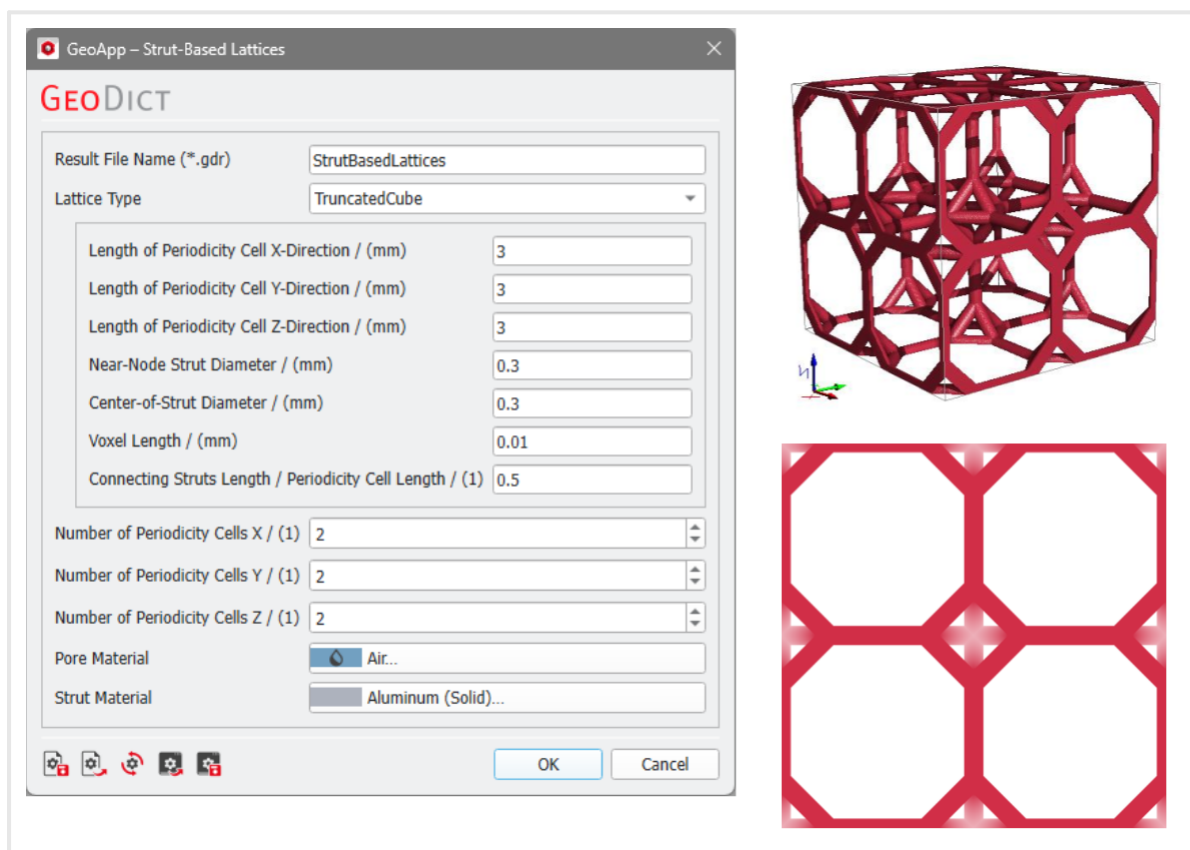
✓ Rhombic-Dodecahedron



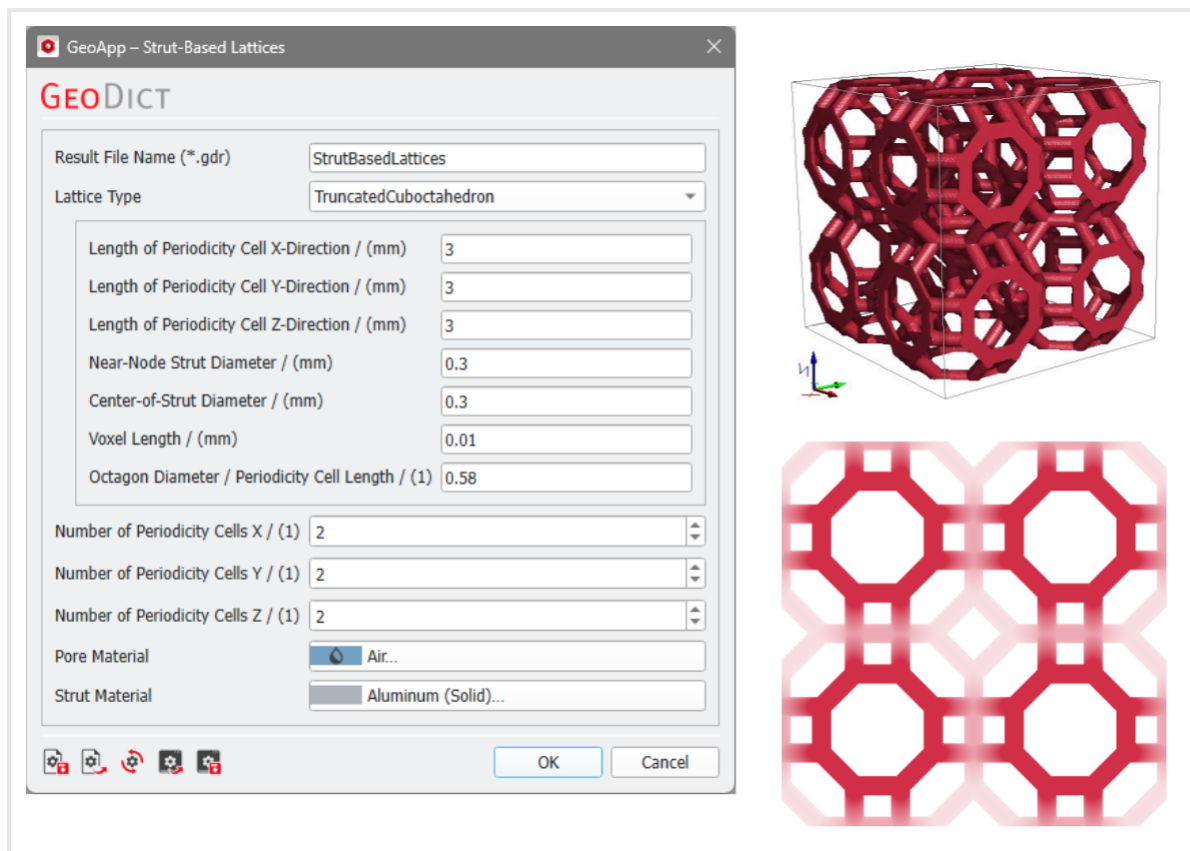
✓Tetrahedron-Based



✓Truncated-Cube



✓ Truncated-Cuboctahedron



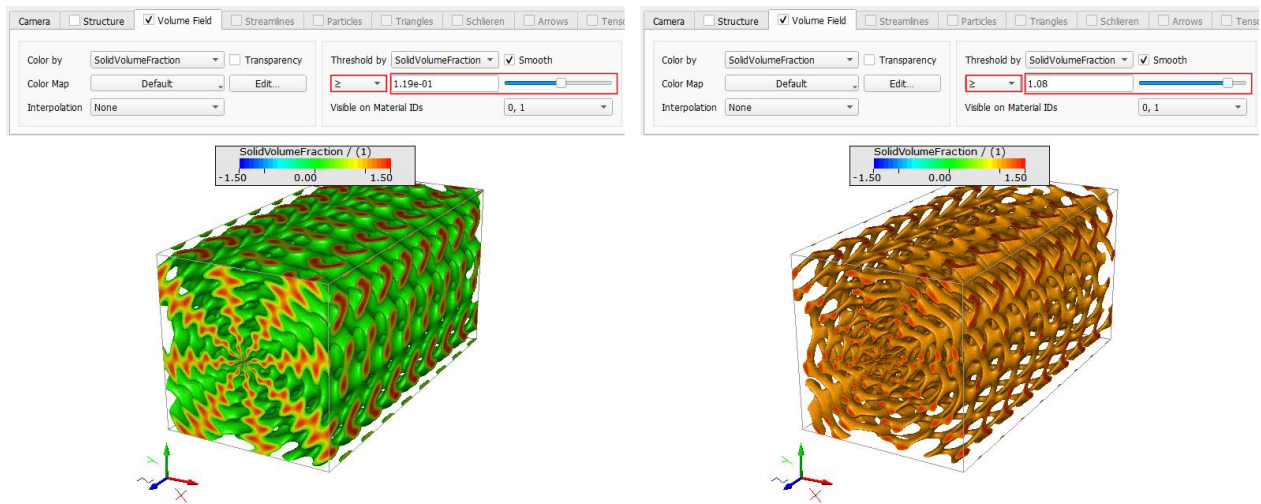
1.5.7 Triply Periodic Minimal Surfaces (TPMS)

What are Triply Periodic Minimal Surfaces (TPMS)?

