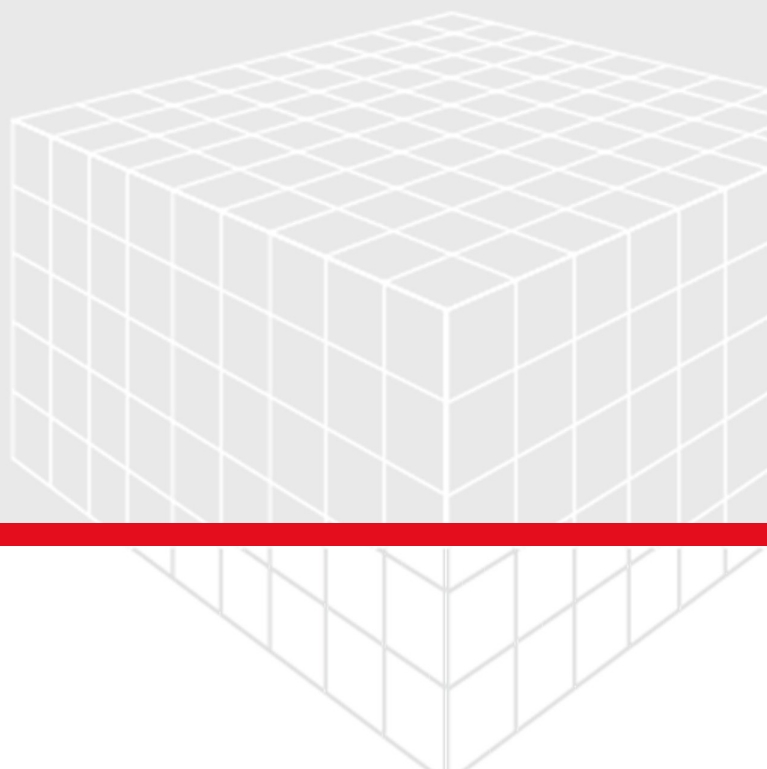


ProcessGeo

User Guide

GEODICT Release 2026

Published: June 2026



GEO DICT

<https://doi.org/10.30423/userguide.geodict>

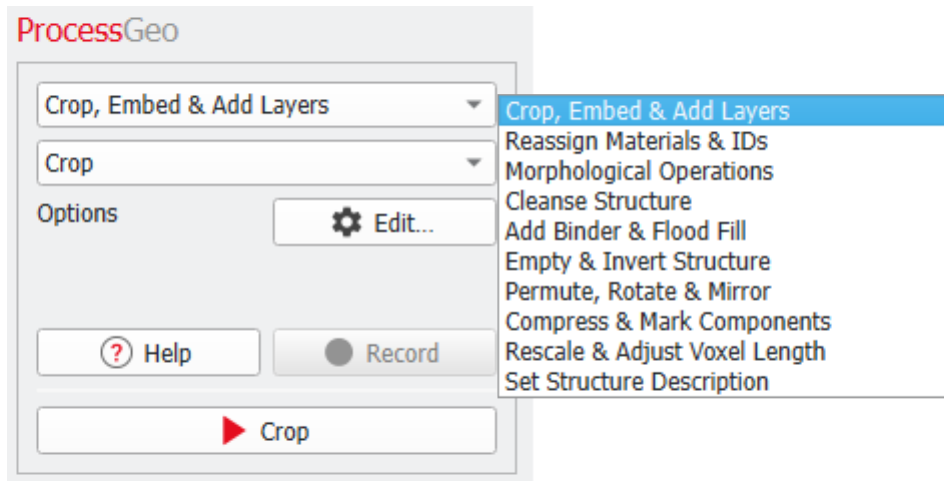
ProcessGeo

1. ProcessGeo	3
1.1 Crop, Embed & Add Layers	5
1.1.1 Crop	5
1.1.2 Embed	7
1.1.3 Repeat	9
1.1.4 Mirror	9
1.2 Reassign Materials & IDs	10
1.2.1 Reassign Material ID	10
1.2.2 Reassign Material	11
1.2.3 Reassign Material of Material ID	12
1.3 Morphological Operations	14
1.3.1 Dilate Structure	14
1.3.2 Erode Structure	17
1.4 Cleanse Structure	21
1.5 Add Binder & Flood Fill	24
1.5.1 Add Binder	24
1.5.2 Flood-Fill Large Pores	39
1.6 Empty & Invert Structure	45
1.6.1 Invert Structure	45
1.6.2 Create Empty Structure	46
1.7 Permute, Rotate & Mirror	48
1.8 Compress & Mark Components	51
1.8.1 Mark Components	51
1.8.2 Compress Structure	53
1.9 Rescale & Adjust Voxel Length	56
1.9.1 Rescale Structure	56
1.9.2 Adjust Voxel Length	59
1.10 Set Structure Description	61

1 ProcessGeo

ProcessGeo offers several options to transform structures in GeoDict. ProcessGeo starts after selecting **Model** → **ProcessGeo** in the Menu bar. The module section to the left of the visualization area changes to the **ProcessGeo** section.

Different commands can be selected from the **ProcessGeo** pull-down menus:



To carry out a command, select it from the menu and click the Options' **Edit...** button. Enter the necessary settings in the dialog that opens. Close the dialog box by clicking **OK**, then click the button corresponding to the command in the module section.



Note! Nearly all **ProcessGeo** commands do not create *.gdr result files - instead, they directly modify the current 3D structure. Do not forget to Save the structure file to your hard disk to keep the modifications.

Learn to use ProcessGeo:

- [Crop, Embed & Add Layers](#)⁵
Crop, embed, repeat, or mirror the structure.
- [Reassign Materials & IDs](#)¹⁰
Substitute one material (or Material ID) for another.
- [Morphological Operations](#)¹⁴
Dilate or erode the structure.
- [Cleanse Structure](#)²¹
Remove material components and noise.
- [Add Binder & Flood Fill](#)²⁴
Add binding material or fill pores.
- [Empty & Invert Structure](#)⁴⁵
Create an empty structure or invert the current structure.
- [Permute, Rotate & Mirror](#)⁴⁸
Perform rotations of the whole structure.

Learn to use ProcessGeo:

- [Compress & Mark Components](#)⁵¹
Compress the structure or mark structure components.
- [Rescale & Adjust Voxel Length](#)⁵⁶
Rescale or adjust the voxel length.
- [Set Structure Description](#)⁶¹
Change the description.



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](#).

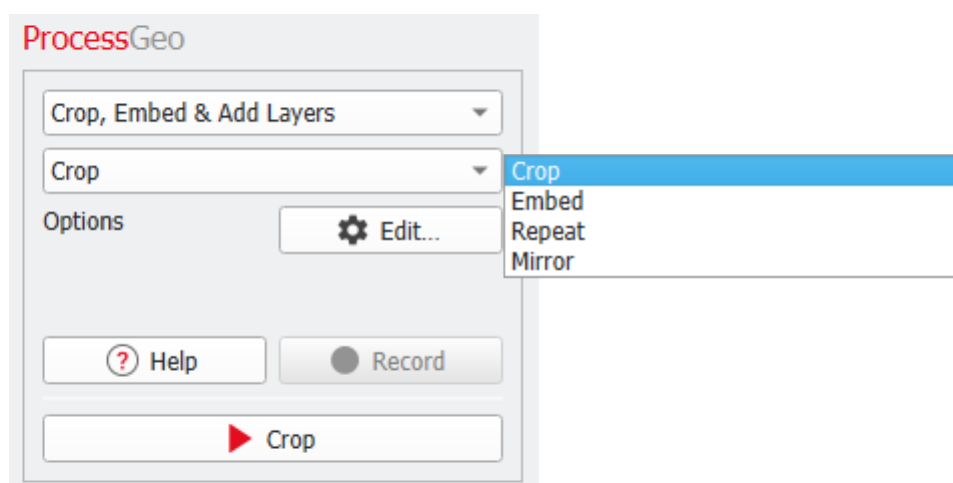
Our tutorials and seminar videos give you a first hands-on experience. They are collected in the [Learning Center](#).

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

1.1 Crop, Embed & Add Layers

In many cases, it is necessary to transform structures in order to build new ones. For instance, the LayerGeo module combines 3D volumes. For this, the dimensions of the merged structures must be compatible. Thus, to merge two structures in **Z** direction, the dimensions in the **X**- and **Y**-direction must be the same.

For these types of operations, it can be useful to crop parts of the structure, grow the structure by embedding, or repeat or mirror the structure or parts of it. To add or delete voxels in the **X**-, **Y**-, or **Z**-direction, click the Options' **Edit...** button.

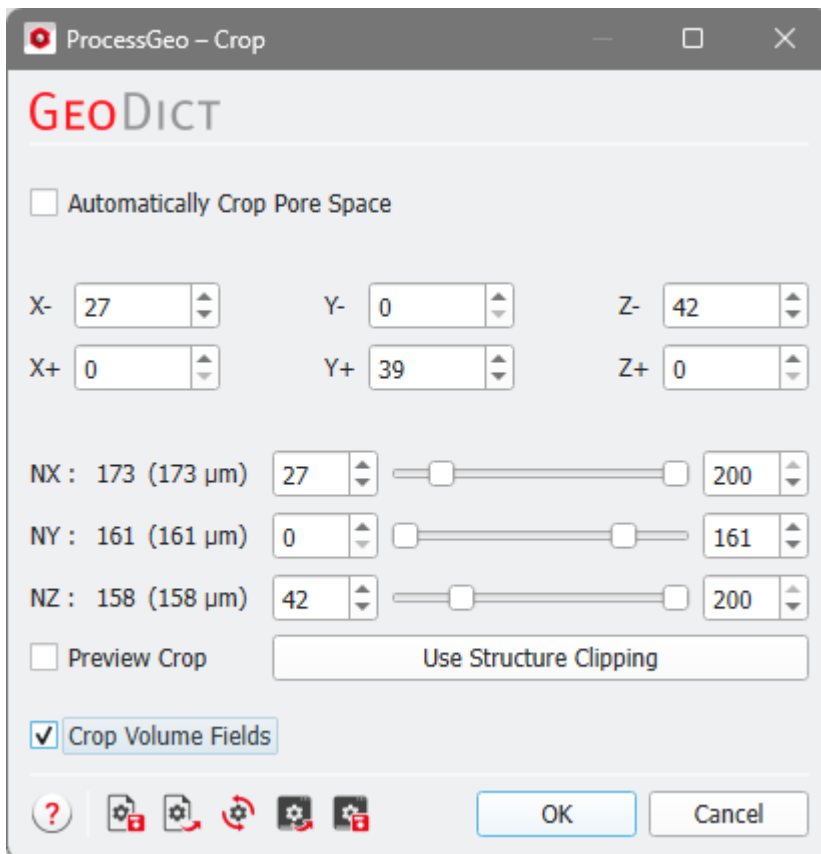


Commands available in the drop-down menu

- [Crop](#)⁵
Crop the structure by a selected number of voxels at the different domain sides.
- [Embed](#)⁷
Enlarge domain by adding additional voxels at the domain sides.
- [Repeat](#)⁹
Apply the repetition of the structure at the domain sides.
- [Mirror](#)⁹
Mirror the structure at the domain sides.

1.1.1 Crop

Crop a part of the structure in the selected direction by the (integer) values entered in **X**-, **X**+, **Y**-, **Y**+, **Z**-, and/or **Z**+



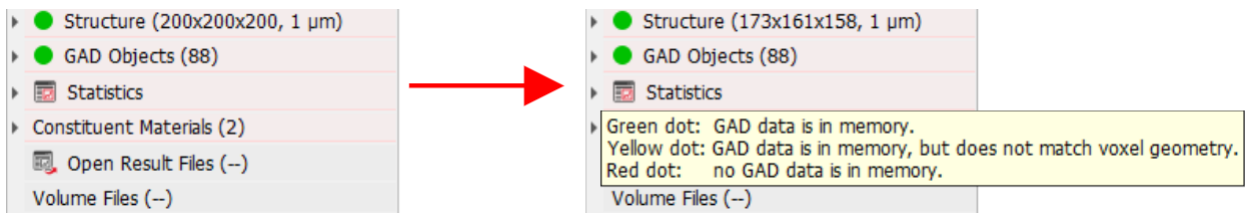
These values can be selected by moving the **NX**, **NY**, and **NZ** sliders or by entering the values directly. The first value determines what is cut away at the beginning of the structure. This value is identical to the value entered in **X-**, **Y-**, and **Z-** respectively. The second value determines the end of the cropped structure. It is equal to **NX** minus **X+**, **NY** minus **Y+**, and **NZ** minus **Z+**, respectively.

Checking **Automatically Crop Pore Space** results in removing slices of the 3D model at the boundary that contain only a Material ID that has been assigned as pore space. In this case, the previously shown settings cannot be selected.

With **Preview Crop** checked, the result of the cropping process is previewed in the Visualization area. The **Use Structure Clipping** button allows to copy the current structure clipping (from the current visualization) as input parameters for cropping.

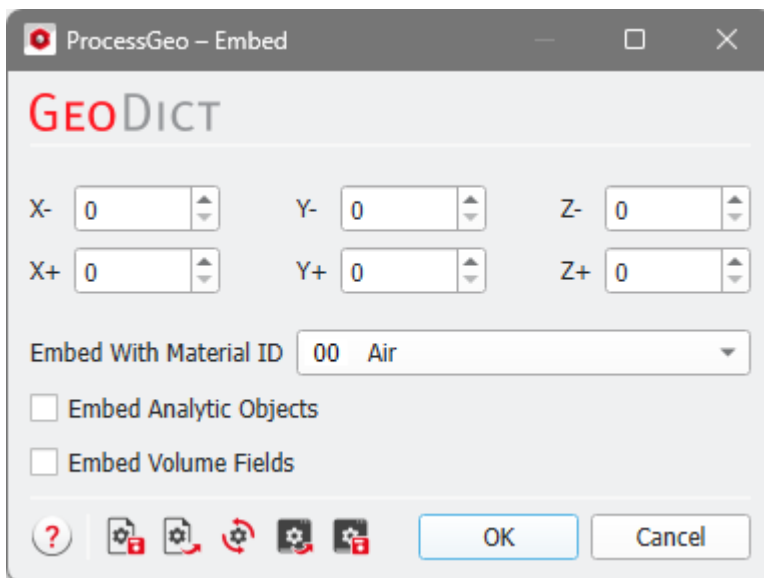
By checking **Crop Volume Fields**, any loaded volume fields are also cropped to the new geometry size during the cropping operation.

The structure's analytic information is preserved during cropping, as indicated by the green dot in front of **GAD Objects** in the project status section. It is possible that some objects lie completely outside of the domain after the cropping. Nevertheless, they are not discarded, and the object information is still stored in the structure file.



1.1.2 Embed

With **Embed**, the domain is enlarged by the defined number of voxels in the directions **X-**, **X+**, **Y-**, **Y+**, **Z-**, and/or **Z+**. The added voxels get the Material ID selected under **Embed with Material ID**.



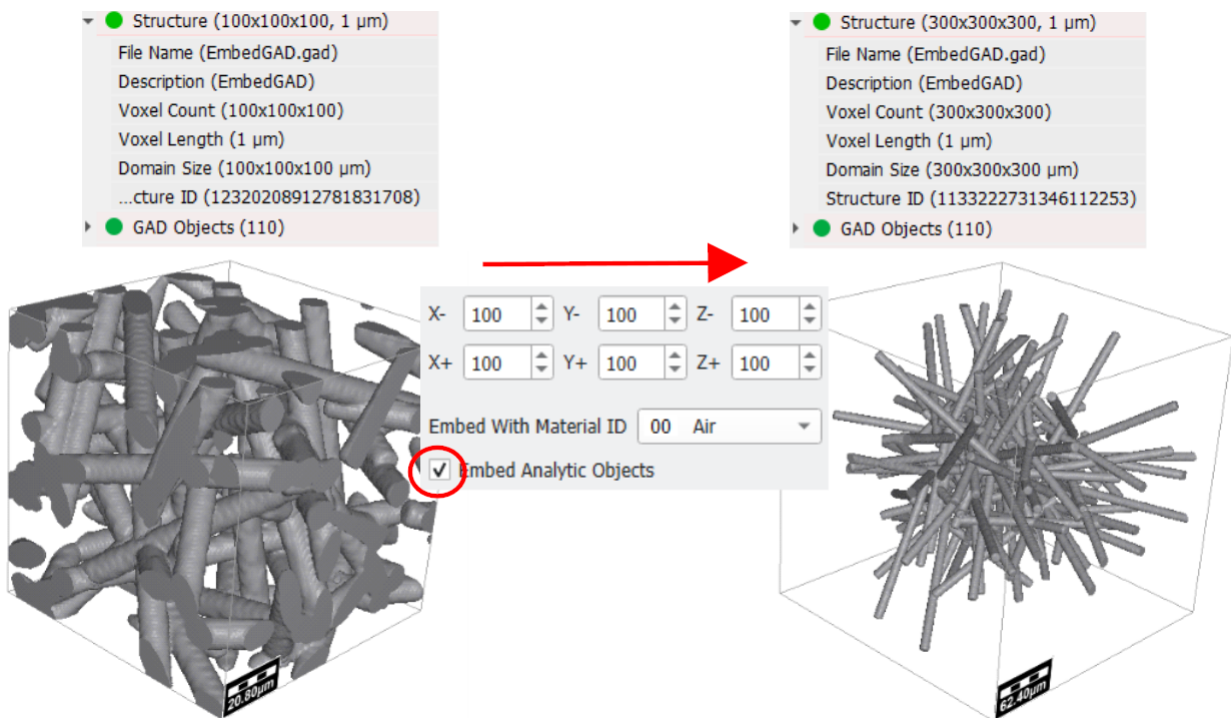
By checking **Embed Volume Fields**, any loaded volume fields are also embedded to the new geometry size during the embedding operation. The volume fields are always embedded with value 0.



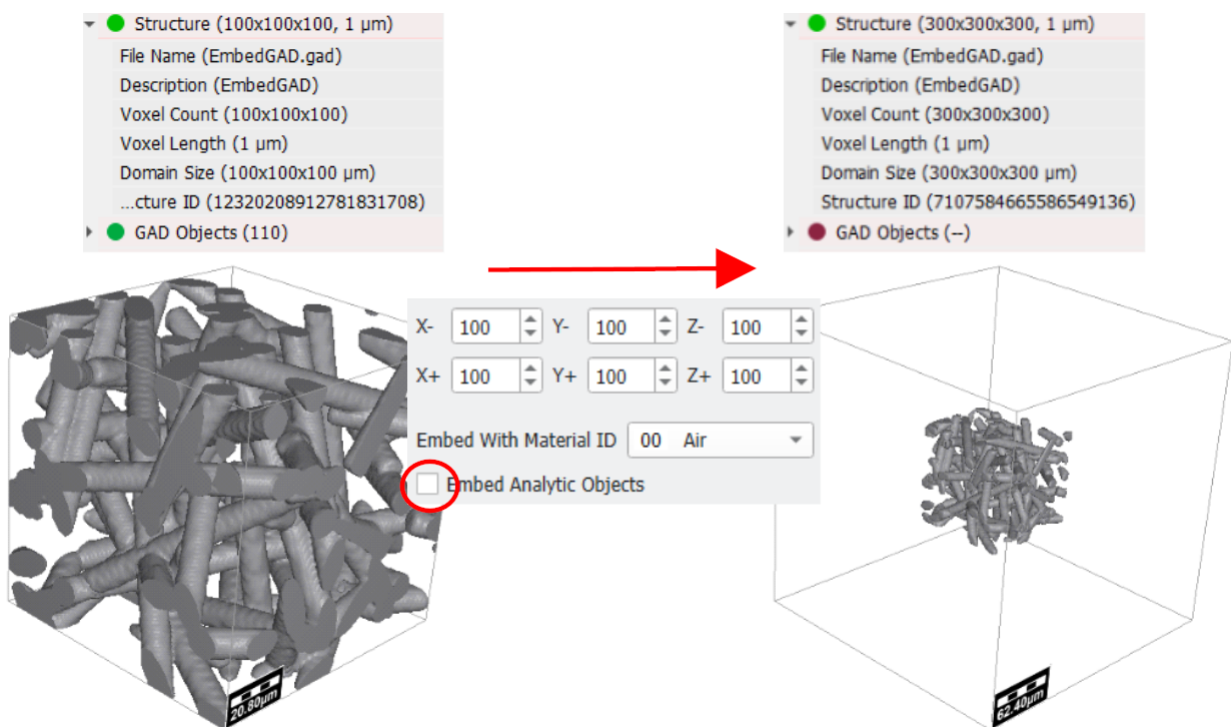
As noted above, in the project status section, a green dot in front of **GAD Objects** indicates that analytic data is in use. The dot changes to red when the structure's analytic information is lost and no GAD data is in memory. It is possible to keep the analytic information of the original structure by checking **Embed Analytic Objects**.

This is illustrated in the following example of a fibrous structure, where the fibers extend beyond the 100 x 100 x 100 domain. The analytic information of the fibers was saved in the file (see the green dot in front of GAD Objects in the status section). Observe the difference in embedding 100 voxels of Air (Material ID 00) in all directions (X+, X-, Y+, Y-, Z+, Z-) with and without **Embed Analytic Objects** used.

When the **Embed Analytic Objects** option is enabled, the analytical information of the fibers in the original GAD file is retained and the fibers can be seen penetrating the region of the embedded voxels.



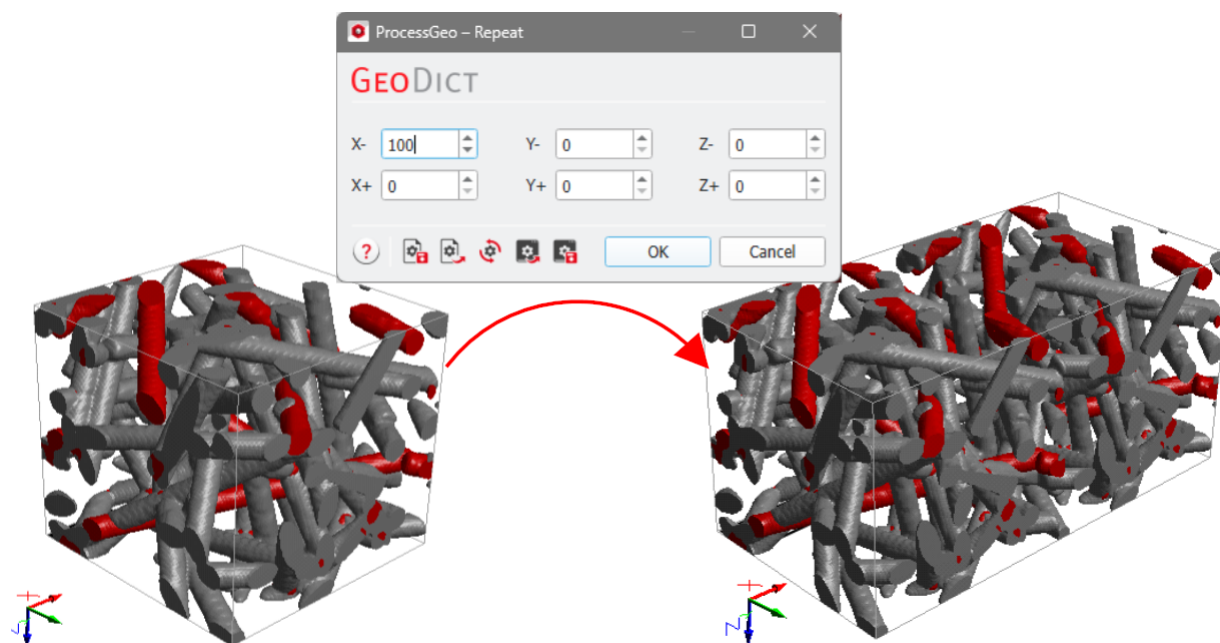
When the **Embed Analytic Objects** option is disabled, the analytical information of the fibers is lost. The fibers appear to end at the boundary of the newly embedded voxels.



1.1.3 Repeat

With **Repeat** the structure is repeated in the direction and by the values entered in the **X-**, **X+**, **Y-**, **Y+**, **Z-**, and **Z+** boxes.

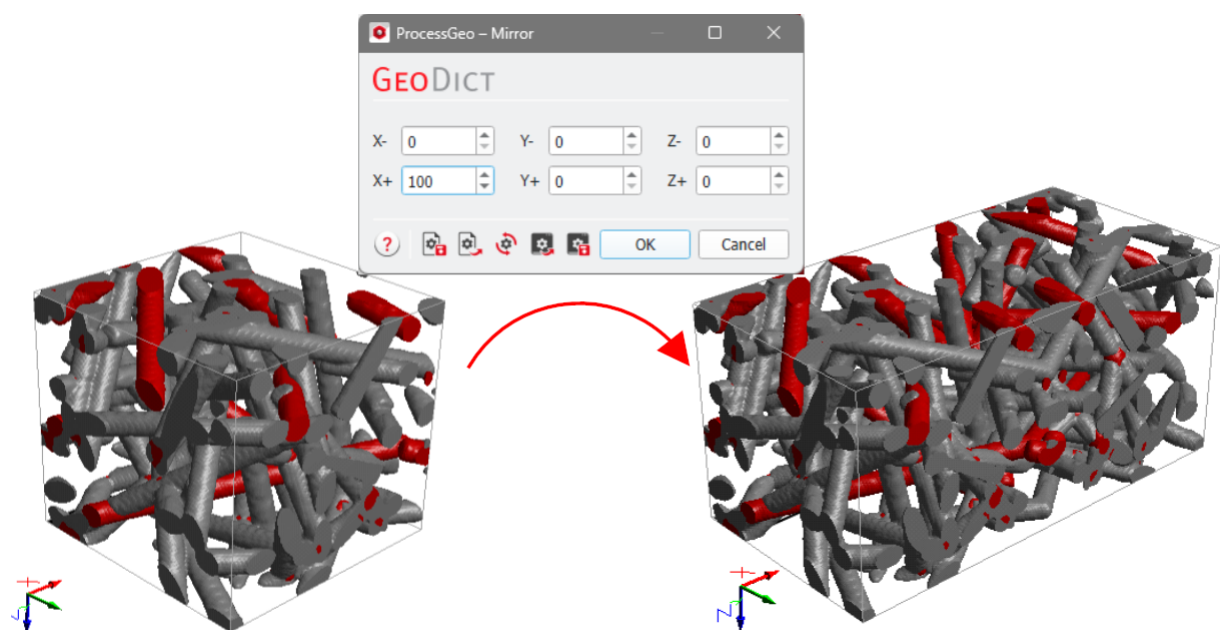
When you run the **Repeat** command, the structure's analytic information is always lost.



1.1.4 Mirror

With **Mirror**, a mirrored copy is added in the selected directions. The structure's size is increased by the values entered in the **X-**, **X+**, **Y-**, **Y+**, **Z-**, and **Z+** boxes. Thus, it is possible to mirror only the first voxel layers of a structure, or the complete domain.

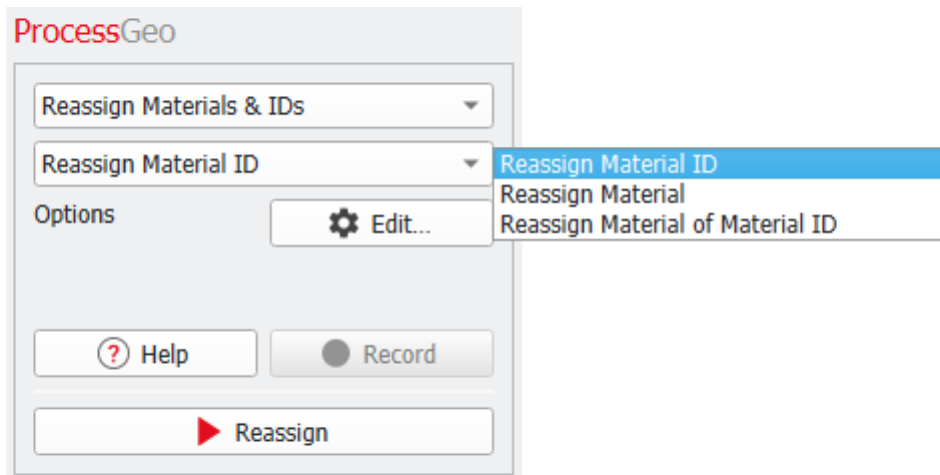
When you run the **Mirror** command, the structure's analytic information is always lost.



1.2 Reassign Materials & IDs

With **Reassign Materials & IDs**, materials and Material IDs in the structure can be changed to other materials or Material IDs.

Click the Options' **Edit...** button to modify the parameters of the selected command.

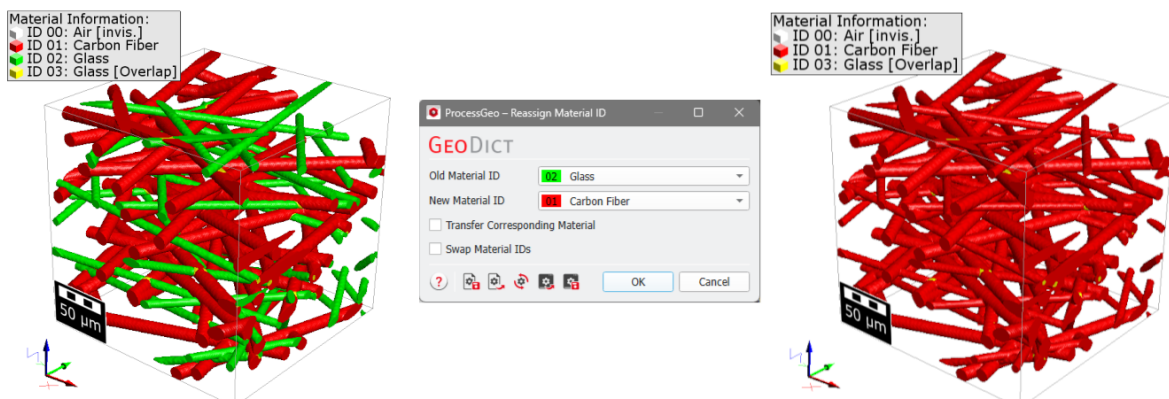


Commands available in the drop-down menu

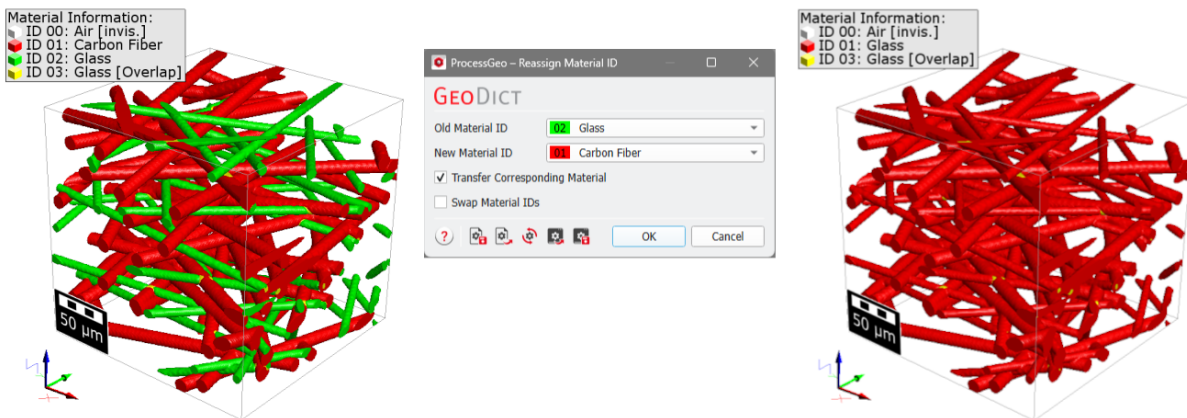
- [Reassign Material ID](#)^[10]
Assign a new Material ID to voxels of a given Material ID.
- [Reassign Material](#)^[11]
Assign a new material from the GeoDict Material Database to all voxels of a selected material.
- [Reassign Material of Material ID](#)^[12]
Reassign the material for a given Material ID, without changing the Material ID.

1.2.1 Reassign Material ID

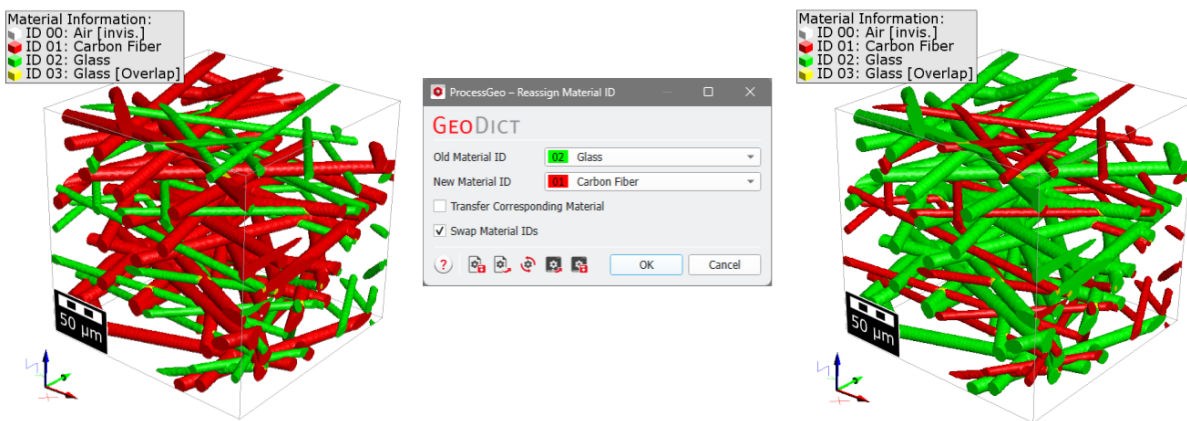
With **Reassign Material ID**, the Material ID of the corresponding voxels in the structure is changed. In the example shown below, the Material ID 02 is reassigned to the Material ID 01. No voxels with Material ID 02 remain in the structure, and it is not possible to distinguish which fibers belonged to which ID (01 or 02) after the reassignment.



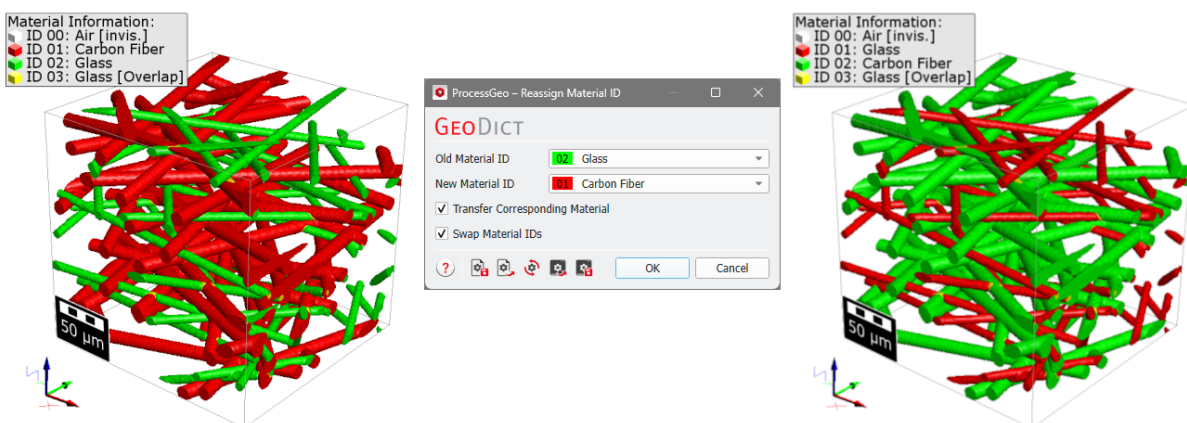
With the additional option **Transfer Corresponding Material** also the material of the new Material ID is changed to the material of the old Material ID.



Using **Swap Material IDs** allows to swap the old and new Material ID.

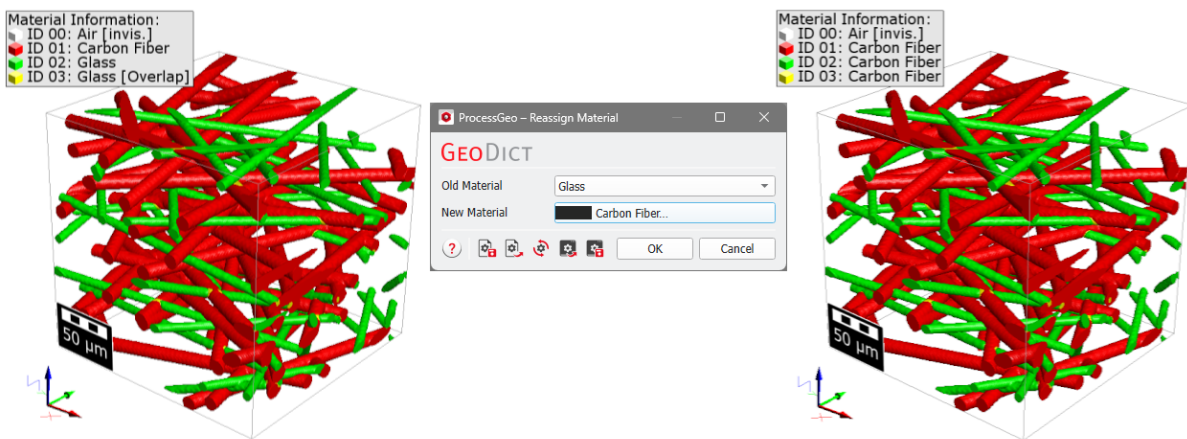


If additionally the option **Transfer Corresponding Material** is chosen, also the corresponding materials are swapped.



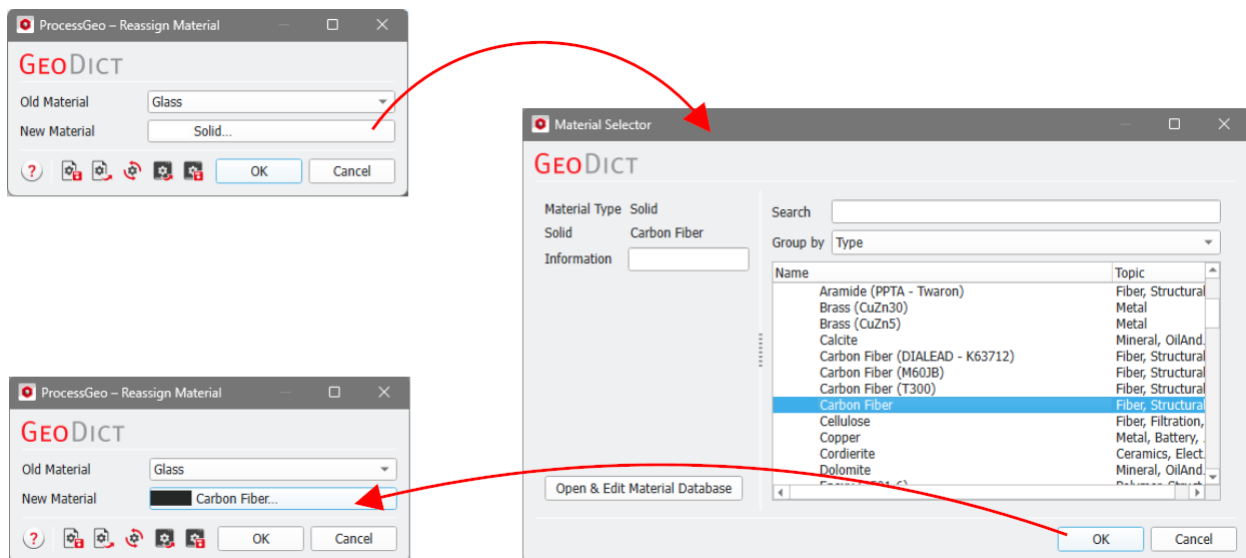
1.2.2 Reassign Material

With **Reassign Material**, a material in the structure is replaced by another material. This means that the material is changed for all Material IDs which are set to this material. In the example below, **Glass** is changed to **Carbon Fiber**.



The material to be changed can be selected from the **Old Material** drop-down menu, which lists all materials that are present in the currently loaded structure.

By clicking on the material name of **New Material**, the **Material Selector** opens and the desired new material can be chosen.



1.2.3 Reassign Material of Material ID

The alternative **Reassign Material of Material ID** corresponds to the option available in the **Select Constituent Materials** dialog. As shown in this example, the material is changed for one selected Material ID (here: *Carbon Fiber* to *Glass* for Material ID 01).