To generate a TPMS-based structure, a volume field is used. With the threshold mode **SmallerEqual** ($\leq$) the structure is composed of all parts of the volume field that have a solid volume fraction less or equal to the given threshold. If **GreaterEqual** ($\geq$) is chosen, then all parts with a higher solid volume fraction remain for the structure. The third mode **GreaterEqualAndSmallerEqual** ($\leq$ & $\geq$) combines both of the previous mentioned threshold modes and therefore needs a lower and an upper threshold to be defined. Everything between the threshold values is kept for the structure.

You can view the volume field on which the structure is based, by selecting the **Volume Field** tab in the Visualization panel. Uncheck **Structure** to only display the volume field given by the solid volume fraction.

The slider in the threshold section can be used to observe the remaining structure when changing the threshold. Choose between $\geq$, $\leq$, and $=$ mode. For the $=$ mode, only the parts with exactly this threshold value are visible.



More information on how to choose the view settings can be found in the Visualization chapter.

In the following, the resulting structures of all **Shape Modes** are shown in both 3D-Rendering and 2D Cross Section View together with the default settings for each shape mode.

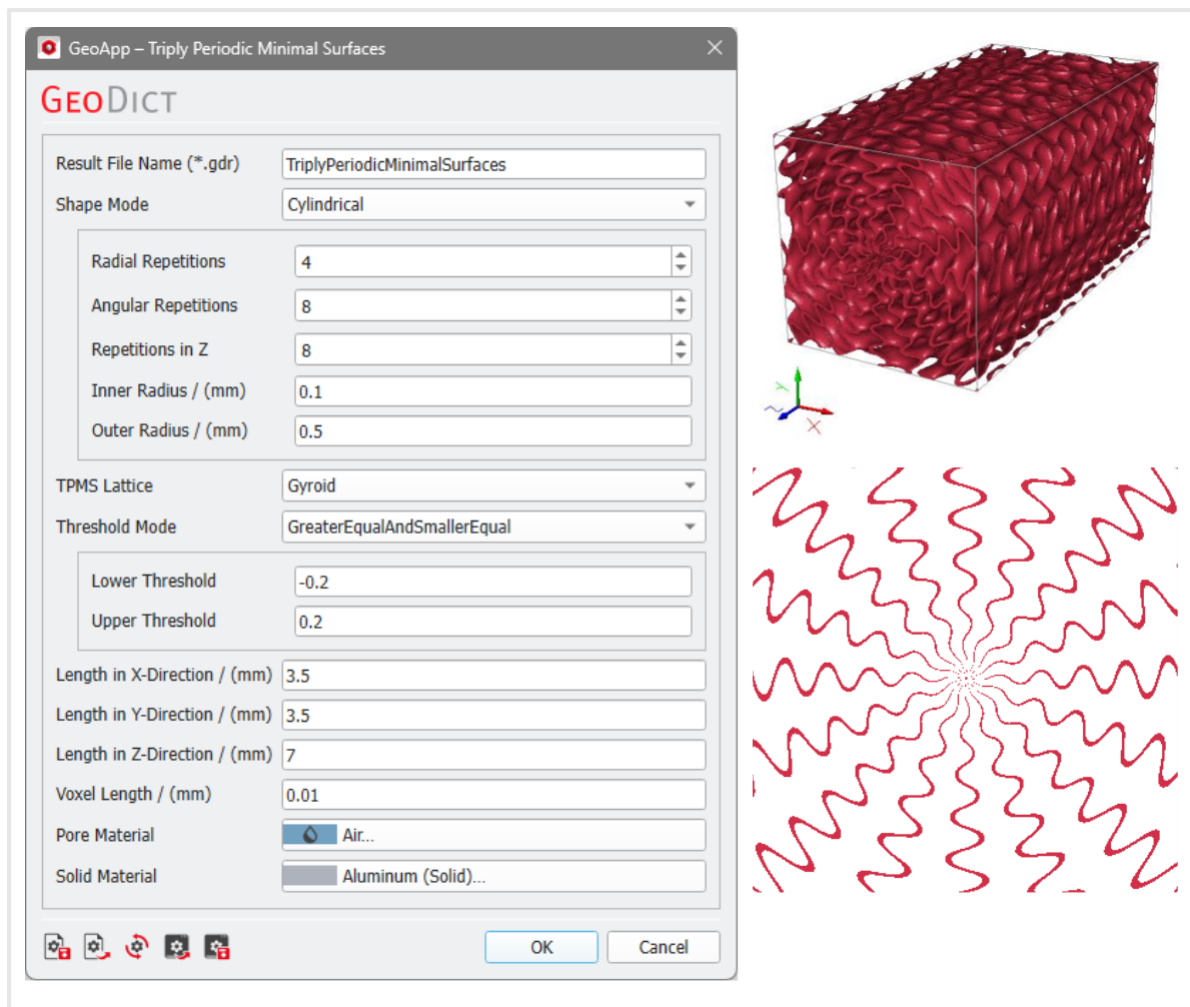


Modules needed to run this GeoApp:

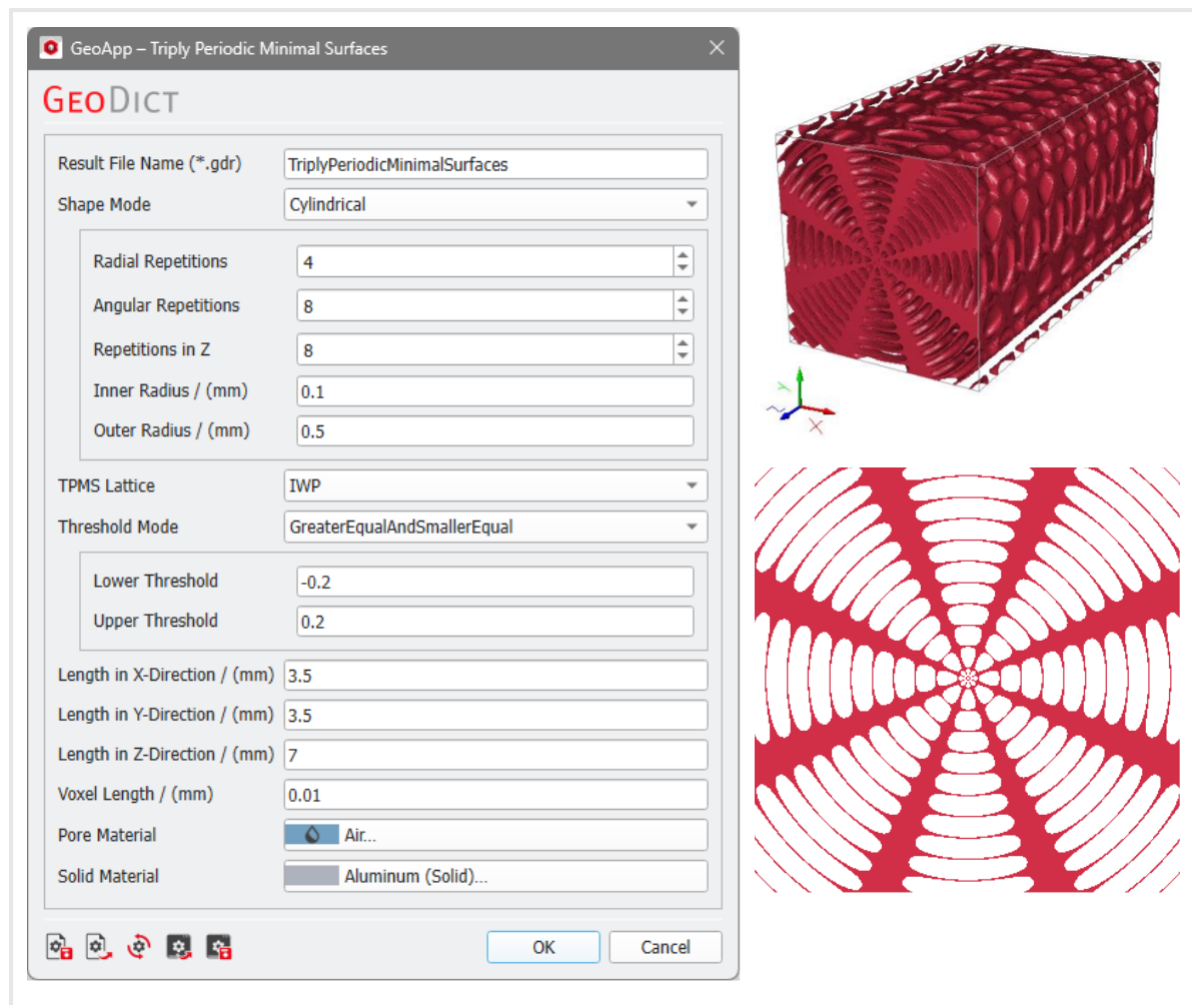
GridGeo

Cylindrical Shape Mode

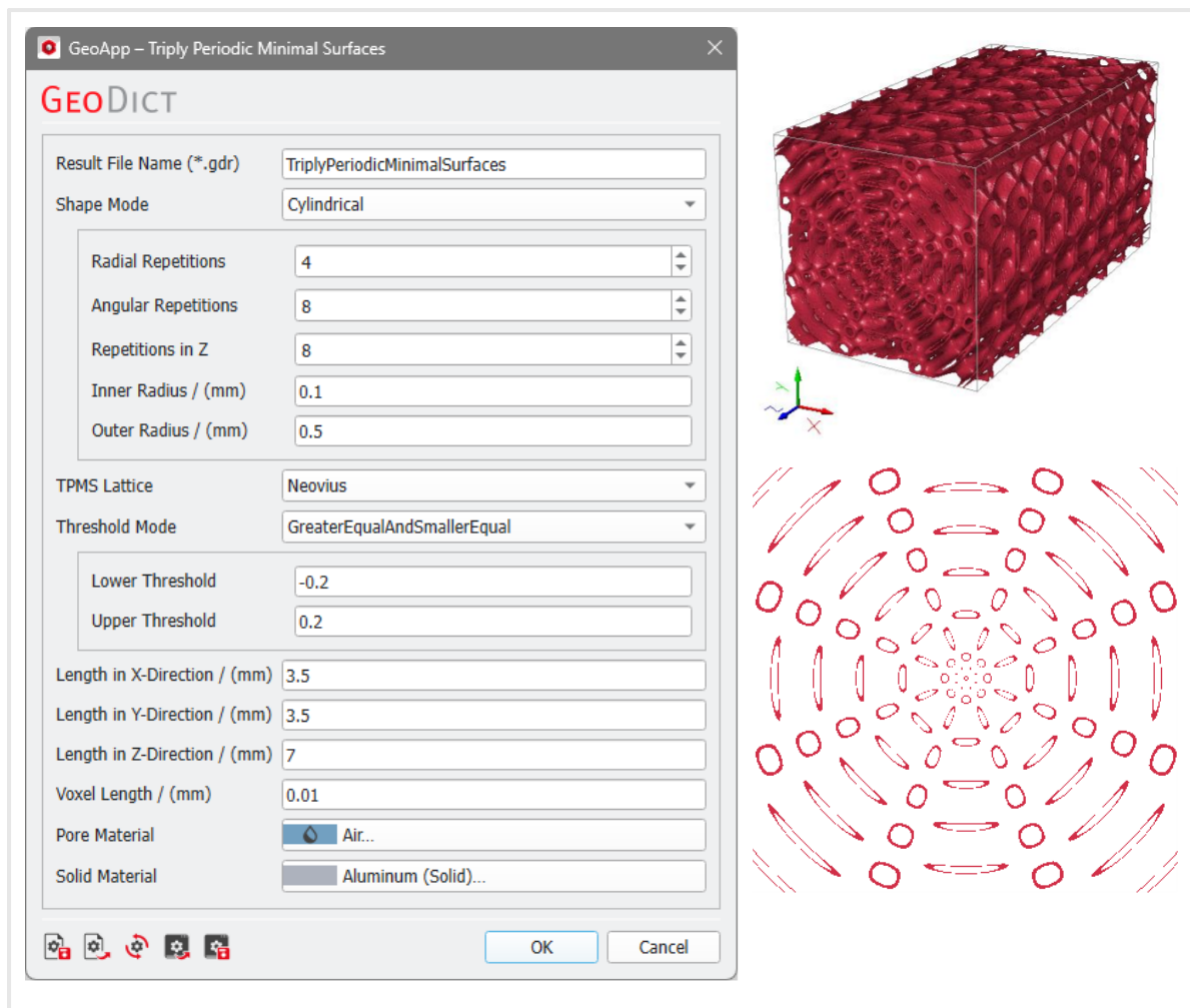
✓ Gyroid



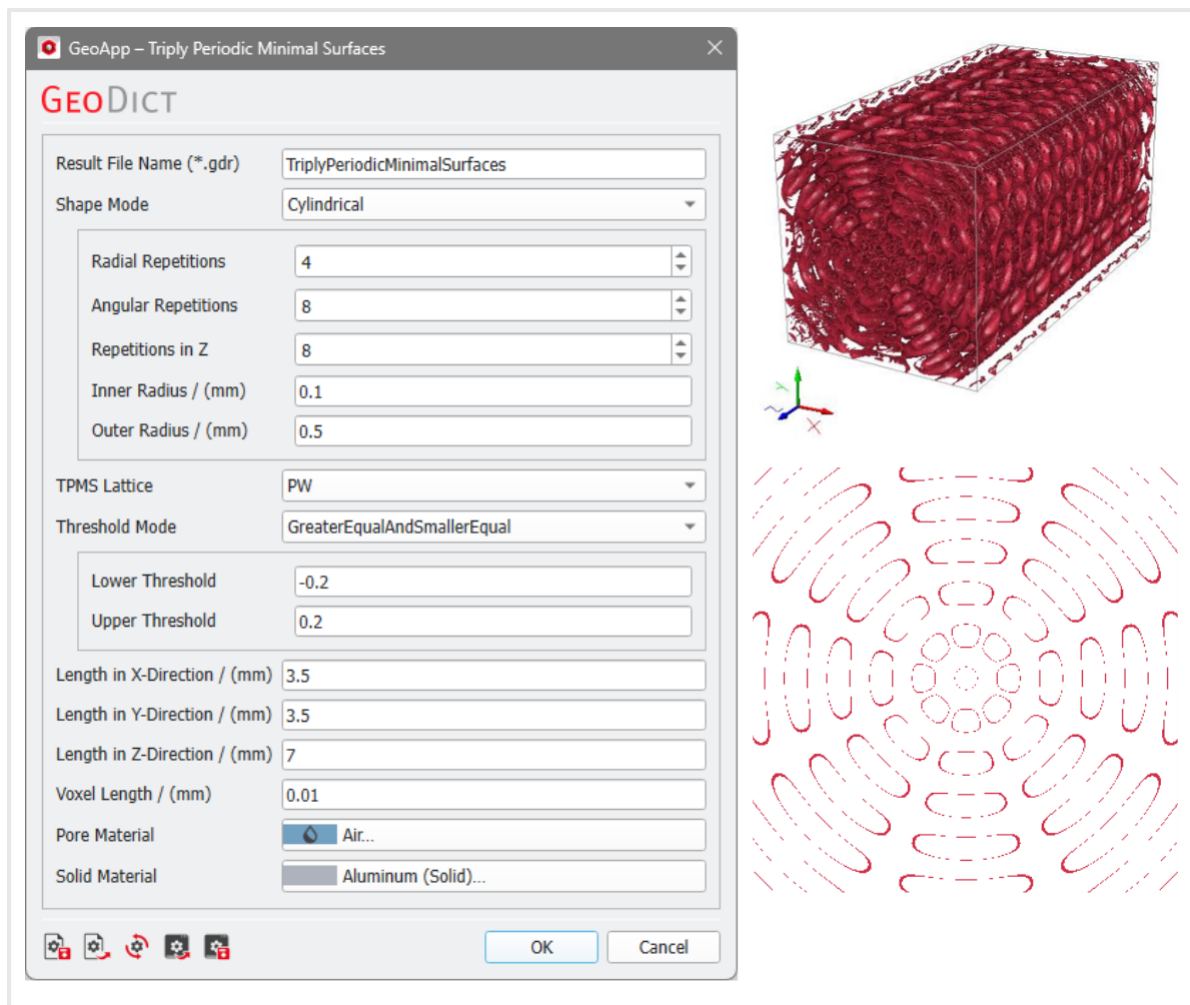
✓ I-WP