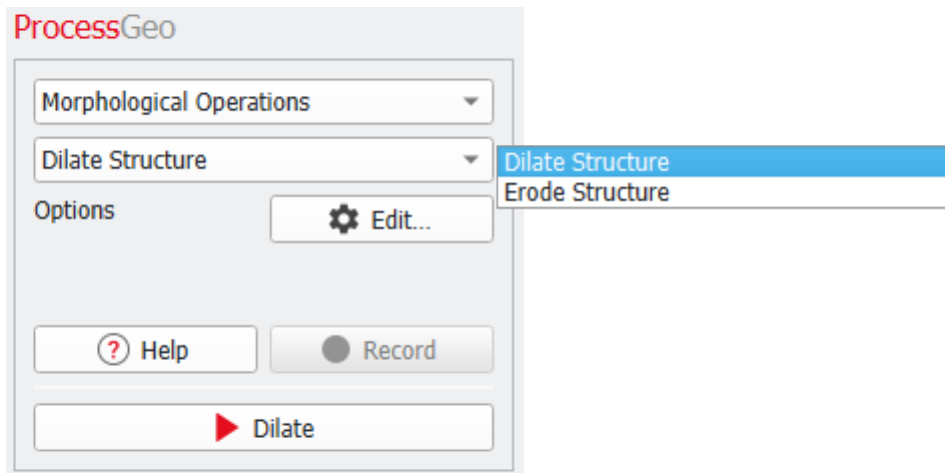


This command is especially helpful, if several Material IDs have the same material, but the material should only be changed for a certain Material ID.

1.3 Morphological Operations

With **Morphological Operations**, you can perform voxel-based **Dilate** and **Erode** operations on the current 3D structure.

Click the Options' **Edit...** button to modify the parameters of the selected command.

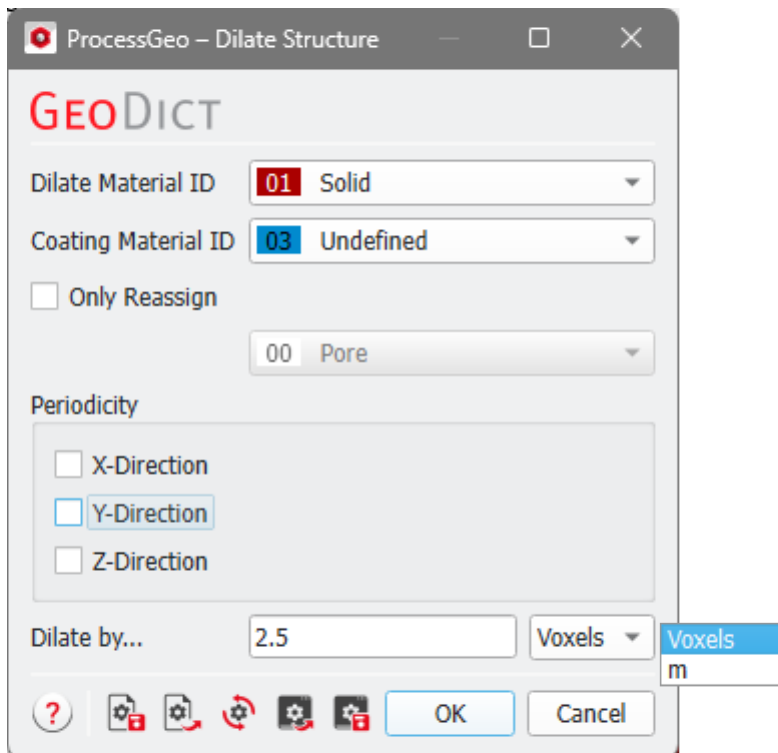


Commands available in the drop-down menu

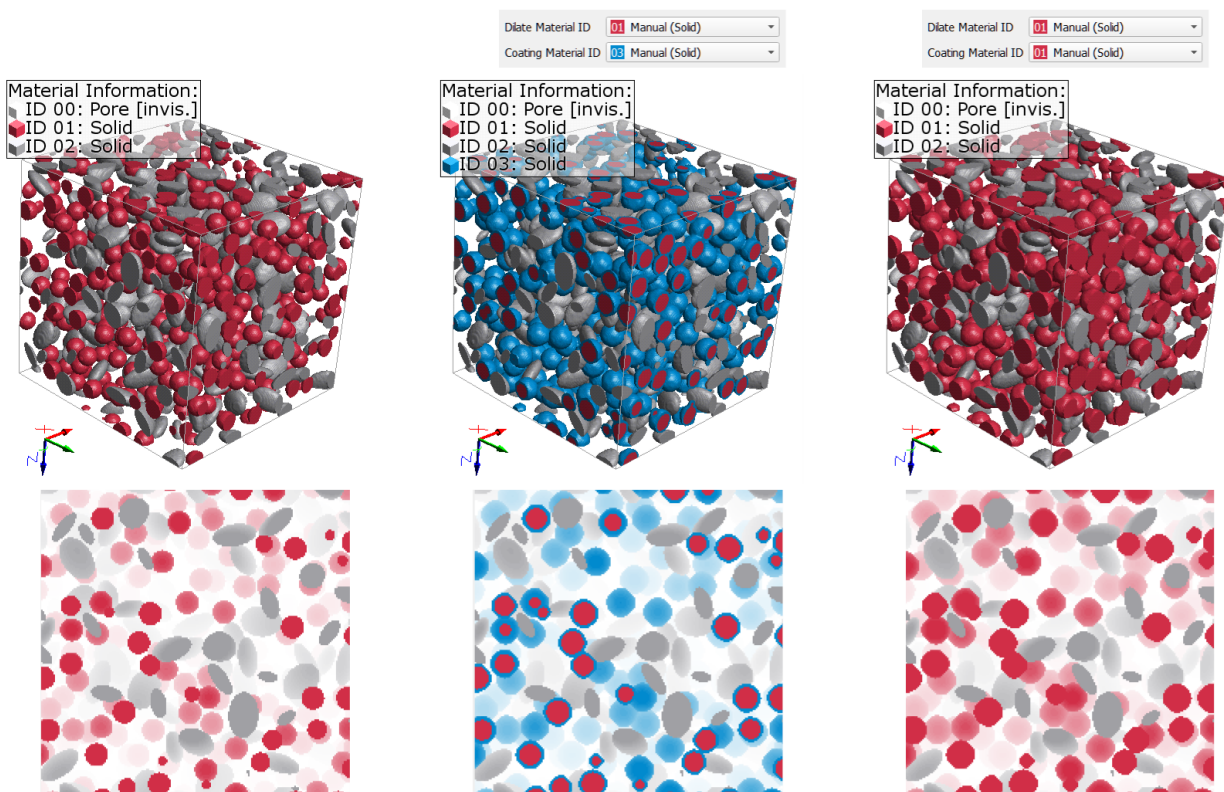
- [Dilate Structure](#)¹⁴
Coat objects in the structure with a certain Material ID.
- [Erode Structure](#)¹⁷
Eliminate solid material from the structure.

1.3.1 Dilate Structure

Dilate performs the morphological operation *Dilation* on the selected Material ID (**Dilate Material ID**) by the distance entered in **Dilate by...**. Be aware that the dilation distance does not need to be an integer number, even when it is given in the **Voxels** unit.

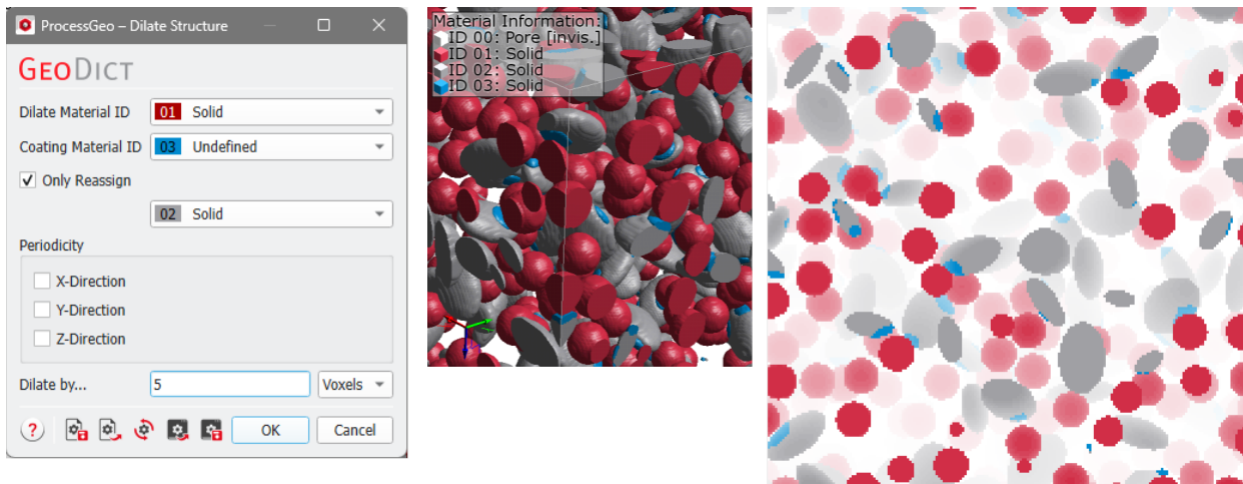


The dilation appears as a coating in the selected **Coating Material ID**. The coating material can be selected to be the same as the material to dilate, for example to increase the diameter of fibers or grains in the structure.

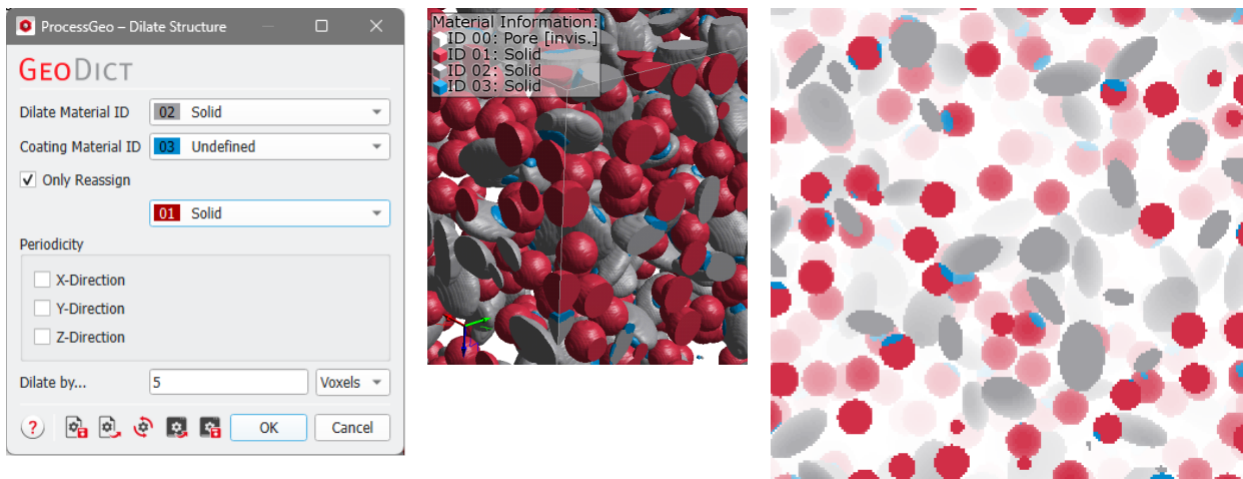


When checking **Only Reassign** and choosing a Material ID from the pull-down menu (e.g., ID 02), only voxels of this Material ID (here: gray) are replaced by voxels of the **Coating Material**

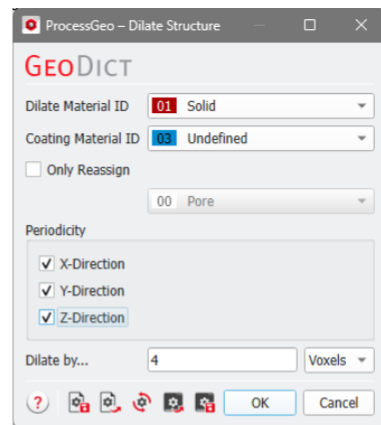
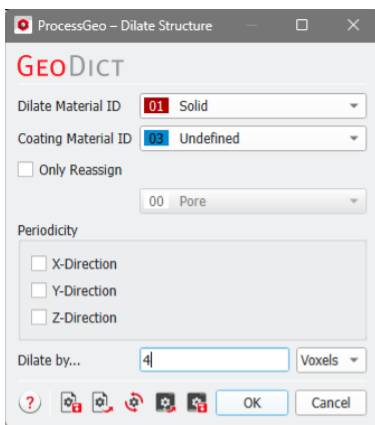
ID (e.g., ID 03, here: **blue**). This occurs only for gray voxels located at a certain distance or less (defined in **Dilate by...**, e.g., 5 voxels) from voxels of the **Dilate Material ID** (e.g., ID 01, here: **red**). The blue coating (03) appears only on some of the gray grains.



When the **Dilate Material ID** is changed to 02 (gray) and **Only Reassign** is chosen to be 01 (red), the blue coating (03) appears now only on some of the red grains.



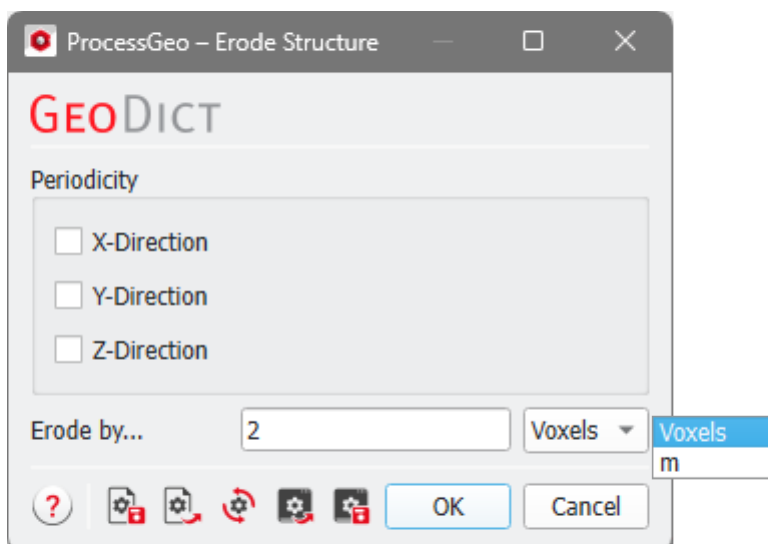
For periodic 3D-structure models, **Periodicity** can be applied either in **X-Direction**, **Y-Direction**, and/or **Z-Direction**. Checking none of the directions means that the structure is cut off at the boundary. For example, compare the effect of dilating periodically in all directions. When periodicity is applied, the blue coating of the red fiber continues on the opposite side of the domain (see the blue spot on the left side).



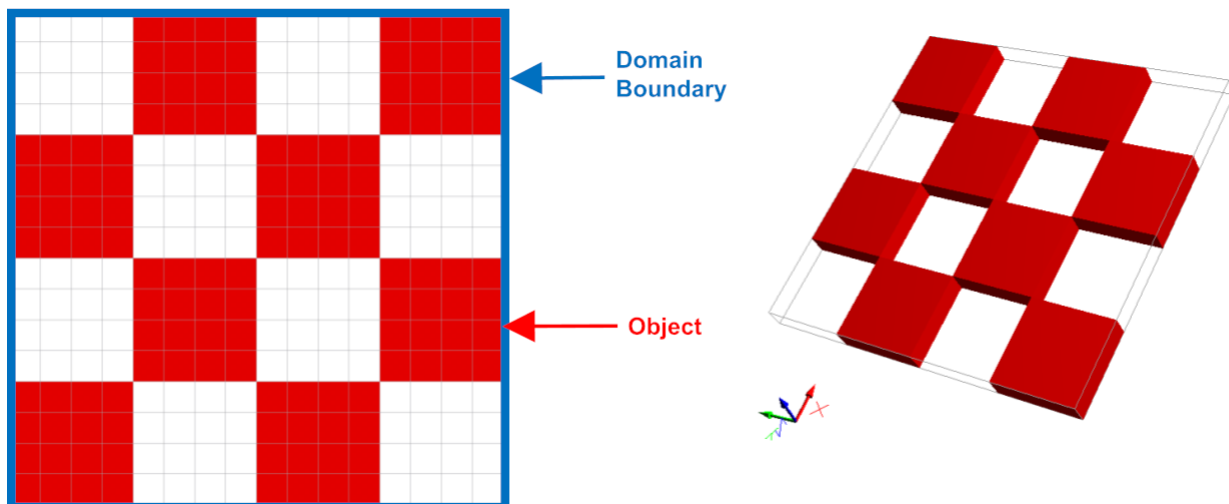
1.3.2 Erode Structure

An *Erosion* operation is done on all solid materials of the structure by the distance entered in **Erode by...**. Be aware that the erosion distance does not need to be an integer number, even when it is given in the **Voxels** unit.

The erosion can be applied also periodically in any of the three space directions.

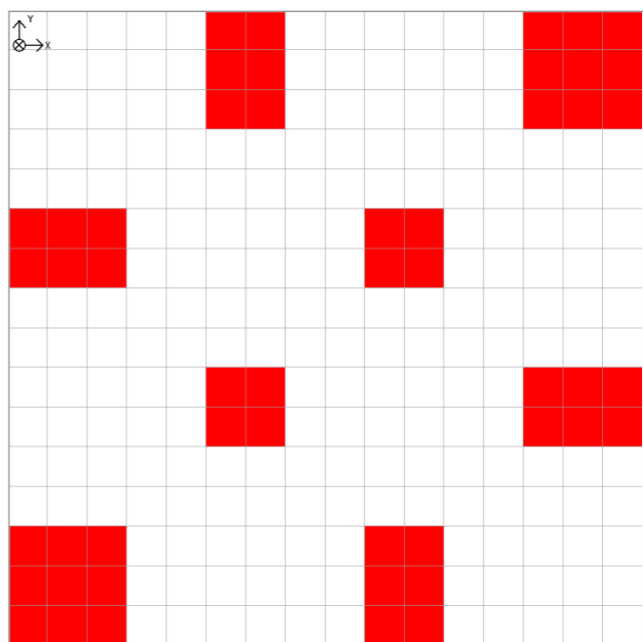
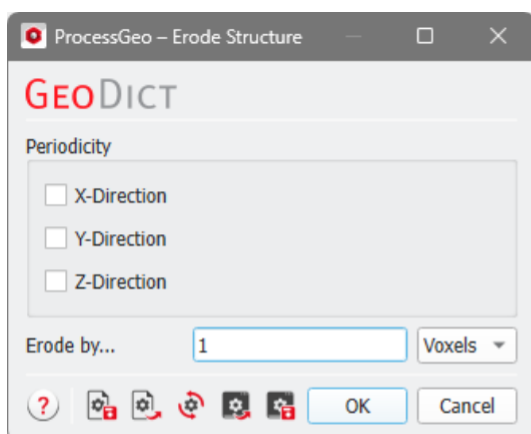


An example of erosion with and without periodicity is shown using the following (very simple) structure.

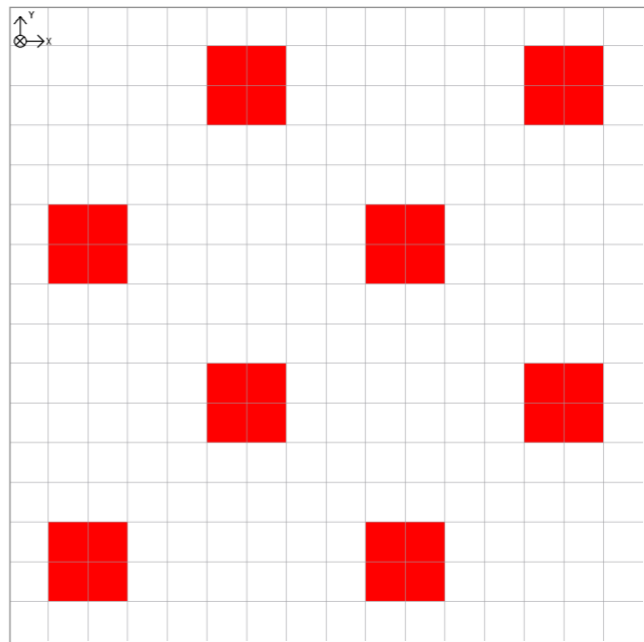
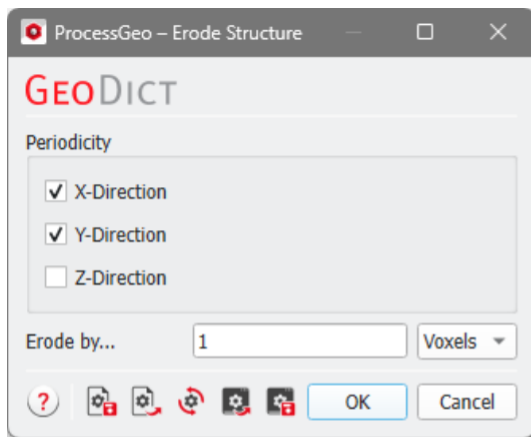


Each of the eight solid objects in the structure is made of 16 red voxels. Each group of solid voxels forming an object alternates with empty space (pore space) made of 16 white voxels.