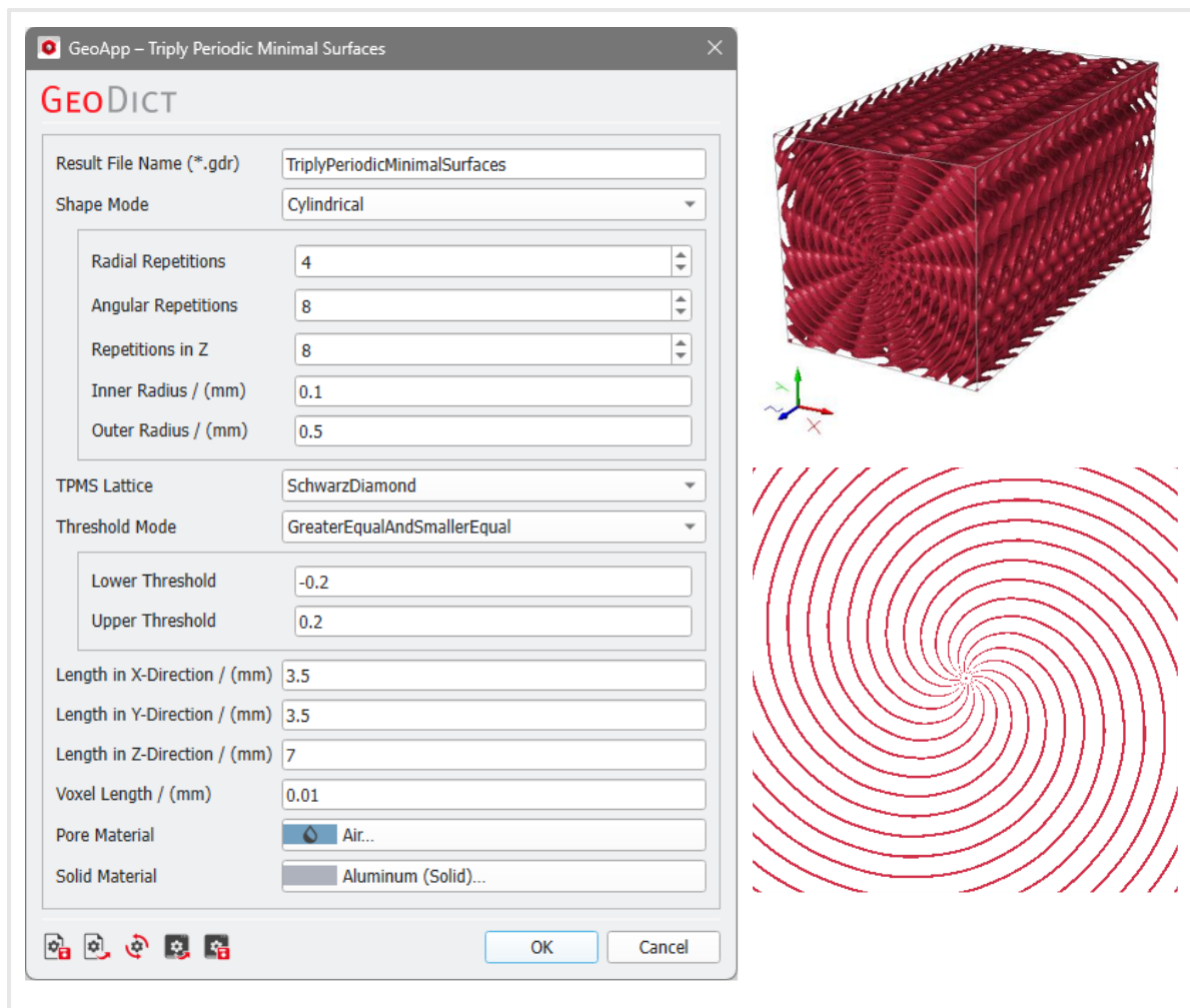
✓ Neovius



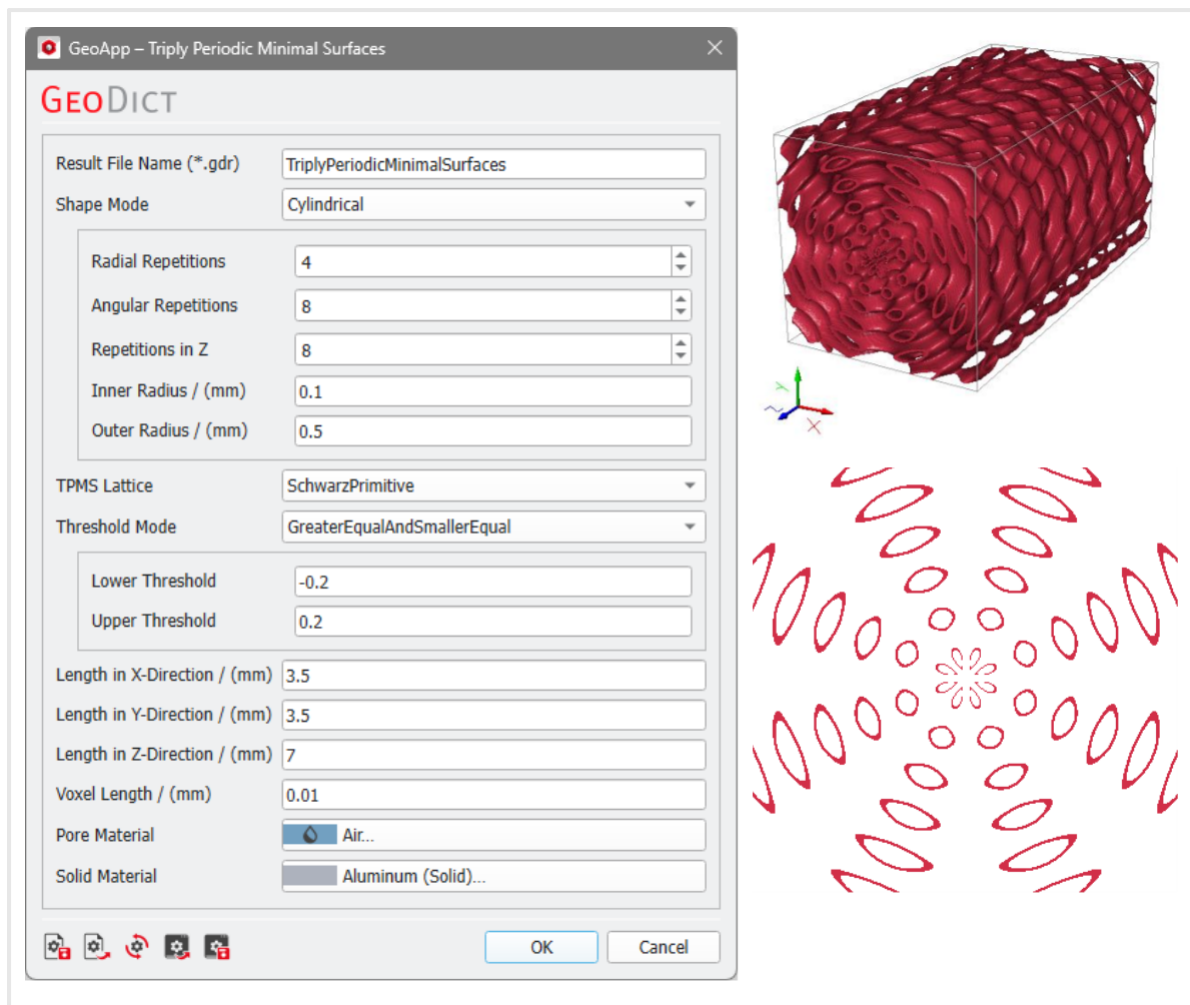
✓P-W



✓ Schwarz-Diamond

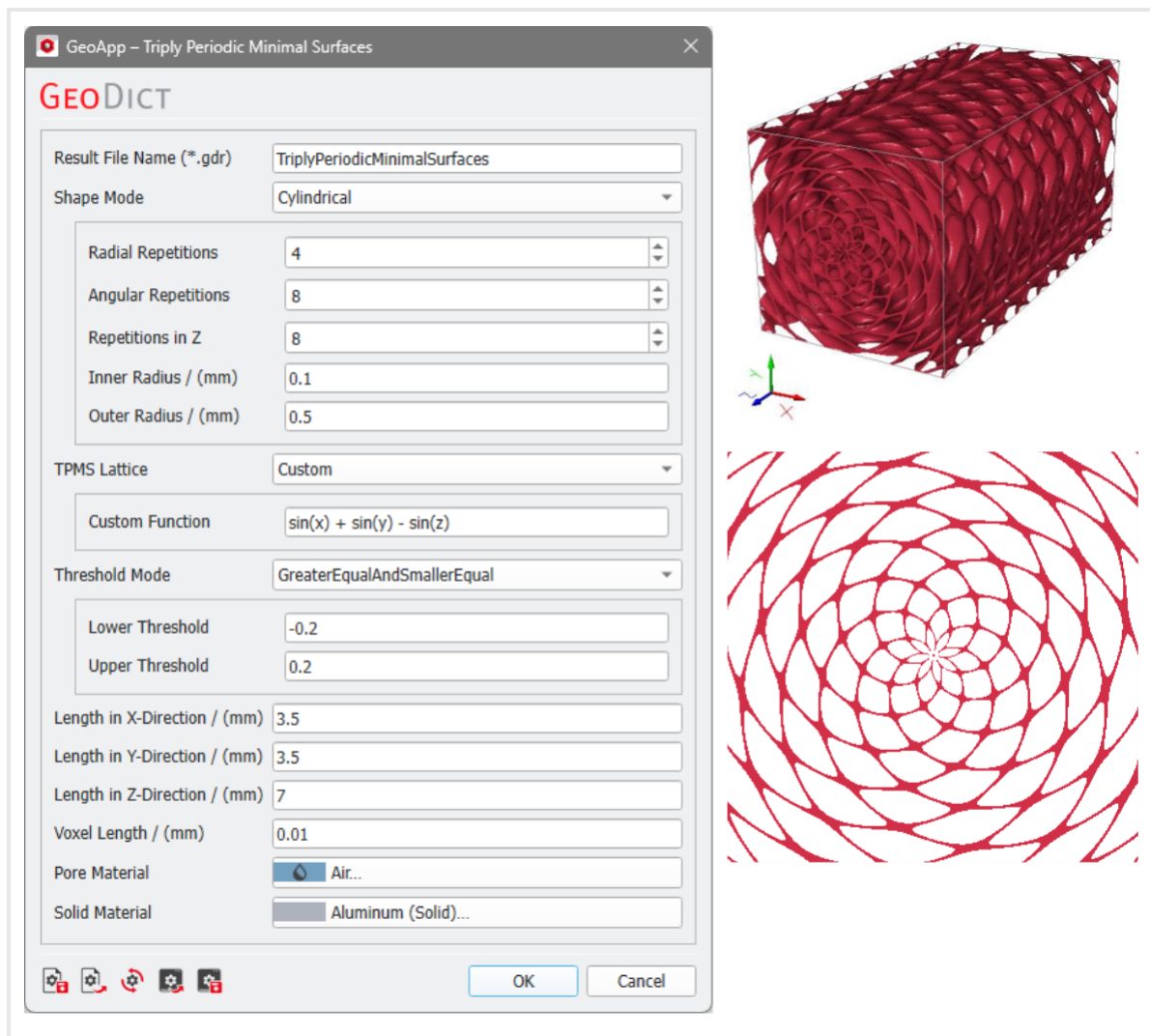