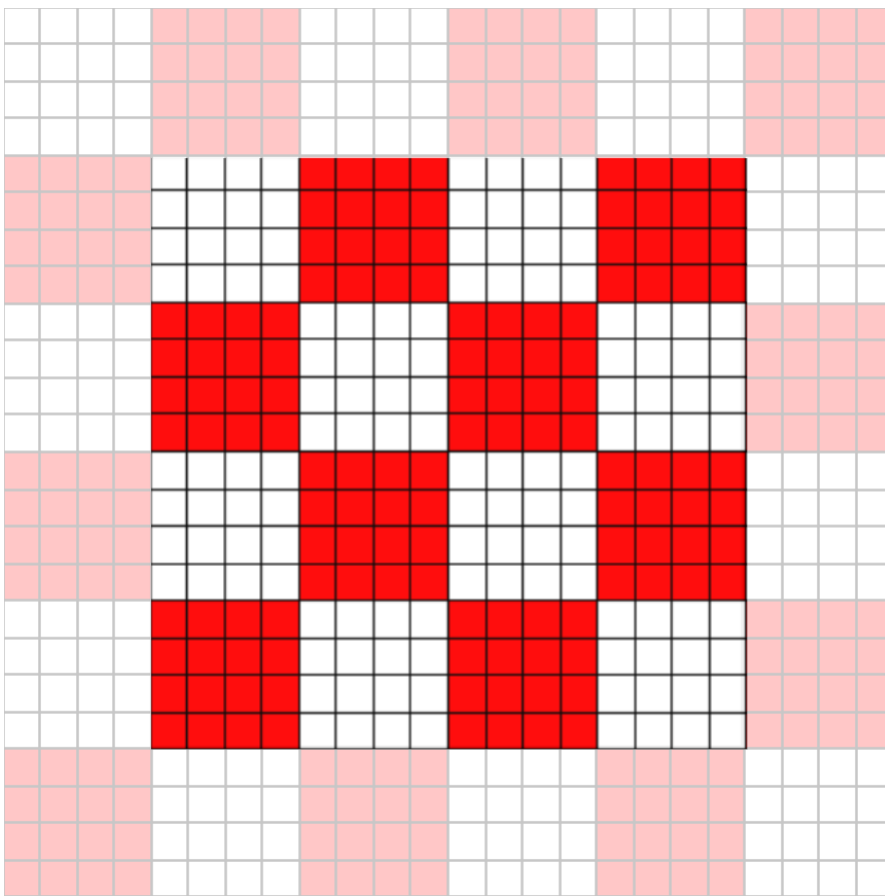
Without the **Periodicity** checkboxes selected, the solid objects (red) are eroded by 1 voxel anywhere an empty voxel (white) touches a solid voxel (red). However, at the boundaries of the domain, where no white voxels are present and no periodicity has been assigned, the red voxels are not eroded.



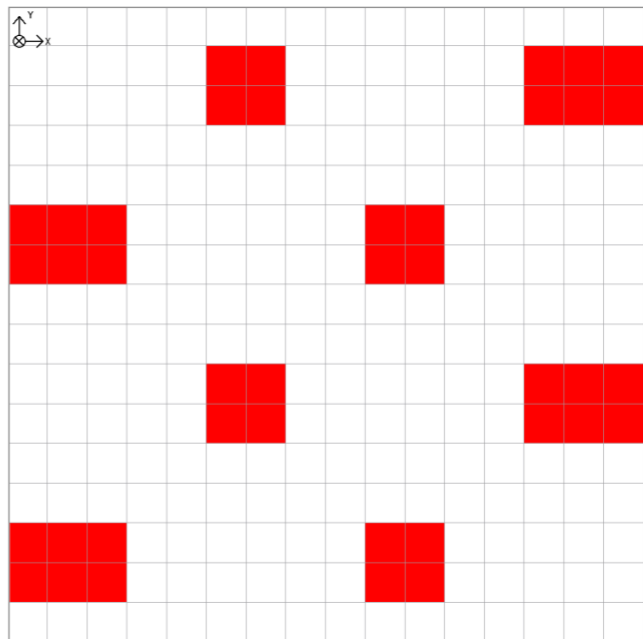
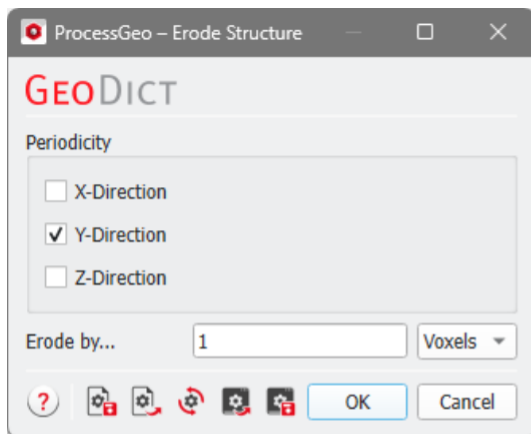
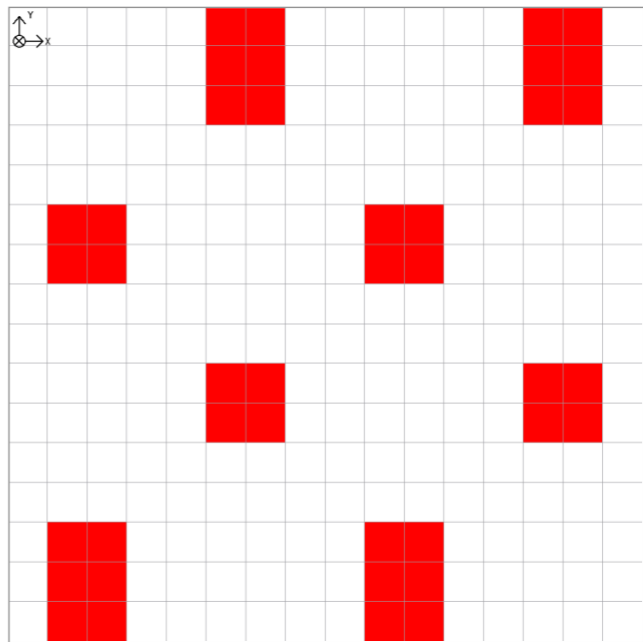
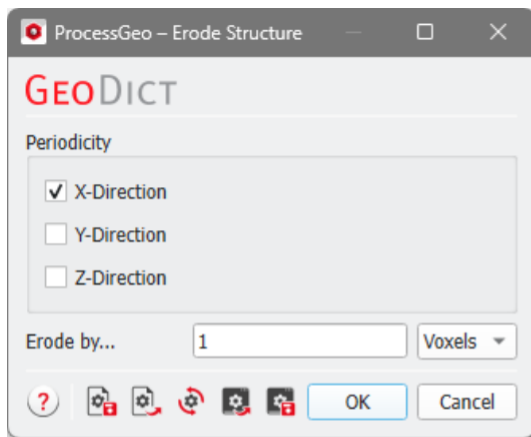
After setting the periodicity in X-Direction and in Y-Direction and choosing again to erode by 1 voxel, the objects are eroded also from the boundaries of the domain. This occurs because by setting this periodicity in X- and Y-Direction, it is assumed that beyond the domain boundaries there is a periodic copy of the complete structure.



In our example structure, this periodic copy places empty voxels (white) immediately adjacent to the solid voxels (red) of the example structure. These white voxels erode the red voxels at the domain boundary.

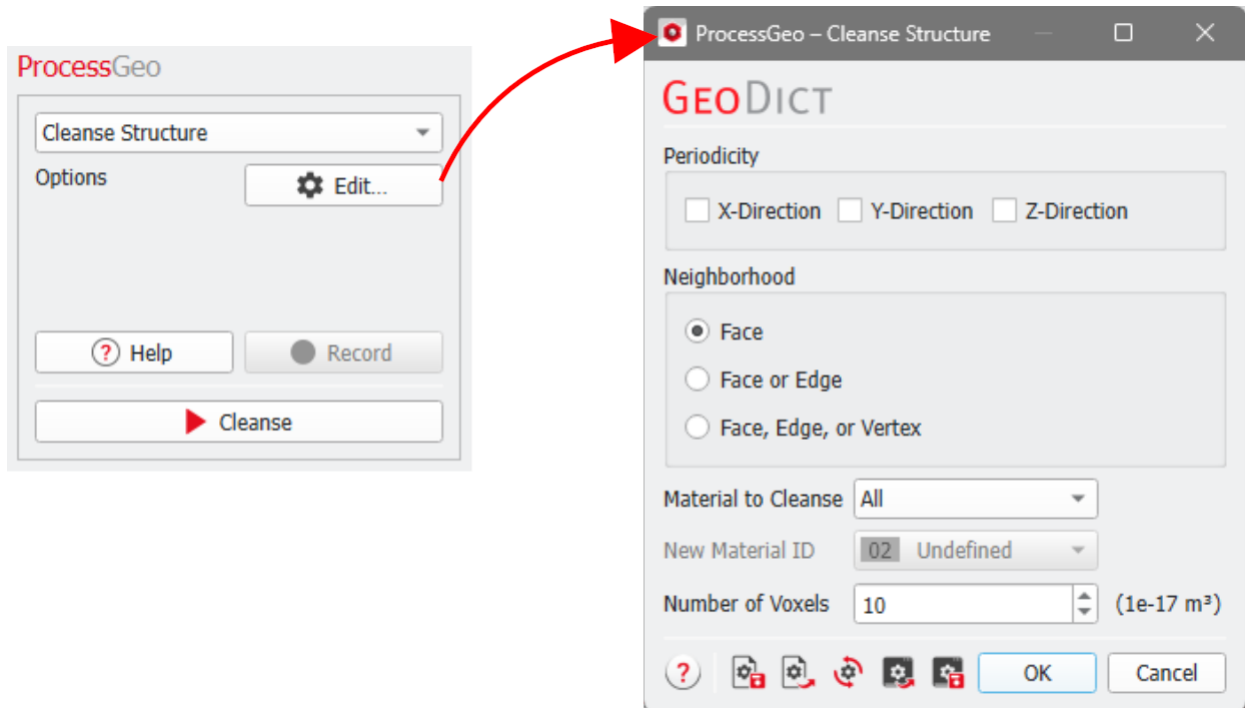


Finally, observe that by setting the periodicity only in X-Direction, or only in Y-Direction and choosing to erode by 1 voxel, the objects are eroded from the boundaries only in X-Direction or only in Y-Direction.



1.4 Cleanse Structure

Cleanse Structure removes small, unconnected components from the structure. It is well-suited for filtering out noise in a structure after a 3D gray-value image is imported and thresholded from a CT scan.



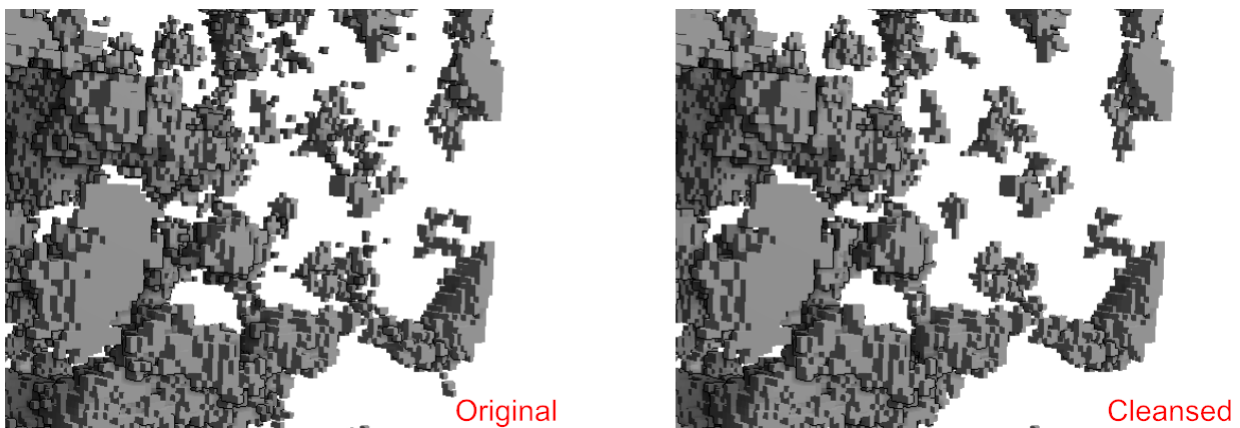
The structure can be cleansed with periodic boundary conditions in all directions, or only in the selected direction(s) (**Periodicity** in **X-Direction**, **Y-Direction**, and/or **Z-Direction**). If no direction is chosen, the structure is cleansed non-periodically.

The selections in the **Neighborhood** panel determine which voxels are detected as connected. Checking **Face** is more restrictive than choosing **Face or Edge**. The most permissive **Neighborhood** condition is **Face, Edge, or Vertex**.

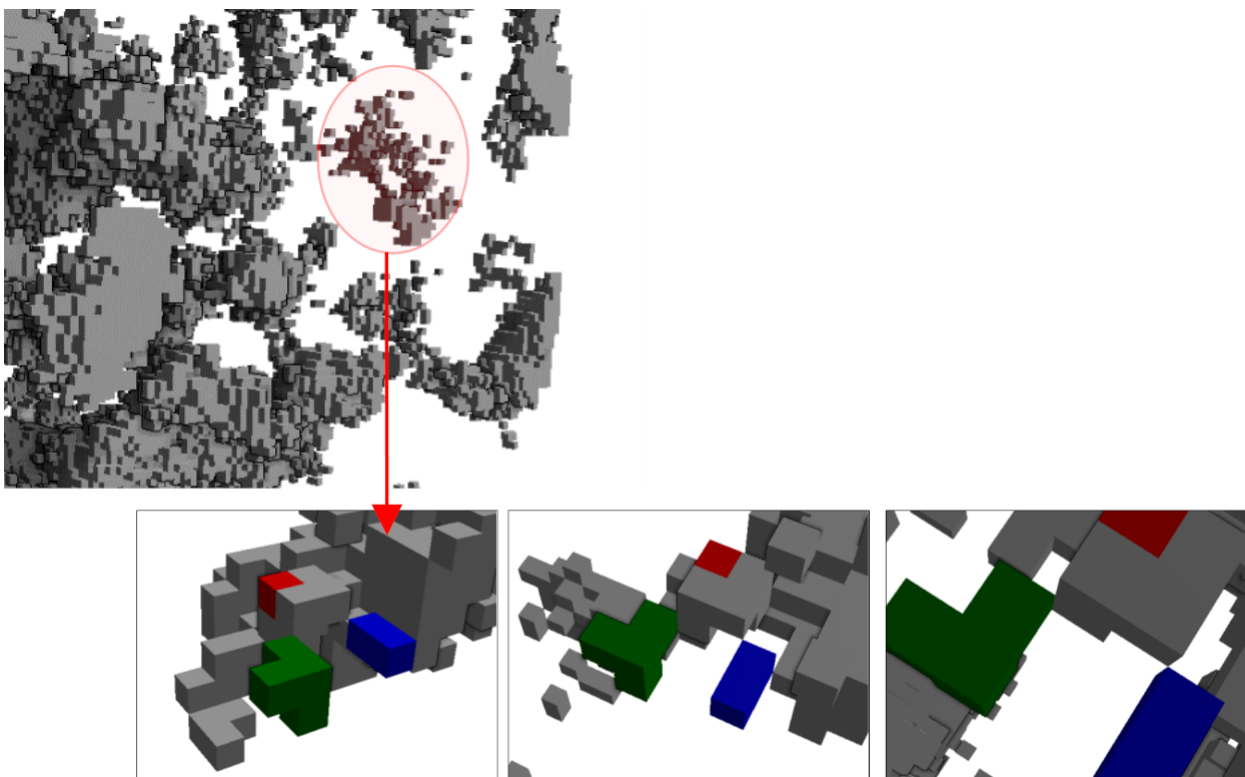
Select the Material ID of the connected components to be removed (**Material to Cleanse**) and the Material ID to be applied to the cleansed components (**New Material ID**). If the material to cleanse is set to **All**, the **New Material ID** is the Material ID of the largest surrounding connected component.

Cleansed are all connected components of the specified Material ID which contain only the given **Number of Voxels** or less.

In this example, **Cleanse Structure** is applied to an imported structure with high levels of noise in the CT image, leading to unwanted components. Here, it is shown how small unconnected components, with less than 10 voxels, are removed with the cleansing.



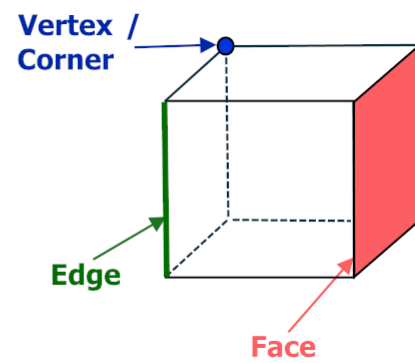
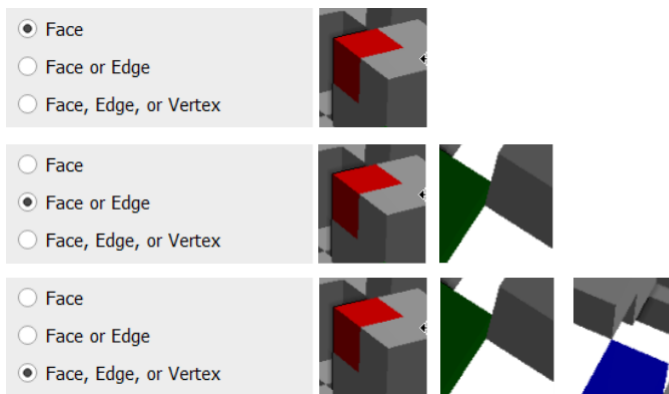
Taking a closer look at the original structure, we see examples for the different cases.



If we choose **Face**, only voxels connected with face contact to at least 10 other voxels (**Number of Voxels** option) remain. The red voxel shown above is connected to the other voxels by faces.

If we choose **Face or Edge**, also voxels connected to at least 10 other voxels over edges remain. The group of green voxels shown above is connected to the other voxels at the edges.

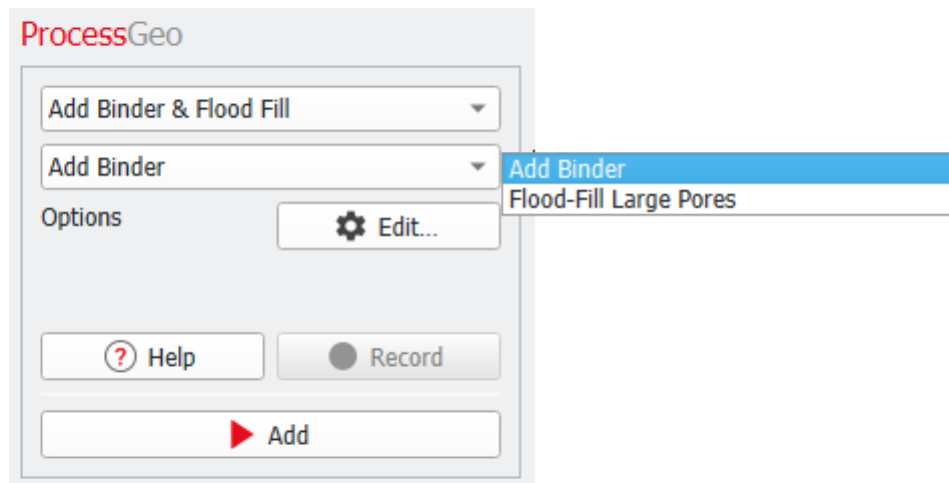
If we choose **Face, Edge, or Vertex**, also voxels connected to at least 10 other voxels over vertex / corner stay. The group of blue voxels shown above is connected to the other voxels at the vertex or corner.