✓ Schwarz-Primitive



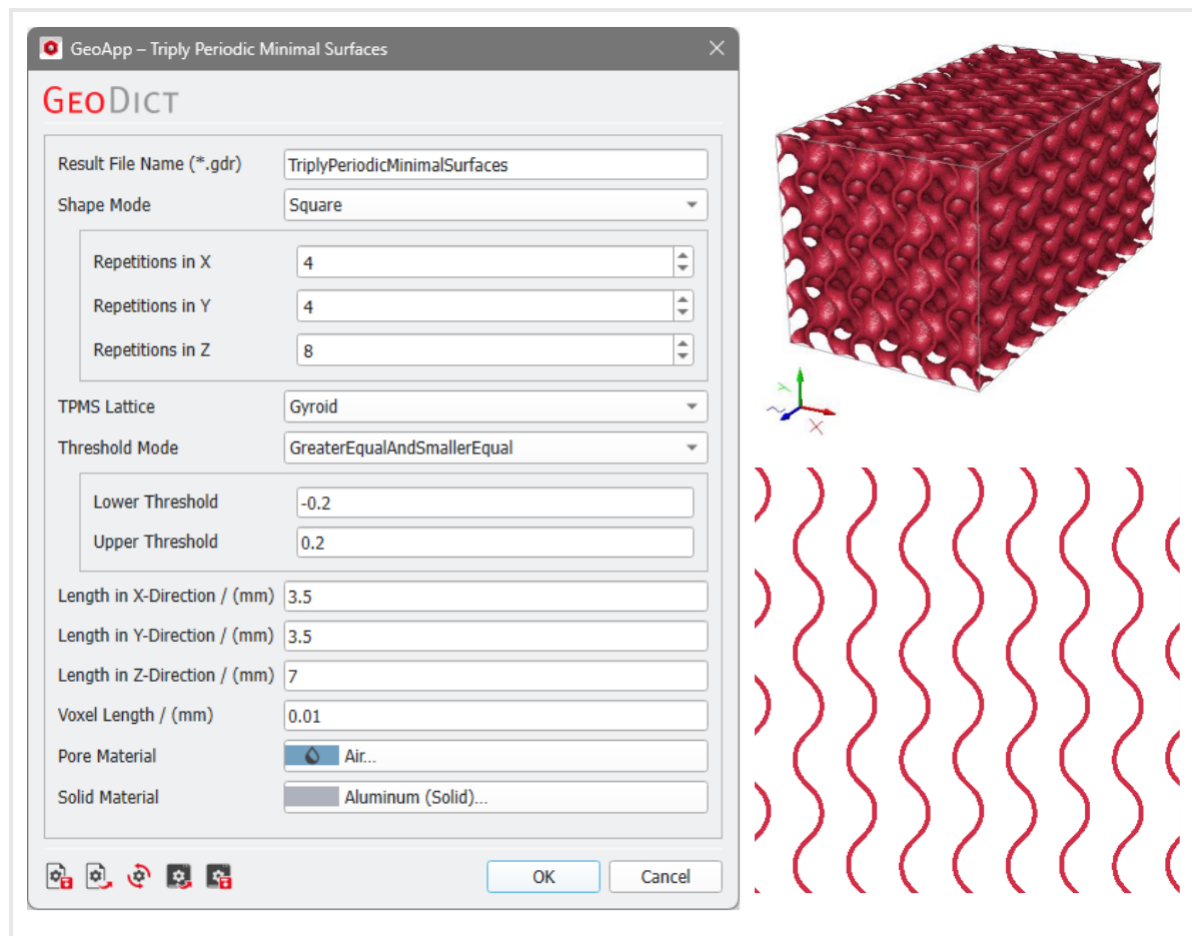
✓ Custom

A custom function in python syntax can be specified to produce a grid of triply periodic minimal surfaces.