1.5 Add Binder & Flood Fill

With **Add Binder & Flood Fill**, you can add material in the pore space of the current structure. Either, you can fill the small pores with a binding material, or you can fill the large pores of the structure with another material.

Click the Options' **Edit...** button to modify the parameters of the selected command.



Commands available in the drop-down menu

- [Add Binder](#)²⁴
Adding material in the shape of a concave meniscus in locations where objects in the structure model are close together.
- [Flood-Fill Large Pores](#)³⁹
Change the material in all pores that have a larger diameter than a specified value.

1.5.1 Add Binder

Adding binder to a structure means adding material in the shape of a concave meniscus in the pore space where surfaces in that structure's material get close together. If there is no pore material in the structure, a warning is given.

For hollow objects, such as cellulose fibers, curved cellulose fibers, hollow fibers, curved hollow fibers, and hollow spheres, the algorithm under **Add Binder** needs analytic data (**GAD objects**) to discern that the empty voxels inside the fibers are not part of the pore space. Without analytic data, i.e., when using voxelized models, binder is also added inside the hollow fibers, which is physically inaccurate.

Topics of Add Binder

- [Options](#)²⁵
Define the Add Binder parameters.
- [Results](#)³⁷
View the Add Binder results.

Options

Clicking the **Options' Edit...** button opens the **Add Binder** dialog.

Result File Name (*.gdr) AddBinder.gdr

General Options Binder Distribution

Stopping Criterion Solid Volume Percentage

Added Solid Volume Percentage / (%) 10

Binder Material (ID 02) Binder (Solid)...

Contact Angle / (°) 0

Binder Anisotropy Factor 1

Periodicity

☐ X-Direction ☐ Y-Direction ☐ Z-Direction

☒ Apply Solid Volume Percentage Correction after Iterations

At the top of the **Add Binder** dialog, the name for the file containing the results of adding binding can be entered in the **Result File Name (*.gdr)** box. The default name can be kept, or a new name can be chosen, fitting the current project.

Clicking **OK** in it closes the dialog and returns to the module section. Clicking **Generate** starts the process.

The parameters are organized in the following tabs:

- [General Options](#)²⁵
Define shape and material of the binder.
- [Binder Distribution](#)³⁴
Define how the binder should be distributed throughout the domain.

General Options

Define the general options, as the amount of binder to be added, the material and stopping criteria.

General Options

Binder Distribution

Stopping Criterion

Solid Volume Percentage

Added Solid Volume Percentage / (%)

10

Binder Material (ID 02)

 Binder (Solid)...

Contact Angle / (°)

0

Binder Anisotropy Factor

1

Periodicity

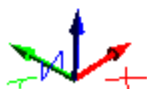
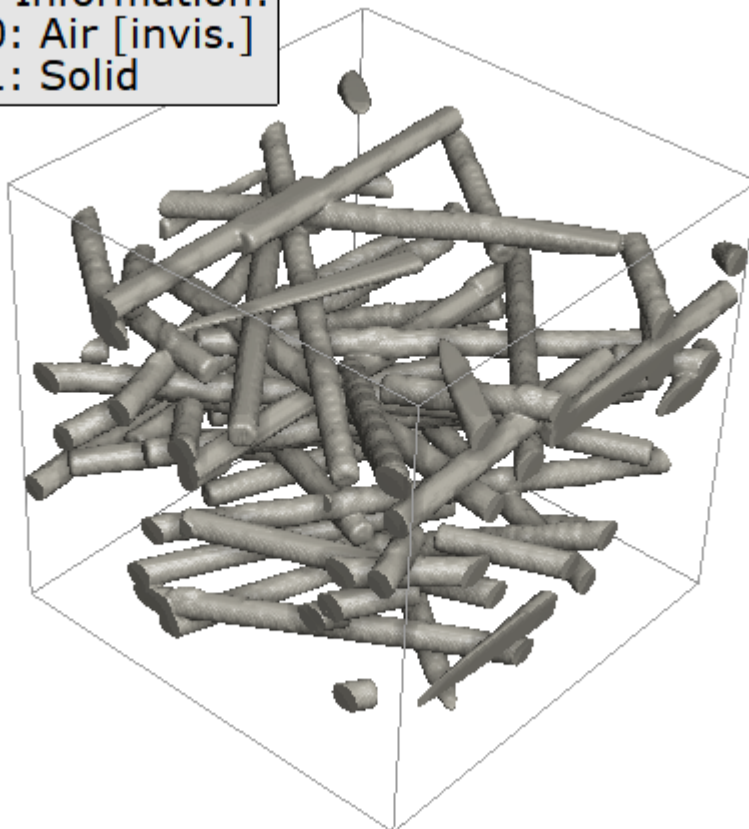
☐ X-Direction
 ☐ Y-Direction
 ☐ Z-Direction

☒ Apply Solid Volume Percentage Correction after Iterations

Stopping Criterion

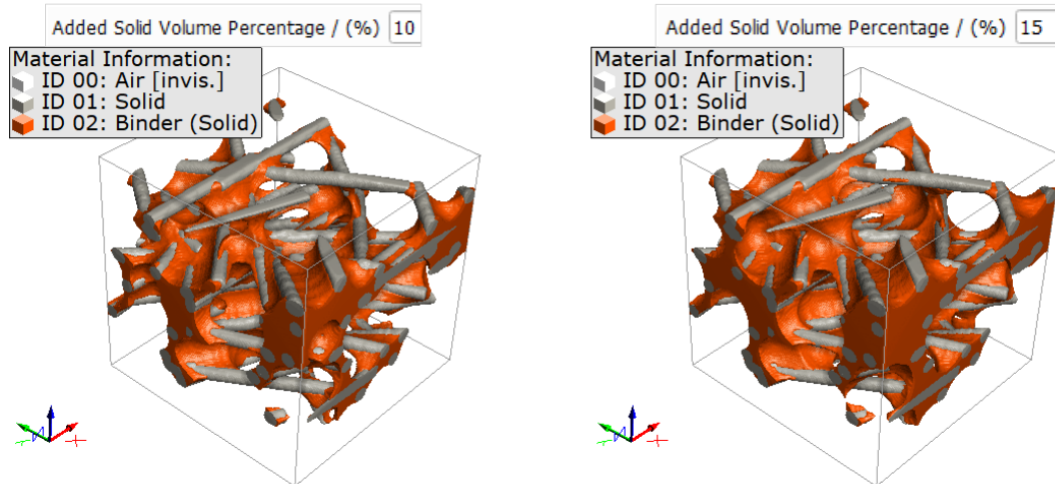
You may choose the most practical stopping criterion when adding binder. The chosen **Stopping Criterion** interrupts the addition of binder when it is reached. The possible stopping criteria are **Solid Volume Percentage**, **Weight Percentage**, and **Grammage**.

Material Information:
 ID 00: Air [invis.]
 ID 01: Solid



✓ Solid Volume Percentage

The process is stopped if the binder volume reaches the desired **Added Solid Volume Percentage**.



✓ Weight Percentage

The process is stopped if the weight of binder reaches a certain percentage of the weight of material. See [below](#) ²⁸ how to select a material for the binder.

It is necessary to set the density for the structure's material (**Material Density**) and for the binder material (**Binder Density**) both in g/cm³, as well as the desired (weight) percentage of binder material to structure material (**Binder Weight Percentage**, in %). That is, a binder weight percentage of 20 means that there are 20 g of binder added per 100 g of objects in the structure.

Stopping Criterion	Weight Percentage
Binder Weight Percentage / (%)	20
Material Density / (g/cm ³)	1
Binder Material (ID 02)	 Binder (Solid)...
Binder Density / (g/cm ³)	2.70009

In the following example, two types of binder (high density: 5 g/cm³ and low density: 0.5 g/cm³) are added to a structure material with a density of 1.1399 g/cm³. Setting a binder weight percentage of 20% (20 g binder/100 g objects), the amount of binder material deposited is much larger when the binder is less dense.

Material Information:
ID 00: Air [invis.]
ID 01: Solid
ID 02: Binder (Solid)

Material Information:
ID 00: Air [invis.]
ID 01: Solid
ID 02: Binder (Solid)

Stopping Criterion: Weight Percentage

Binder Weight Percentage / (%) 20

Material Density / (g/cm³) 1.1399

Binder Material (ID 02) Binder (Solid)...

Binder Density / (g/cm³) 5

Stopping Criterion: Weight Percentage

Binder Weight Percentage / (%) 20

Material Density / (g/cm³) 1.1399

Binder Material (ID 02) Binder (Solid)...

Binder Density / (g/cm³) 0.5

For **Weight Percentage**, when **Manual** or **Undefined** are selected, you must enter the density of the binder (**Binder Density (g/cm³)**). If a material is selected from the database, the **Binder Density** of the binder material is automatically entered. If a manual material is used frequently, it is useful to save it to the material database.

✓ Grammage

The addition of binder stops when the **Added Grammage** (material and binder, g/m²) is reached.

See [below](#) , how to select a material for the binder.

Stopping Criterion Grammage

Added Grammage / (g/m²) 10

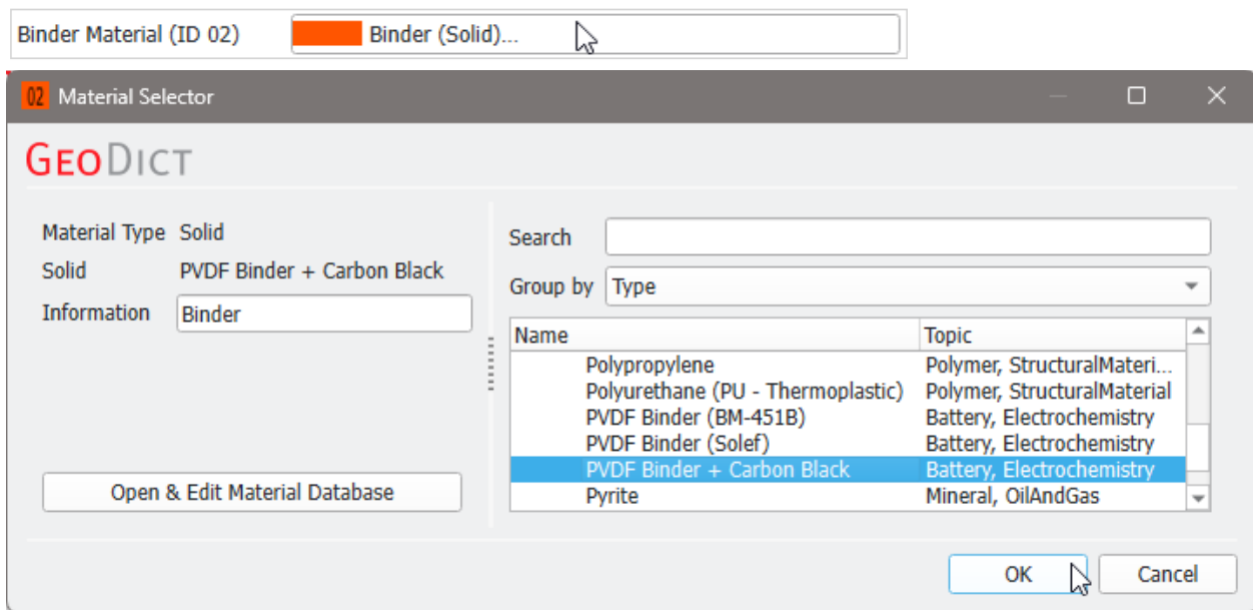
Binder Material (ID 02) Binder (Solid)...

Binder Density / (g/cm³) 2.7

For grammage, when manual or undefined are selected, the density of the binder is not automatically taken from the database and you must enter it manually (**Binder Density (g/cm³)**). If a manual material is used frequently, it is useful to save it to the material database.

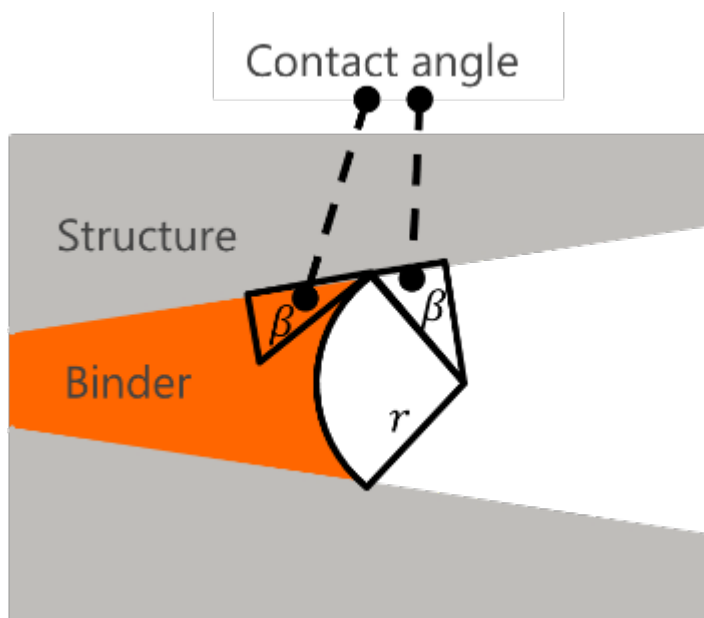
Binder Material

The **Binder Material** is assigned to the next available Material ID, and the appropriate material to be used as binder should be selected from the material database by clicking the button.



Contact Angle

The **Contact Angle** defines the angle in which the binder is deposited in relation to the materials in the structure. Values between 0° and 60° are accepted. When entering values larger than 60°, the value will be changed to 60° automatically. The contact angle helps to optimize and realistically model the addition of binder.



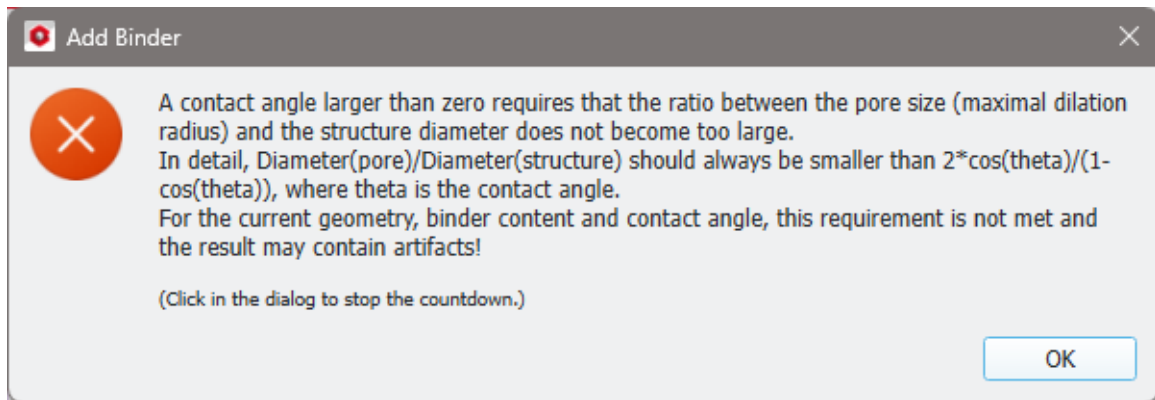
✓ Requirements for large contact angles

The contact angle must fulfill the following requirement:

$$\frac{\text{Diameter(Pore)}}{\text{Diameter(Structure)}} < \frac{2 \cos(\theta)}{1 - \cos(\theta)}$$

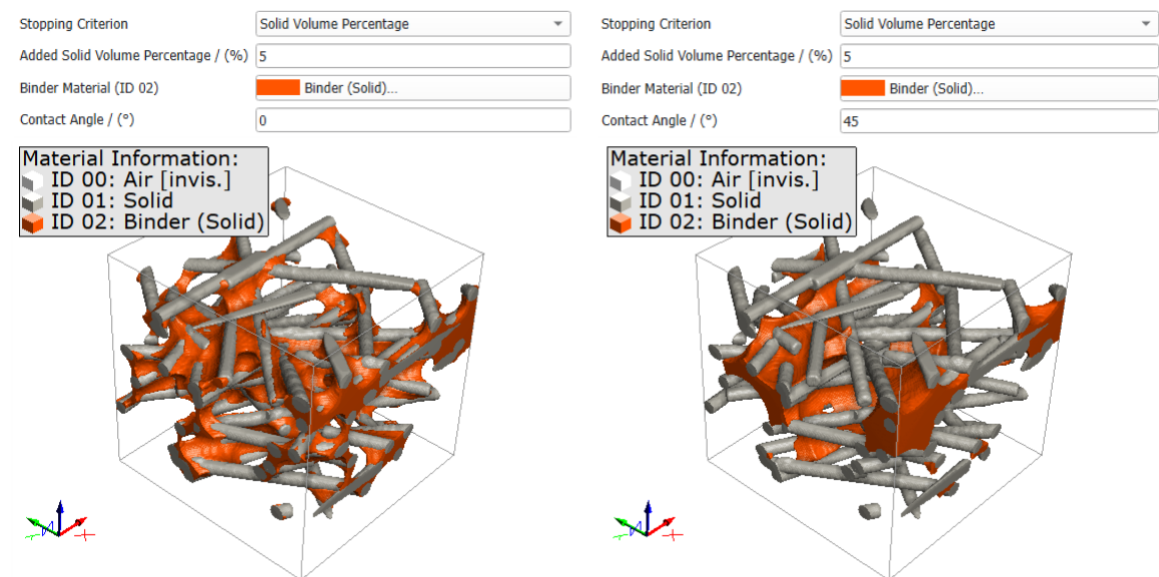
(1) Contact Angle Requirement

where θ is the contact angle and Diameter(Pore) means the maximal dilation radius. If this requirement is not met, a warning message appears. It is recommended to inspect the resulting structure to detect artifacts.



✓ Contact Angle Example

Observe the effect of adding binder with a **Contact Angle** of 0° or 45°.



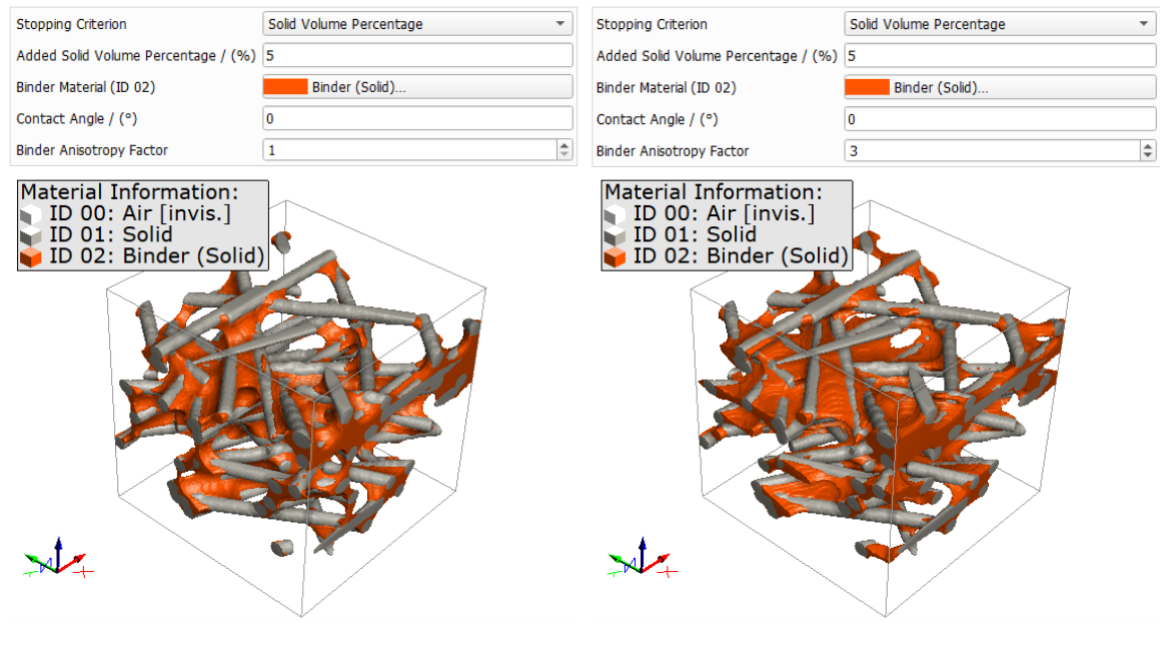
Binder Anisotropy Factor

The **Binder Anisotropy Factor** allows to control the grade of binder anisotropy in the X-Y-plane. If the factor is the default value of 1, the binder is distributed isotropically. By choosing larger values, the binder is distributed in the XY-plane but then, the contact angle value is not

accurate anymore.