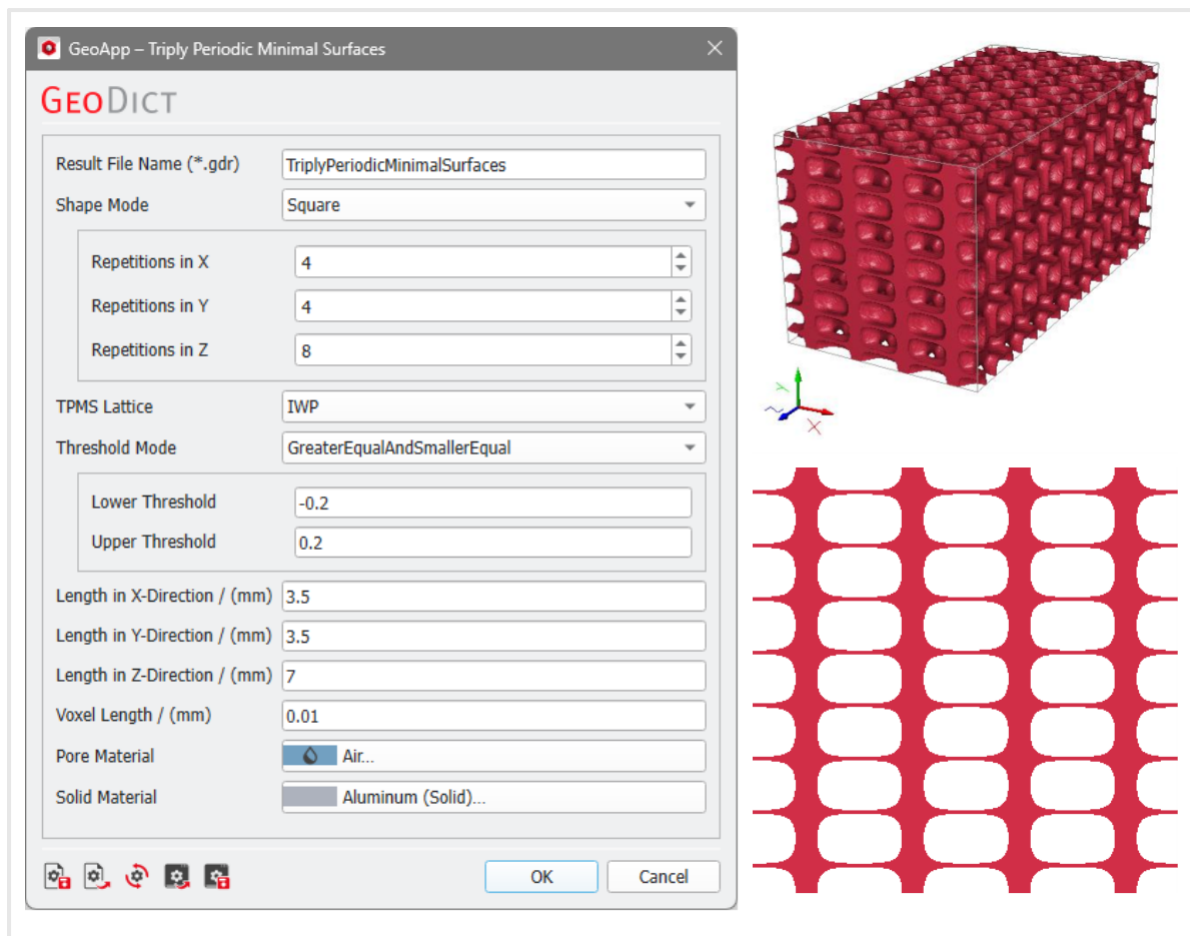


Square Shape mode

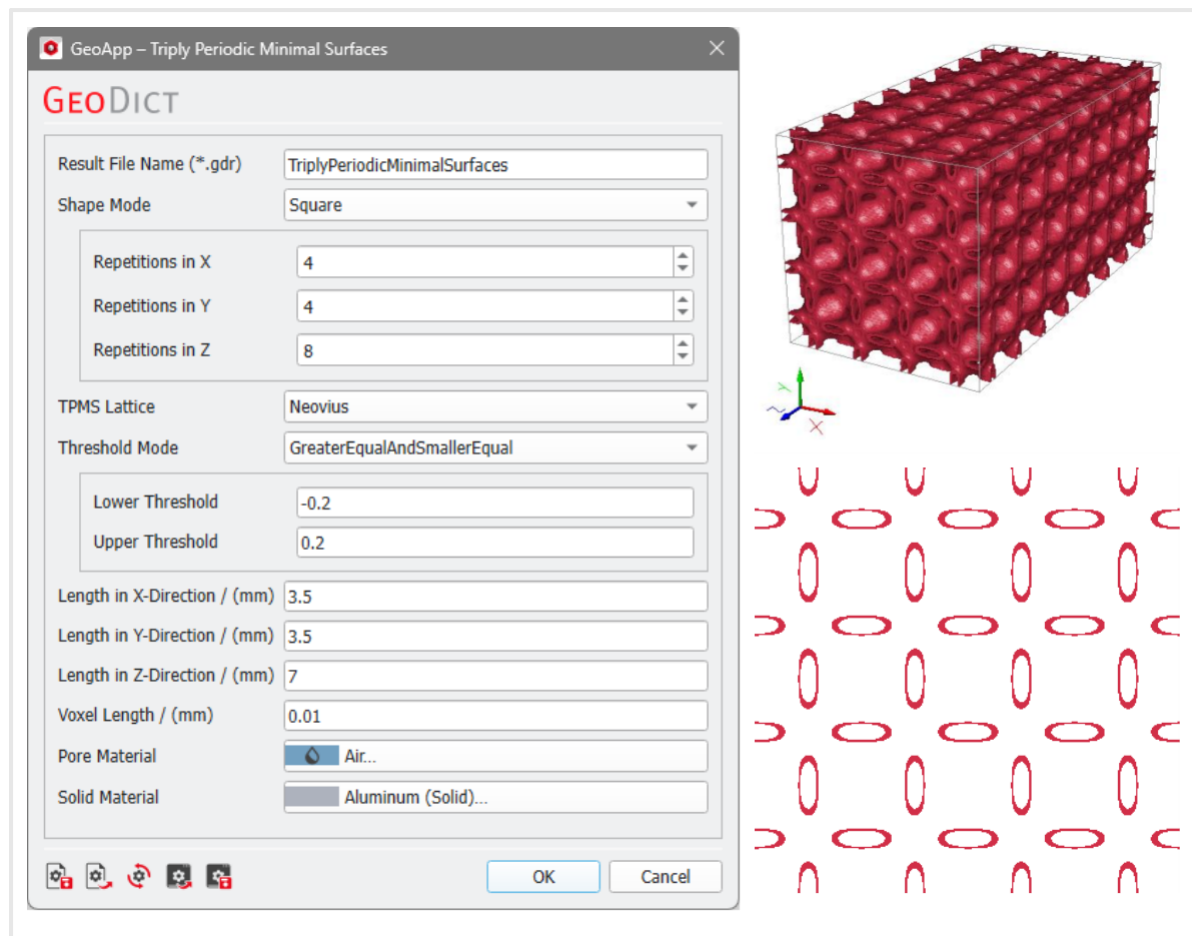
✓ Gyroid



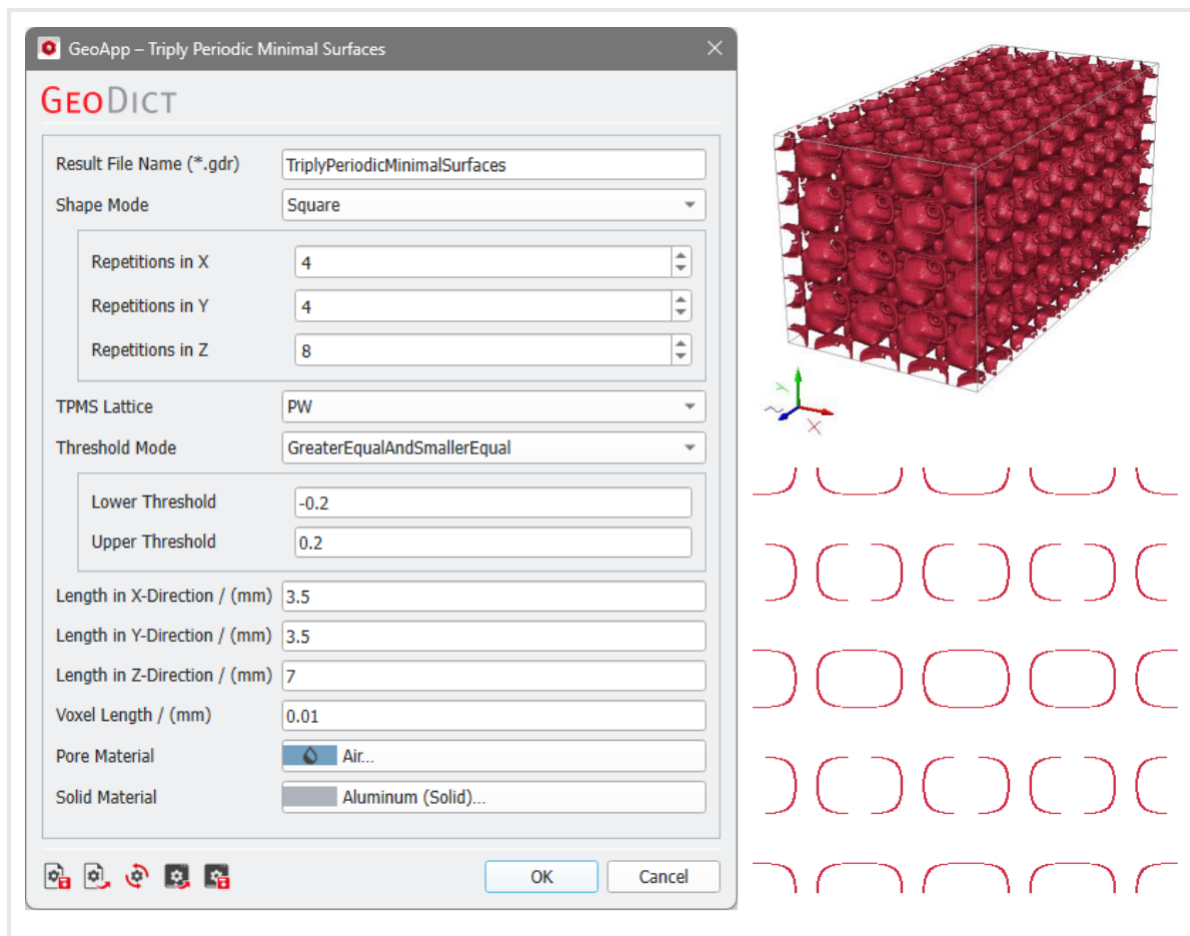
✓ I-WP