✓ Binder Anisotropy Factor Example

Observe the effect of changing the **Binder Anisotropy Factor** from (the default) 1 to 3 when adding binder. With a binder anisotropy factor of 3, the binder is added in the direction of the XY-plane.



Periodicity

When the 3D-structure model is periodic in one or more directions, the binder can be added periodically: in all directions, only in the selected direction (**Periodic X**, **Periodic Y** and/or **Periodic Z**), or non-periodically. Adding binder periodically in certain direction(s) only makes sense if the 3D-structure model is periodic in that/those direction(s).

Periodicity

☐ X-Direction ☐ Y-Direction ☐ Z-Direction

Apply Solid Volume Percentage / Weight Percentage / Grammage Correction after Iterations

The algorithm adds binder until the iteration stops according to the given stopping criterion. Thus, the given value for **Solid Volume Percentage** / **Weight Percentage** / **Grammage** is usually not reached precisely and there are few cases, where the algorithm even does not converge.

If the amount of binder should be reached perfectly, it can be corrected by checking **Apply**

Solid Volume Percentage Correction after Iterations, Apply Weight Percentage Correction after Iterations or **Apply Grammage Correction after Iterations** depending on the chosen stopping criterion.

Selecting this option adds or removes binder surface voxels after the iterations are stopped until the given binder value is reached precisely.



Important! Using the correction feature reduces the **Contact Angle** precision.

General Options

Binder Distribution

Stopping Criterion

Solid Volume Percentage

Added Solid Volume Percentage / (%)

5

Binder Material (ID 02)

 Binder (Solid)...

Contact Angle / (°)

0

Binder Anisotropy Factor

1

Periodicity

☐ X-Direction
 ☐ Y-Direction
 ☐ Z-Direction

☒ Apply Solid Volume Percentage Correction after Iterations

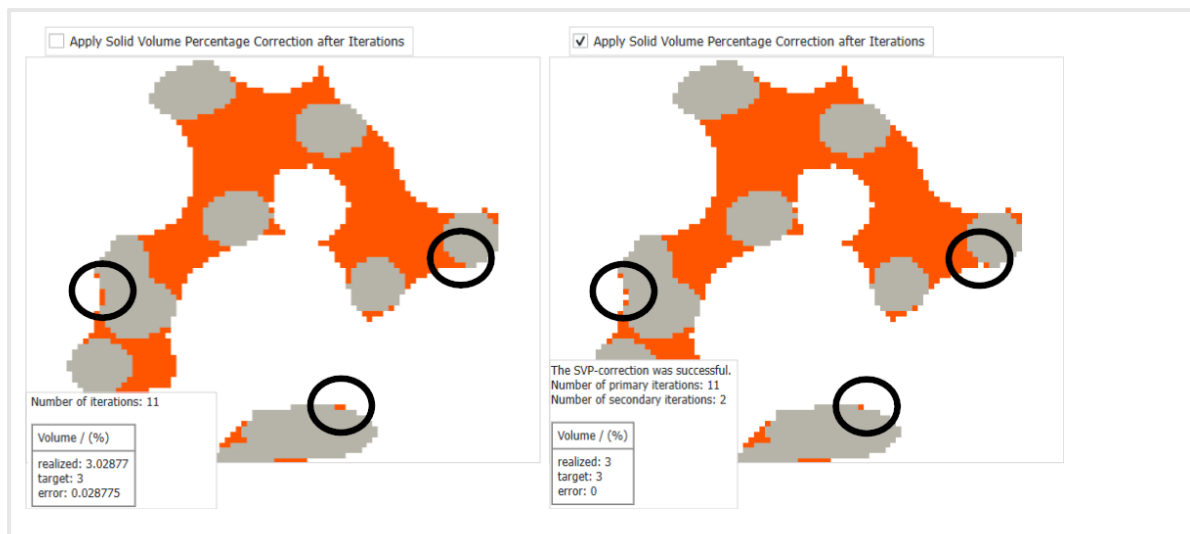


☒ Apply Weight Percentage Correction after Iterations

☒ Apply Grammage Correction after Iterations

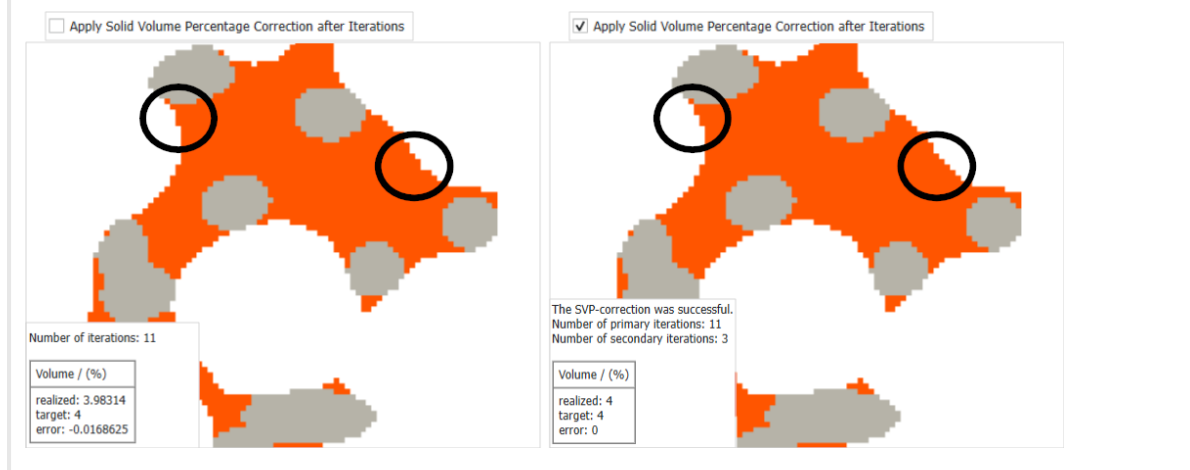
✓ Binder amount larger than target

If the realized amount of binder after the iterations is larger than the target value, voxels are removed from exposed positions, i.e., voxels with only one contact to another binder voxel.



✓ Binder amount smaller than target

In the other case, if the amount of binder is smaller than the target value, the algorithm adds voxels on positions with the most binder voxel neighbors.



✓ Algorithm

In detail, the algorithm applies small dilations and erosions to keep a smooth surface. In detail four steps are performed:

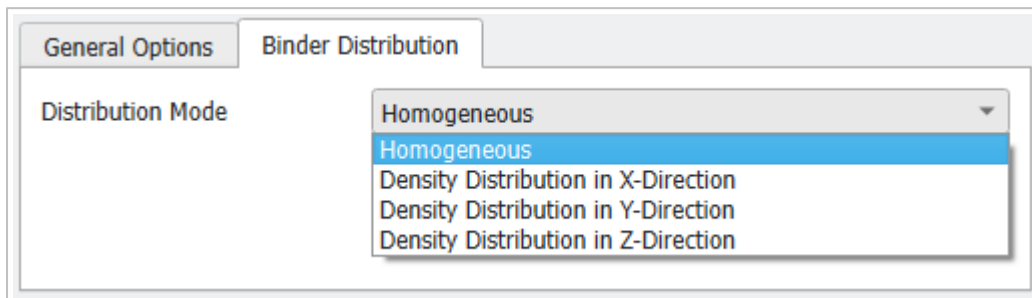
1. First, a voxel-zone at the surface is defined by the smallest possible dilation / erosion.
2. Within this voxel zone the algorithm again applies dilations / erosions. This reduces the voxel zone further.
3. Afterwards only a small surface layer remains that is maximal one voxel thick.
4. These remaining voxels are randomly reassigned.

The random reassignment is done to prevent biased change of the curvature.

Binder Distribution

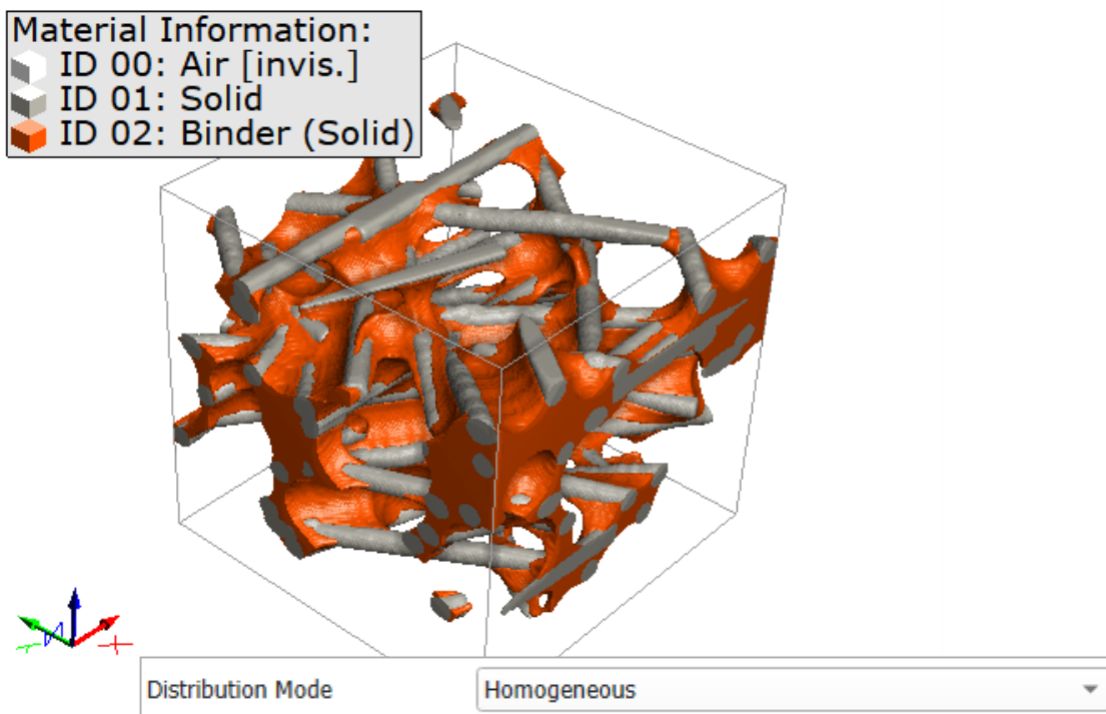
In real life, the process of adding binder to the material is affected by gravity and the viscosity of the binder, leading to inhomogeneous distributions. This effect can be modeled by defining a distribution of the binder under the **Binder Distribution** tab.

The binder either can be distributed homogeneously throughout the domain or follow a distribution in X-, Y- or Z- direction.



Homogeneous

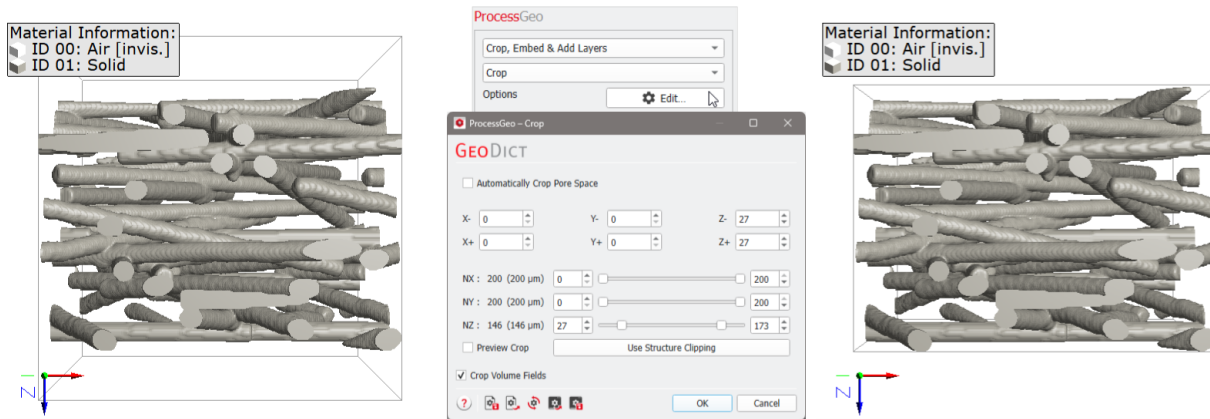
The default distribution is **Homogeneous**, but it can be changed to a **Density Distribution** to allow the modeling of inhomogeneity. For the default case, the binder is distributed homogeneously throughout the domain.



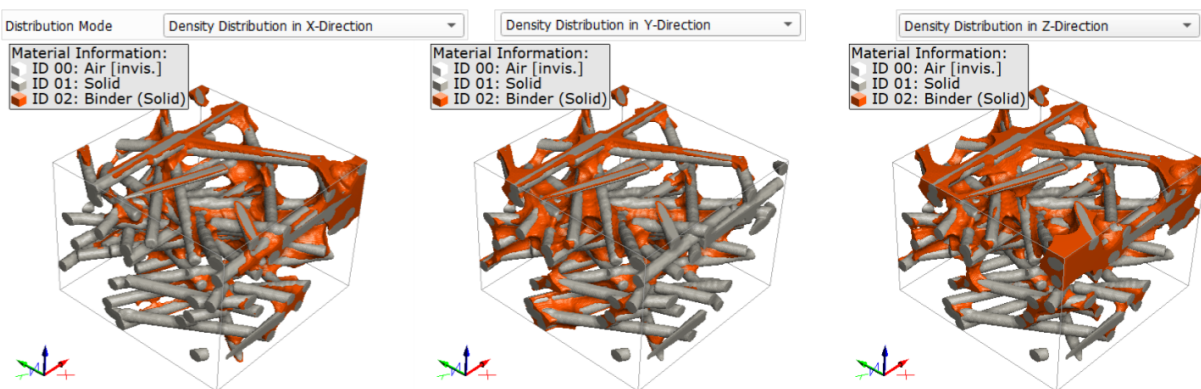
Density Distribution

To model a **Density Distribution**, no inlet or outlet should be left in the structure. If the

structure has an inlet or outlet in the chosen direction, remove it by cropping with **Model - ProcessGeo - Crop, Embed & Add Layers - Crop**. This is necessary because the algorithm strives to reach the desired binder amount for each sub-segment and will try to add binder in the empty domain. Alternatively, the amount of binder might be set to zero for these segments.



Select the direction for the desired density distribution.



In the examples we consider a density distribution in Z-direction. Then, the **Number of Rows** defines the number of Z-segments. To change the number of segments, change the **Number of Rows** to the number of segments desired.

Distribution Mode: Density Distribution in Z-Direction

Z-layer (Z _{min} , Z _{max})	Relative Density
Z-layer 1 (0 , 16)	0
Z-layer 2 (16 , 32)	0.25
Z-layer 3 (32 , 48)	0.5
Z-layer 4 (48 , 64)	0.75
Z-layer 5 (64 , 81)	1
Z-layer 6 (81 , 97)	1.25
Z-layer 7 (97 , 113)	1.5
Z-layer 8 (113 , 129)	1.75
Z-layer 9 (129 , 146)	2

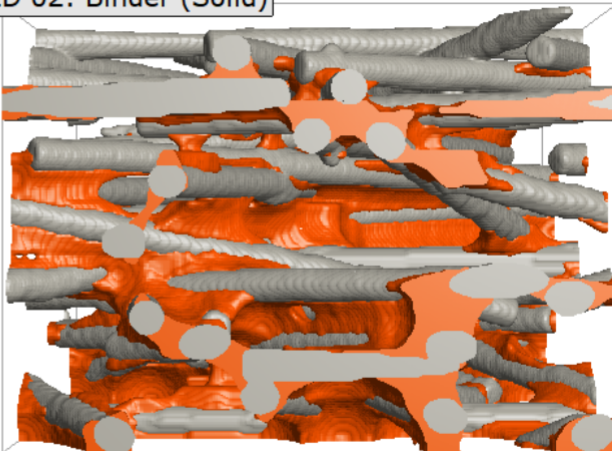
Probability Sum: Normalize

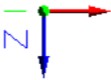
Number of Rows: 9

Load... Save...

Material Information:

- ID 00: Air [invis.]
- ID 01: Solid
- ID 02: Binder (Solid)





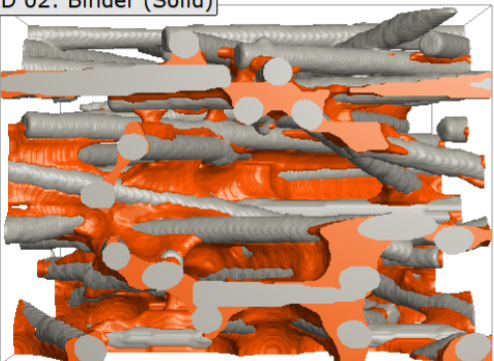
Z

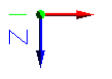
In each section the binder is generated separately according to the rules defined in the **General Options** tab. The **Added Solid Volume Percentage / (%)** is scaled with the normalized **Relative Density** given in the table of **Binder Distribution**.

Added Solid Volume Percentage / (%) 5

Material Information:

- ID 00: Air [invis.]
- ID 01: Solid
- ID 02: Binder (Solid)



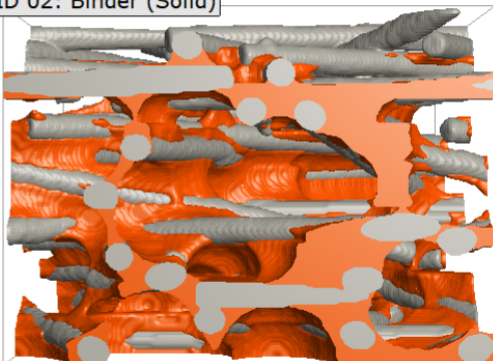


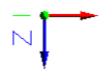
Z

Added Solid Volume Percentage / (%) 10

Material Information:

- ID 00: Air [invis.]
- ID 01: Solid
- ID 02: Binder (Solid)

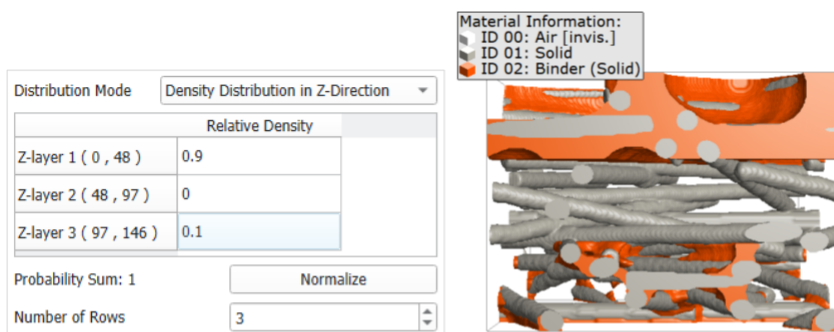




Z

The **Binder Distribution** can be entered in form of a ratio in the **Relative Density** table.

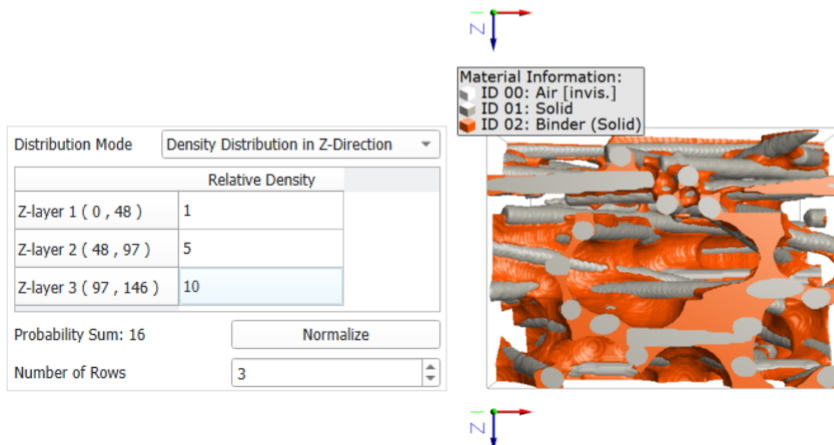
In the images below, three different segments are clearly discernible with a binder distribution according to the relative values given in the table.



90% of the binder is distributed in the Z-layers 0-48.

0% of the binder is distributed in the Z-

10 % of the binder is distributed in the Z-

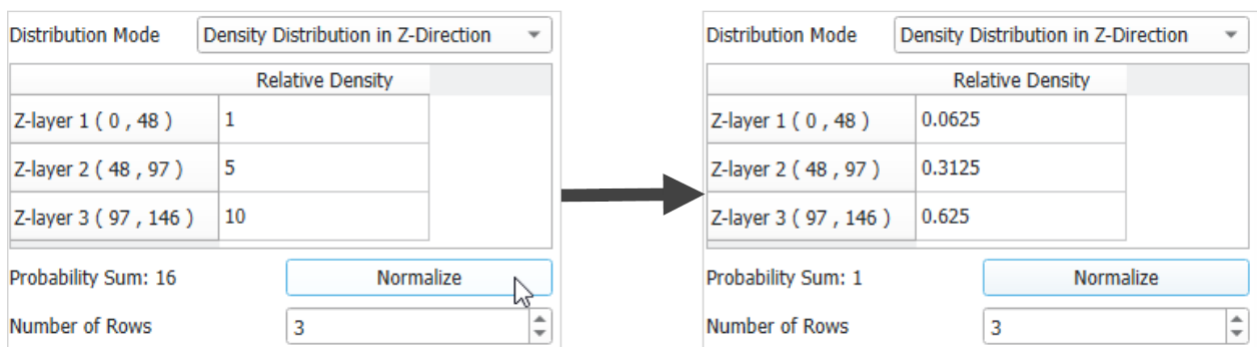


6% of the binder is distributed in the Z-layers 0-48.

31% of the binder is distributed in the Z-

63% of the binder is distributed in the Z-

Clicking the **Normalize** button ensures the Relative Density values sum up to one.

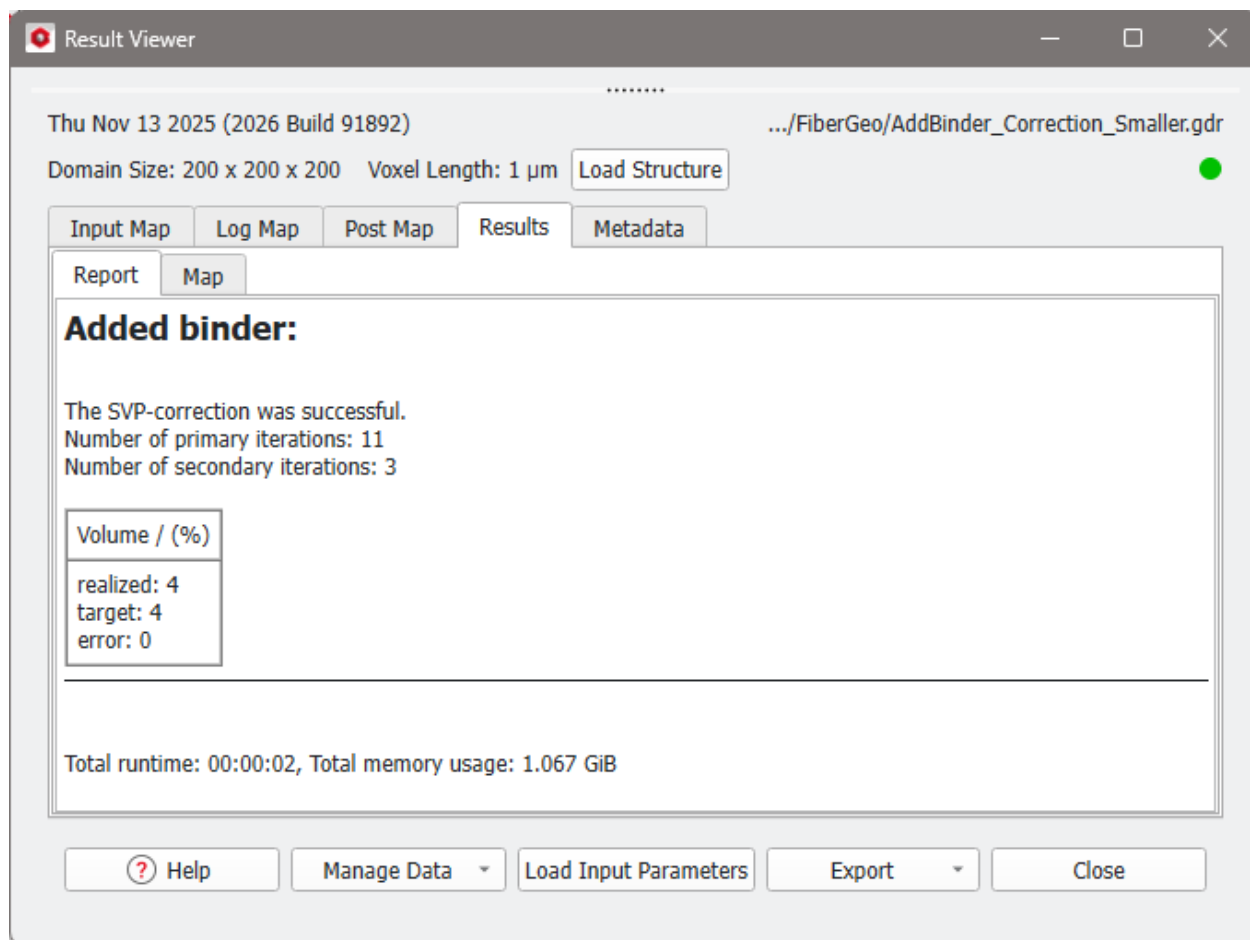


With the buttons **Load...** and **Save...** the distribution can be loaded/saved as text file which can be opened with other software as, e.g., Microsoft Excel.

Results

After the binder generation, the new structure with added binder is shown in the visualization area and the result file (*.gdr) is opened in the Result Viewer.

The **Results - Report** tab shows information about the binder generation, as number of iterations, target binder volume and realized binder volume.



If **Weight Percentage** or **Grammage** were selected as **Stopping Criterion**, additionally the realized and target binder weight percentage and grammage are given.

Volume / (%)	Grammage / (g/m ²)	Weight / (%)
realized: 3.46524	realized: 20	realized: 20
target: ---	target: ---	target: 20
error: ---	error: ---	error: 2.59463e-05

If a non-homogeneous binder distribution was defined, the binder volumes additionally are given for each defined layer.

Input Map

Log Map

Post Map

Results

Metadata

Report

Map

Added binder:

Volume / (%)	Grammage / (g/m ²)	Weight / (%)
realized: 1.27263 target: --- error: ---	realized: 19.9999 target: --- error: ---	realized: 19.9999 target: 20 error: -5.52607e-05

Layer 1

The SVP-correction was successful.

Volume / (%)	Grammage / (g/m ²)	Weight / (%)
realized: 3.62099 target: --- error: ---	realized: 53.9998 target: --- error: ---	realized: 53.9998 target: 54 error: -0.00017705

Layer 2

No binder to add.
The SVP-correction was skipped.

Volume / (%)	Grammage / (g/m ²)	Weight / (%)
realized: 0 target: --- error: ---	realized: 0 target: --- error: ---	realized: 0 target: 0 error: 0

Layer 3

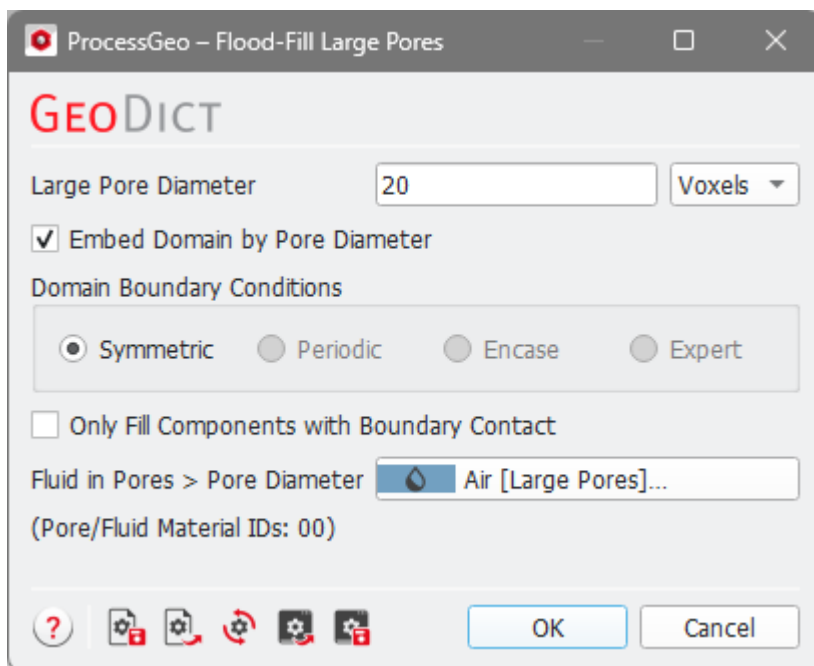
The SVP-correction was successful.

Volume / (%)	Grammage / (g/m ²)	Weight / (%)
realized: 0.196888 target: --- error: ---	realized: 6.00001 target: --- error: ---	realized: 6.00001 target: 6 error: 1.12676e-05

1.5.2 Flood-Fill Large Pores

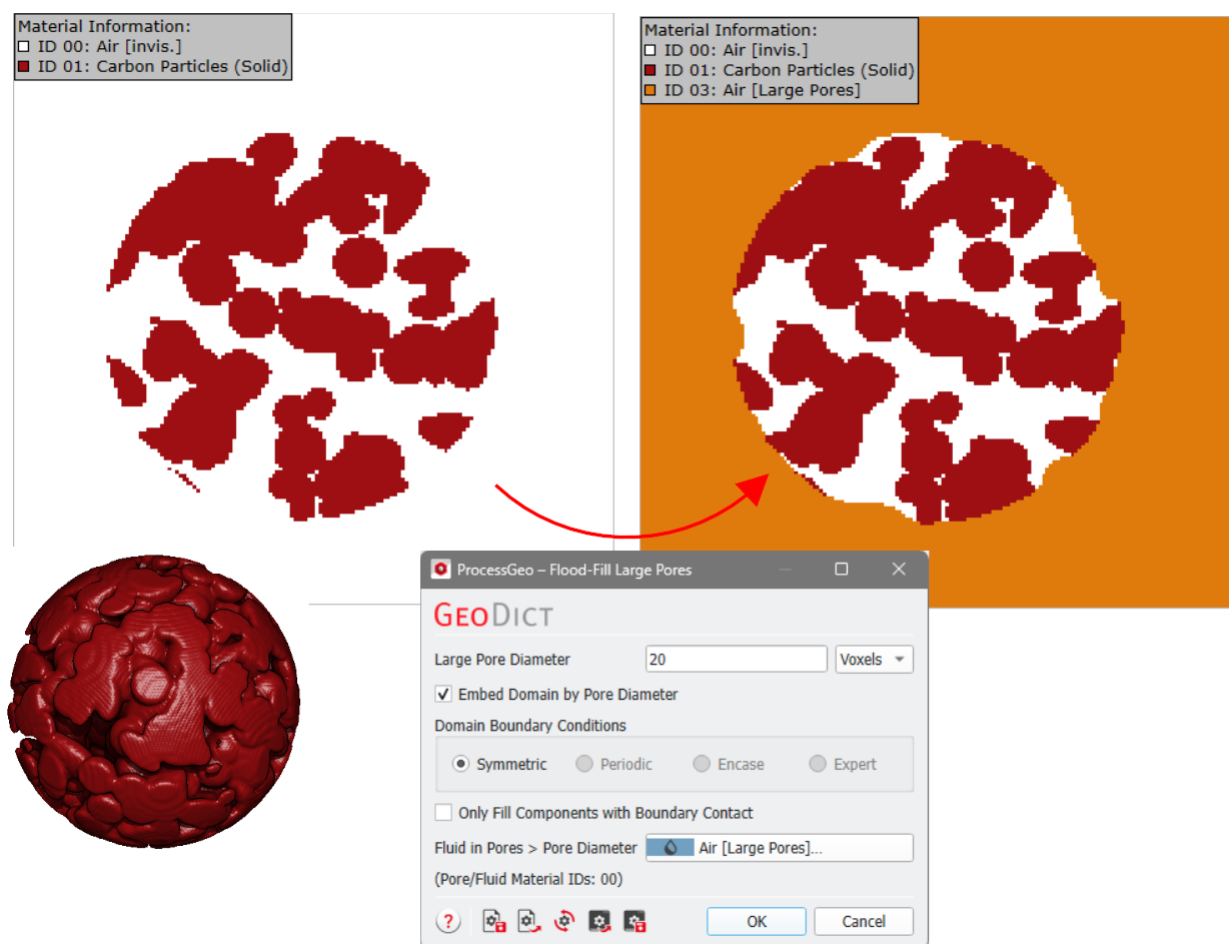
In ProcessGeo, the Flood-Fill feature allows to separate large and small pores, when at least two scales of pore sizes are present in the microstructure.

In a practical case, it might be used to fill up and separate all the empty pore-space around single grains, which internally have much smaller pores. This is done with an example structure with a single grain that contains small pores.



The value entered in **Large Pore Diameter** defines the size for a large pore and excludes smaller pores from being flood-filled. In the following example, the value entered for Large Pore Diameter (20 voxels) is larger than the diameter of the small pores inside the grain. As a result, the pore space around the grain is flood-filled and the smaller pores inside the grain remain untouched.

The material to fill the large pores can be selected by clicking on the material next to **Fluid in Pores > Pore Diameter** and choosing the material from the Material Selector dialog. Then all pores with a diameter that is larger than the previously defined **Large Pore Diameter** are assigned to this material. The Material ID in these pores is also changed to the next available Material ID.

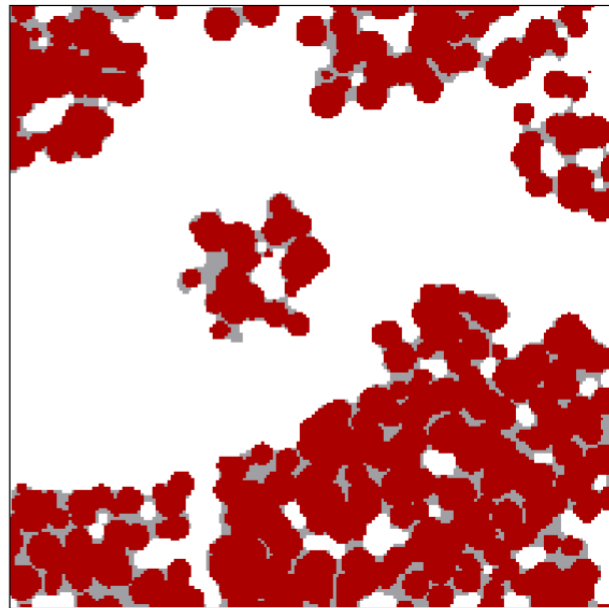
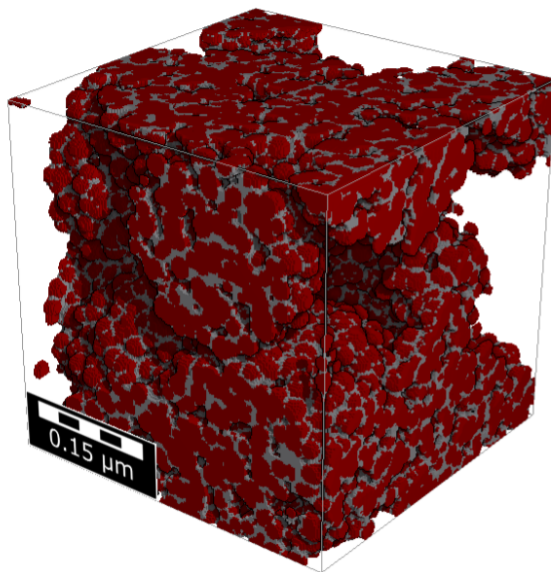


Domain Boundary Conditions

Different boundary settings can have a big influence on the flood-filling results. The **Domain Boundary Conditions** can be set to be **Symmetric**, **Periodic** (recommended for periodic structures), **Encase**, or **Expert**. With **Expert** you can set boundary conditions (Symmetric, Periodic, Encase) for each direction separately. Keeping **Embed Domain by Pore Diameter** checked does not allow to change the domain boundary conditions. Instead, the structure is embedded with a layer of empty voxels that has the same thickness as entered under **Large Pore Diameter**. Thus, pores at the boundary of the original structure belong to the pore space of the embedded structure and are filled. This avoids artifacts at the original domain boundary, but slightly increases runtime and memory usage.

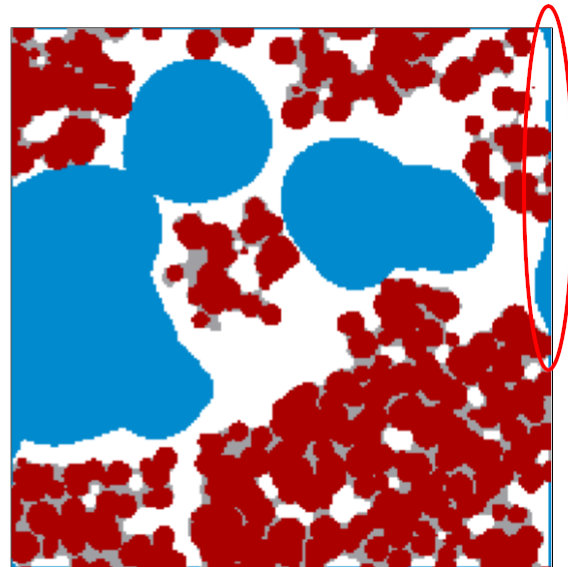
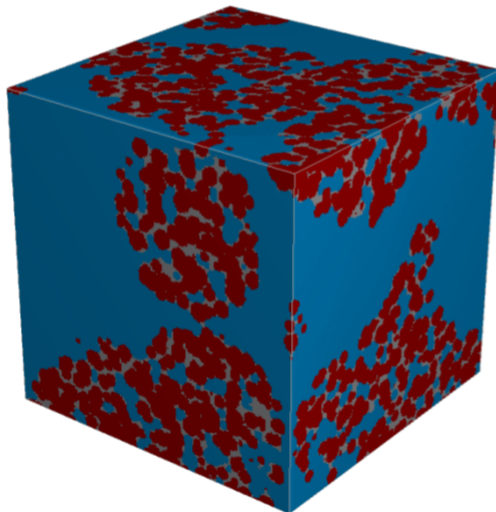
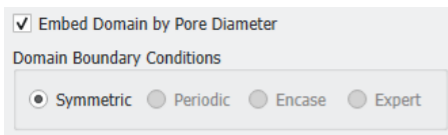
When the **Only Fill Components with Boundary Contact** option is selected, only the large pores connected to the domain boundary are filled.

The effect of different boundary conditions for flood-filling of large pores is demonstrated below. This catalyst layer like structure was generated with the Catalyst Layer GeoApp.



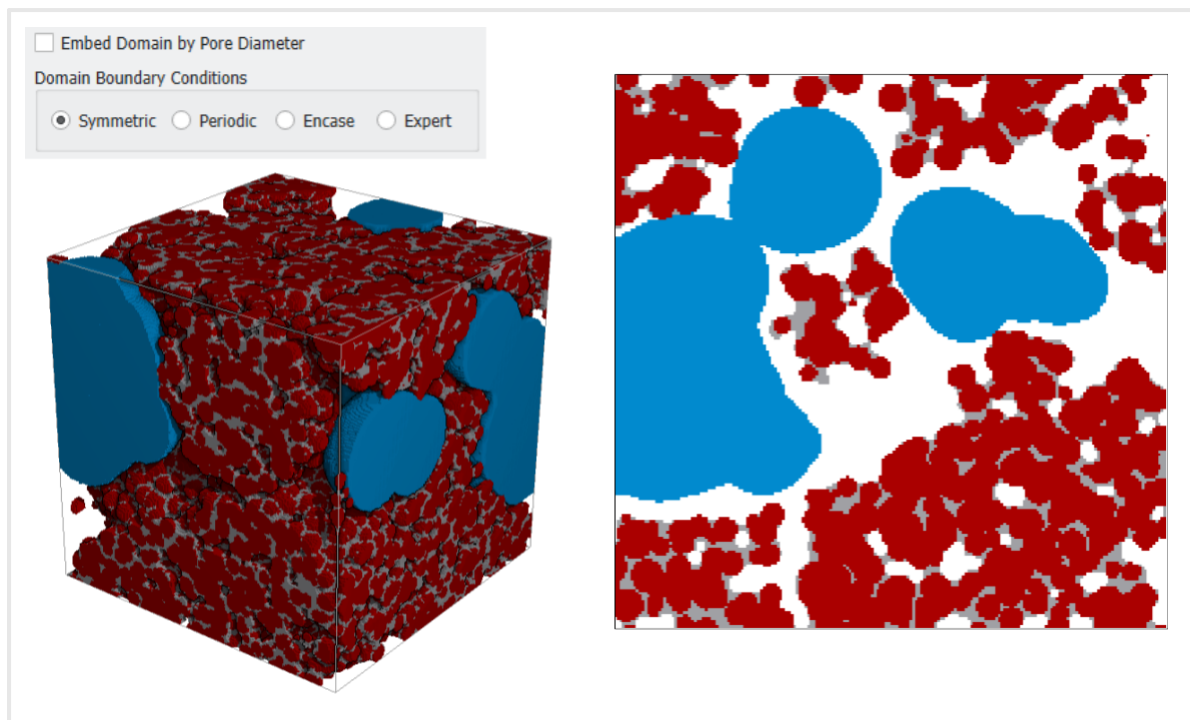
✓ Symmetric boundary conditions with Embed Domain by Pore Diameter enabled

When the domain is embedded, all pores at the original domain boundaries are flooded. Observe in the example, that for a **Large Pore Diameter** of 50 voxels, only the outermost voxel layers of the original domain are flooded, the flooding cannot enter into the smaller pores inside of the domain.