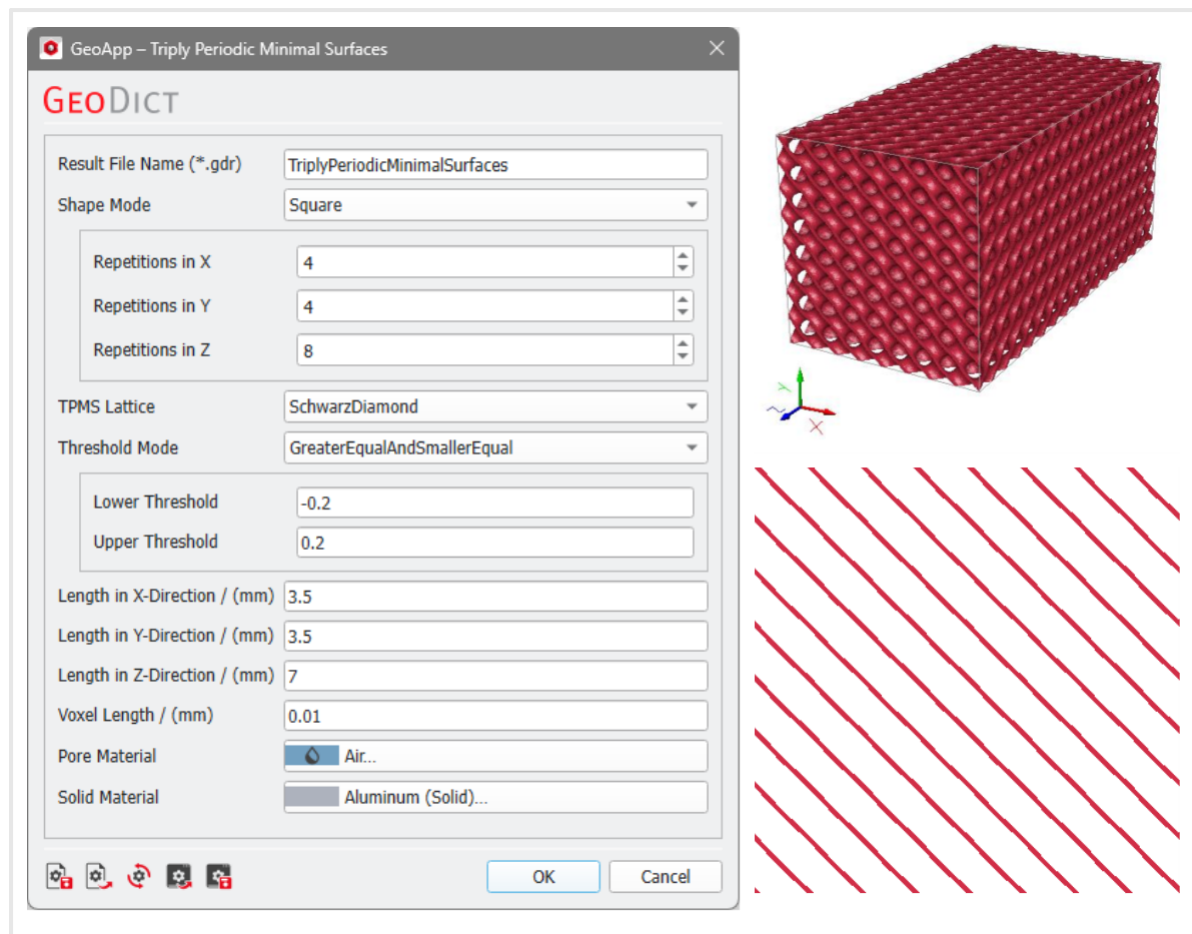
✓ Neovius



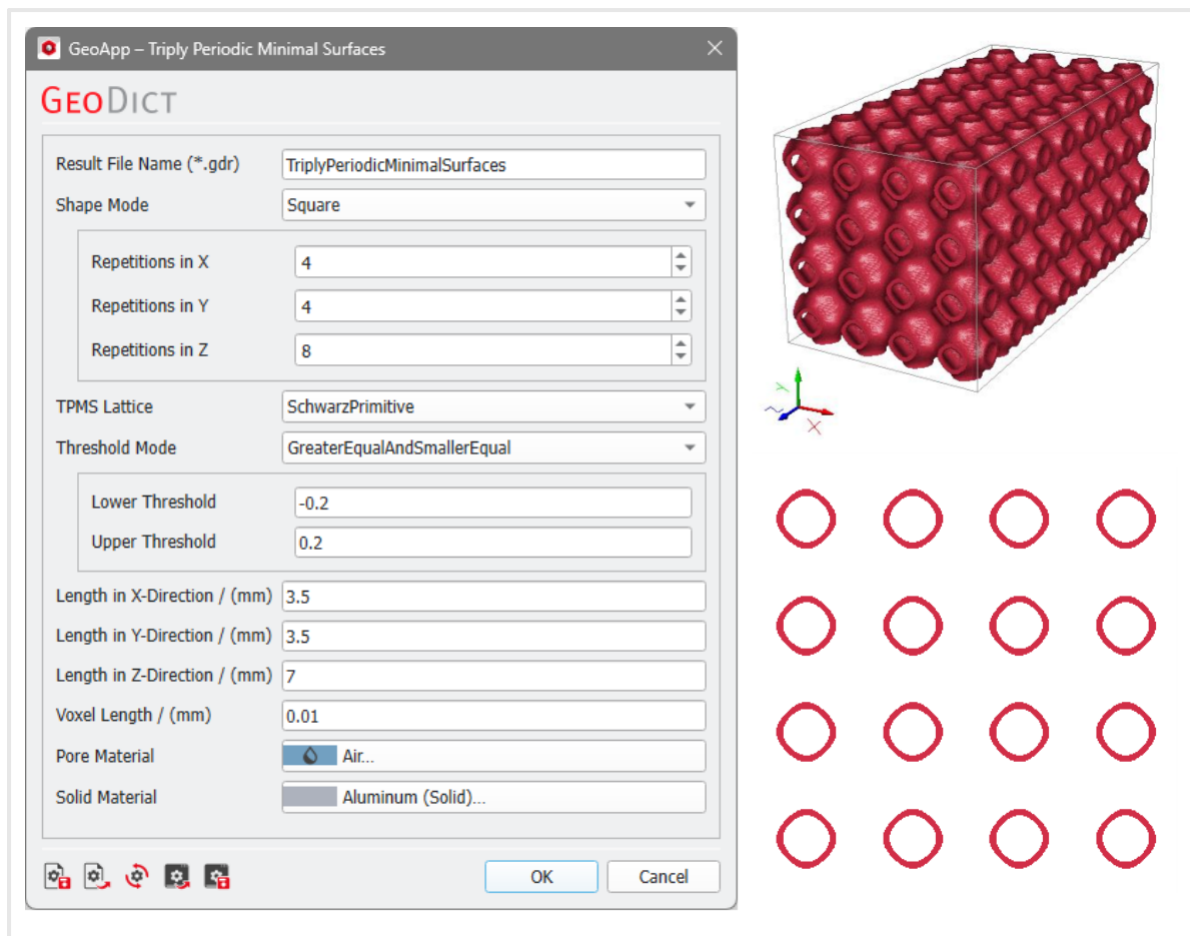
✓P-W



✓ Schwarz-Diamond

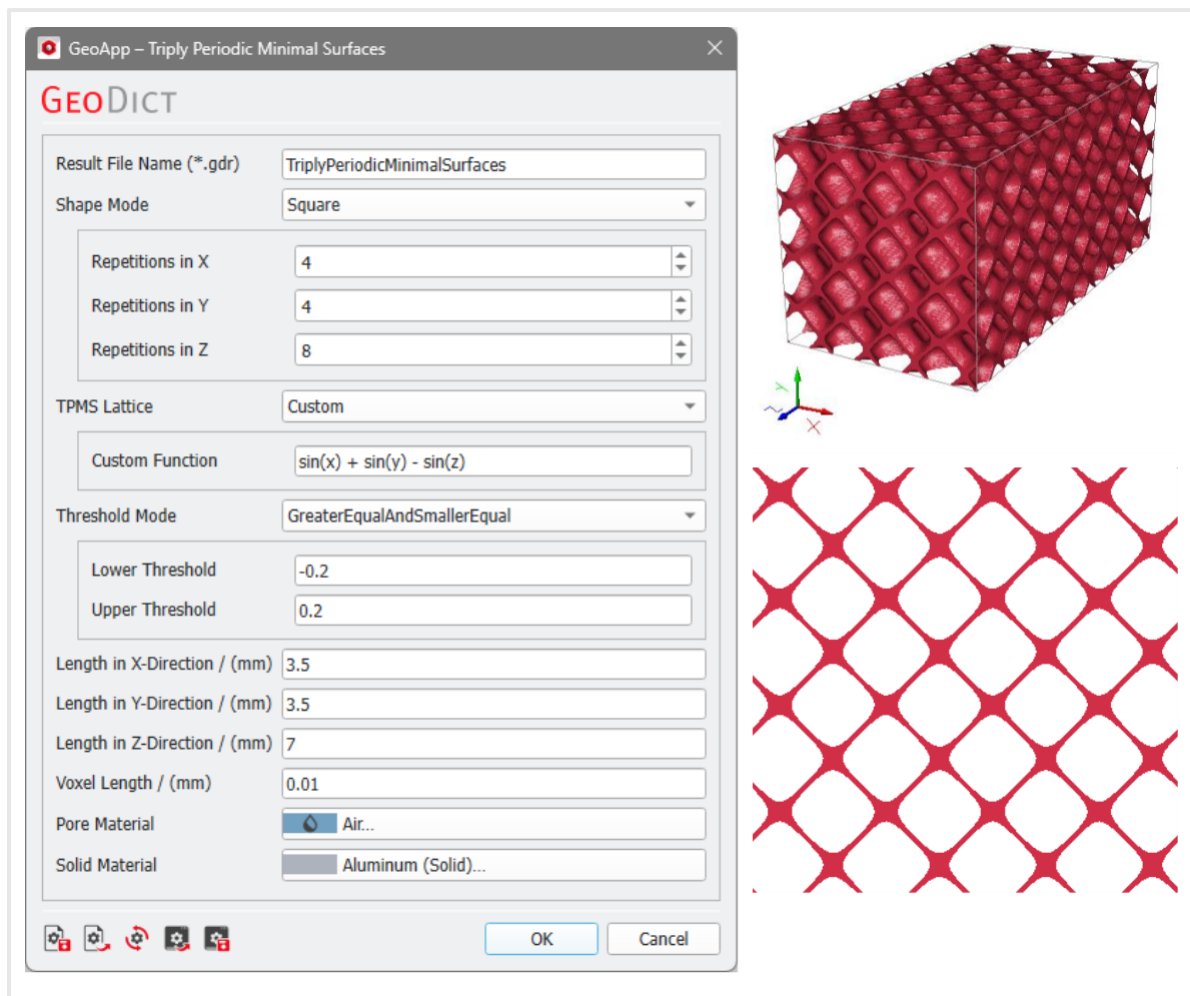


✓ Schwarz-Primitive



✓ Custom

A custom function in python syntax can be specified to produce a grid of triply periodic minimal surfaces.



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