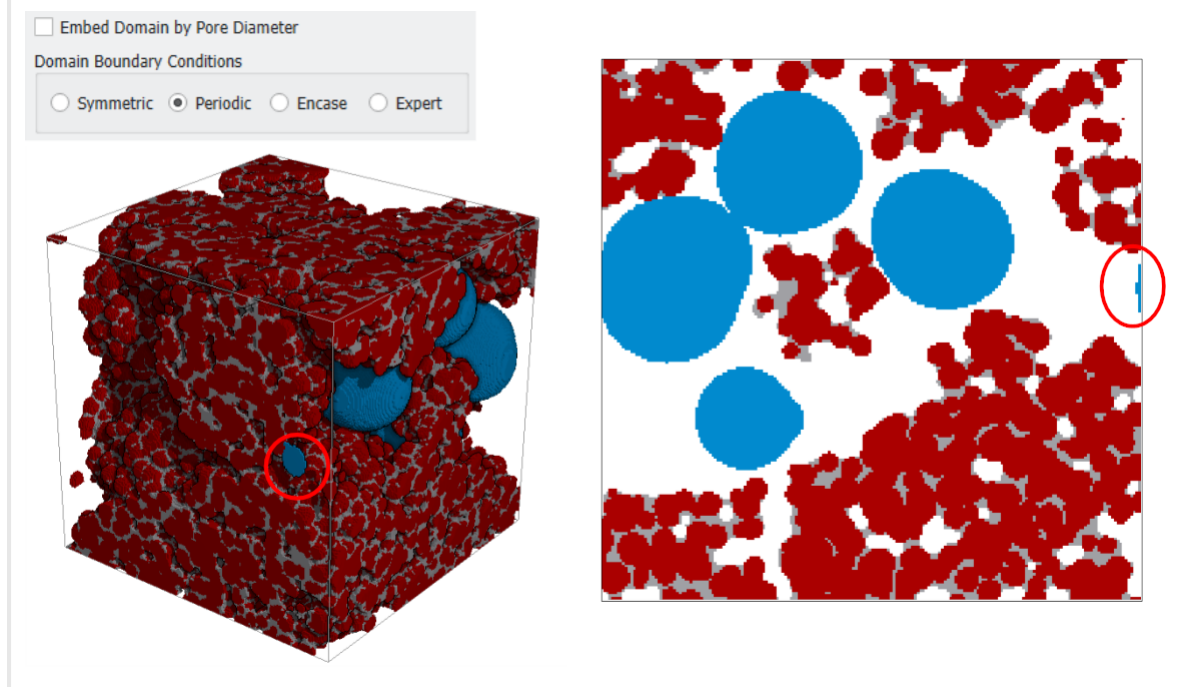
✓ Symmetric boundary conditions

For **Symmetric** boundary conditions, the structure is mirrored at the domain boundaries. Therefore, the center of a large pore may lie on the boundary of the domain, with the pore extending by its radius into and out of the domain.



✓ Periodic boundary conditons

The usage of Periodic boundary conditions is recommended for periodic structures. Notice how the pores extend to the other side of the domain in the example.



✓ Encase boundary conditions

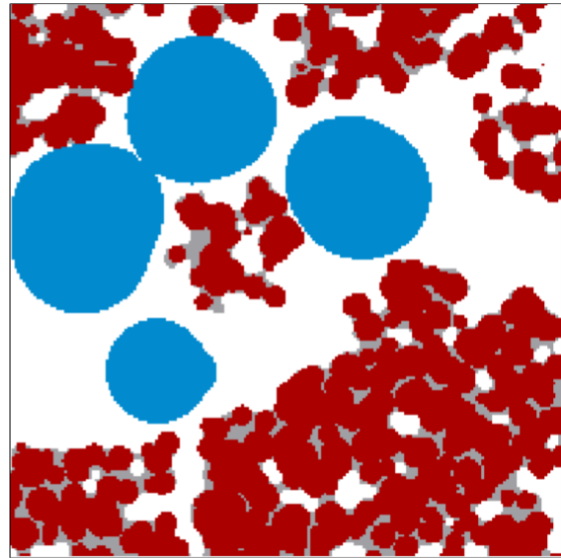
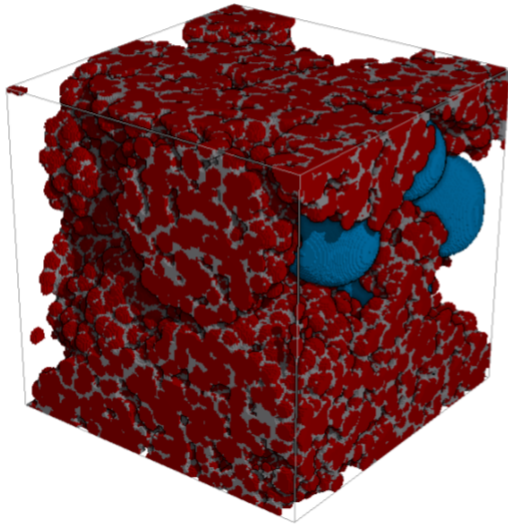
When choosing **Encase** boundary conditions, the structure is embedded internally within a layer of solid voxels. That means that the pores do not extend outside of the

domain and the whole pore diameter has to fit into the original domain.

☐ Embed Domain by Pore Diameter

Domain Boundary Conditions

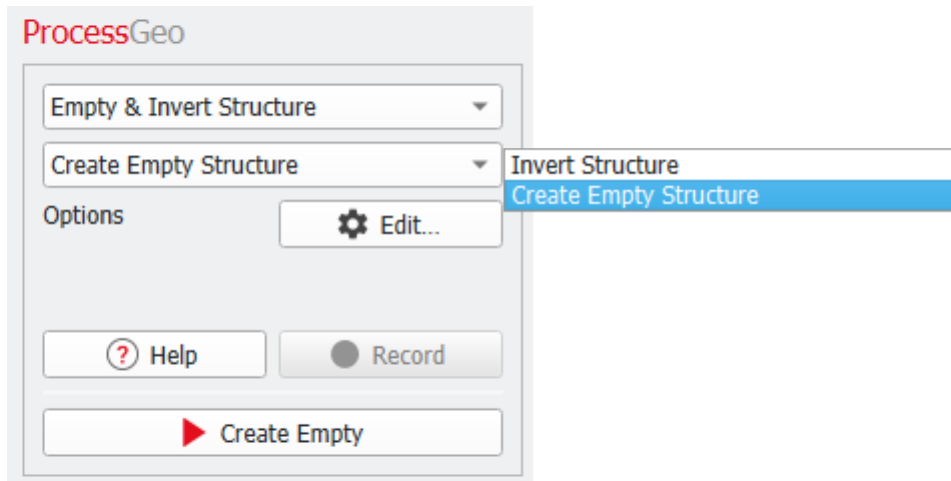
☐ Symmetric ☐ Periodic ☒ Encase ☐ Expert



1.6 Empty & Invert Structure

With **Empty & Invert Structure**, you can create a new empty structure or invert the current structure by switching the pores and solids.

Click the Options' **Edit...** button to modify the parameters of the selected command. For the **Invert** command, no options are available. Simply click **Invert** in the ProcessGeo section.



Commands available in the drop-down menu

- [Invert Structure](#)⁴⁵
Switch solid voxels to pores and pores to solid voxels. Analytic material information is lost.
- [Create Empty Structure](#)⁴⁶
Create an empty domain with dimensions NX, NY, and NZ.

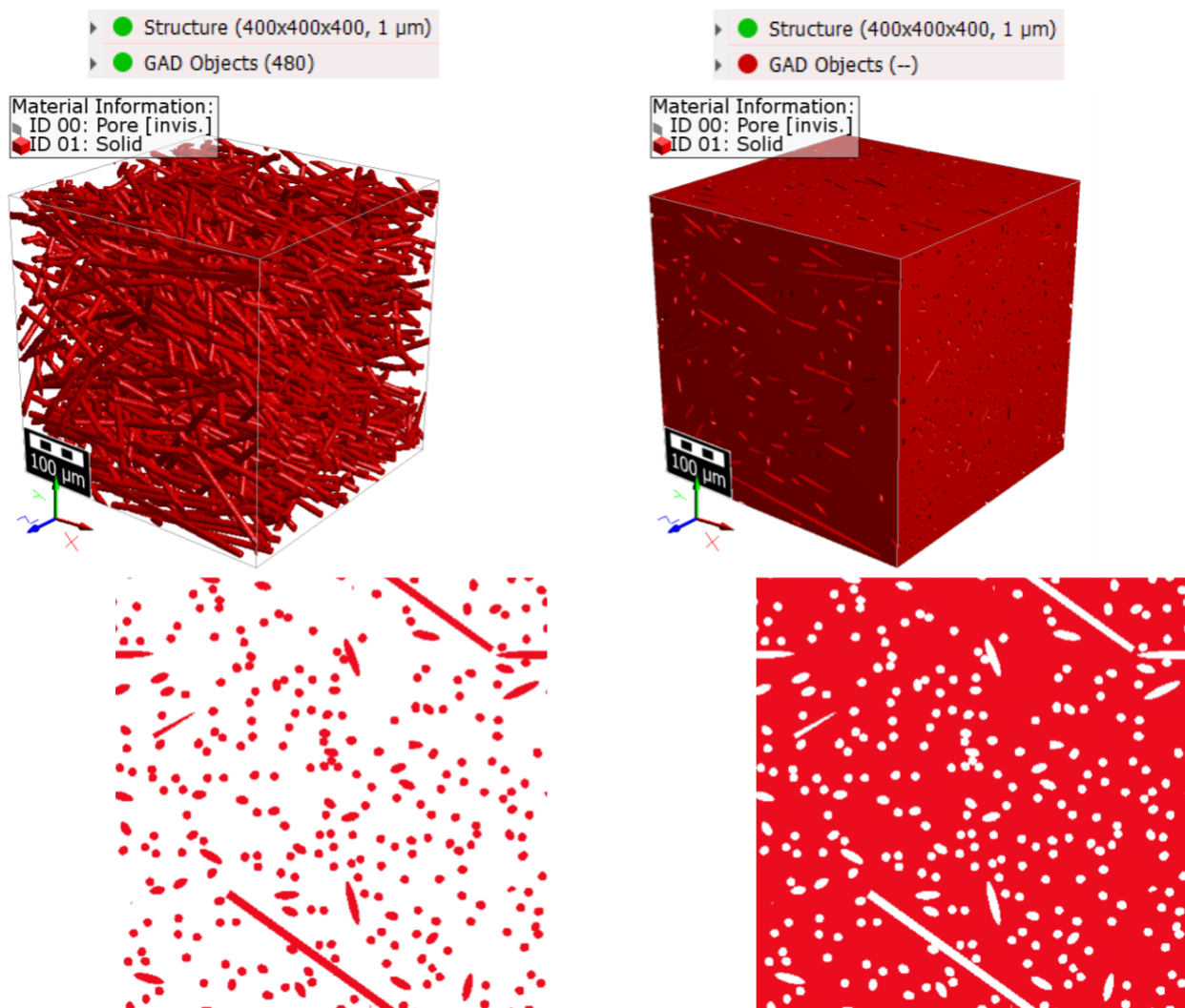
1.6.1 Invert Structure

With **Invert Structure** you can easily switch solid voxels to pores and pores to solid voxels. **Invert Structure** interchanges background and structure voxels. Use this feature when treating images where background and structure values are permuted, e.g., some types of tomographic images.



Important! The **Invert** command in fact reassigns all materials with non-zero IDs to ID 00, and reassigns the material with ID 00 to Material ID 01. Only in the default situation where ID 00 denotes the pore space and non-zero IDs denote solid materials, this switches pore and solid phase. In any other situation, Invert will not work as intended and you have to use the [Reassign Material ID command](#)¹⁰ instead.

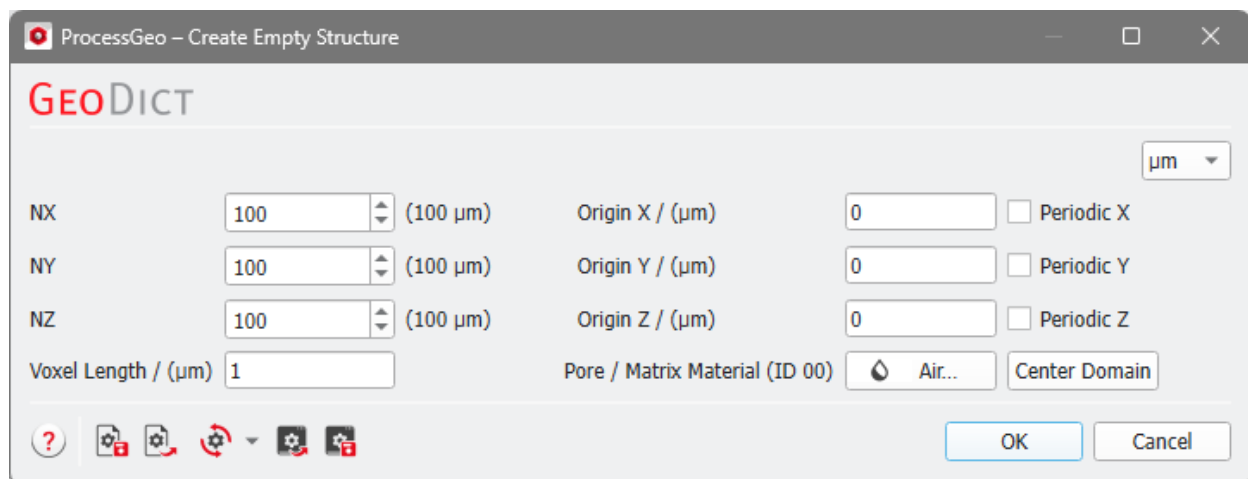
The analytic object (GAD) information is lost by inverting because all materials are mapped to void space in this case.



1.6.2 Create Empty Structure

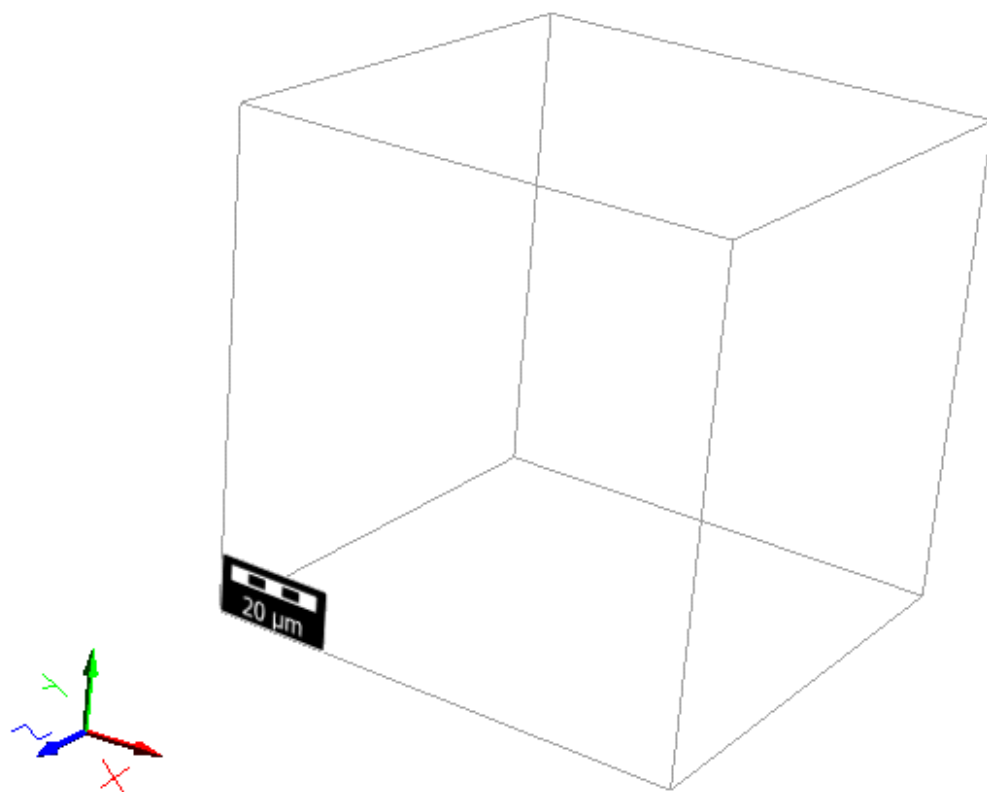
An empty domain can be generated with **Create Empty Structure**.

In the dialog, enter the parameters defining size, resolution, origin, and periodicity of the empty geometry. Also, instead of an empty domain, a material from the Material Database can be assigned to Material ID 00. In this way, a block of any given material can be generated. Clicking **OK** closes the dialog and clicking on **Create Empty** starts the creation.



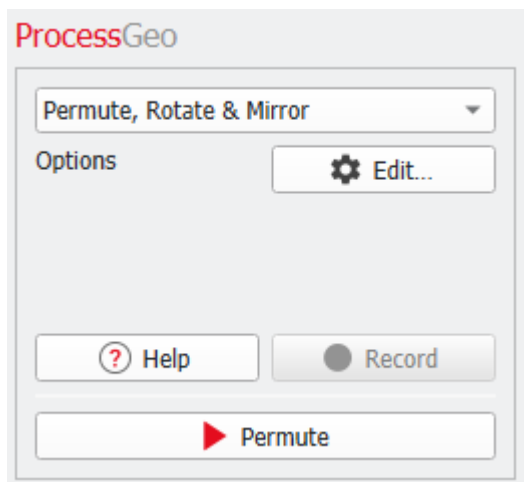
An empty geometry with the given size is created.

Material Information:
ID 00: Air [invis.]



1.7 Permute, Rotate & Mirror

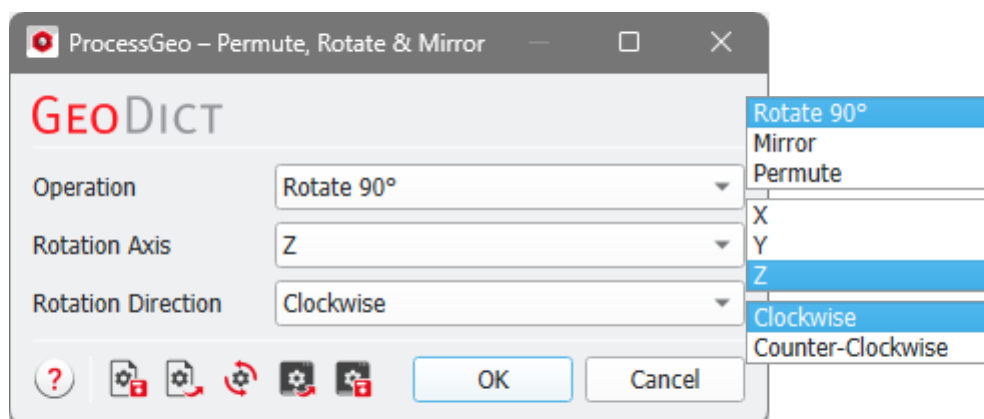
Select **Permute, Rotate & Mirror** in the ProcessGeo section and click the **Edit...** button to change the input parameters.



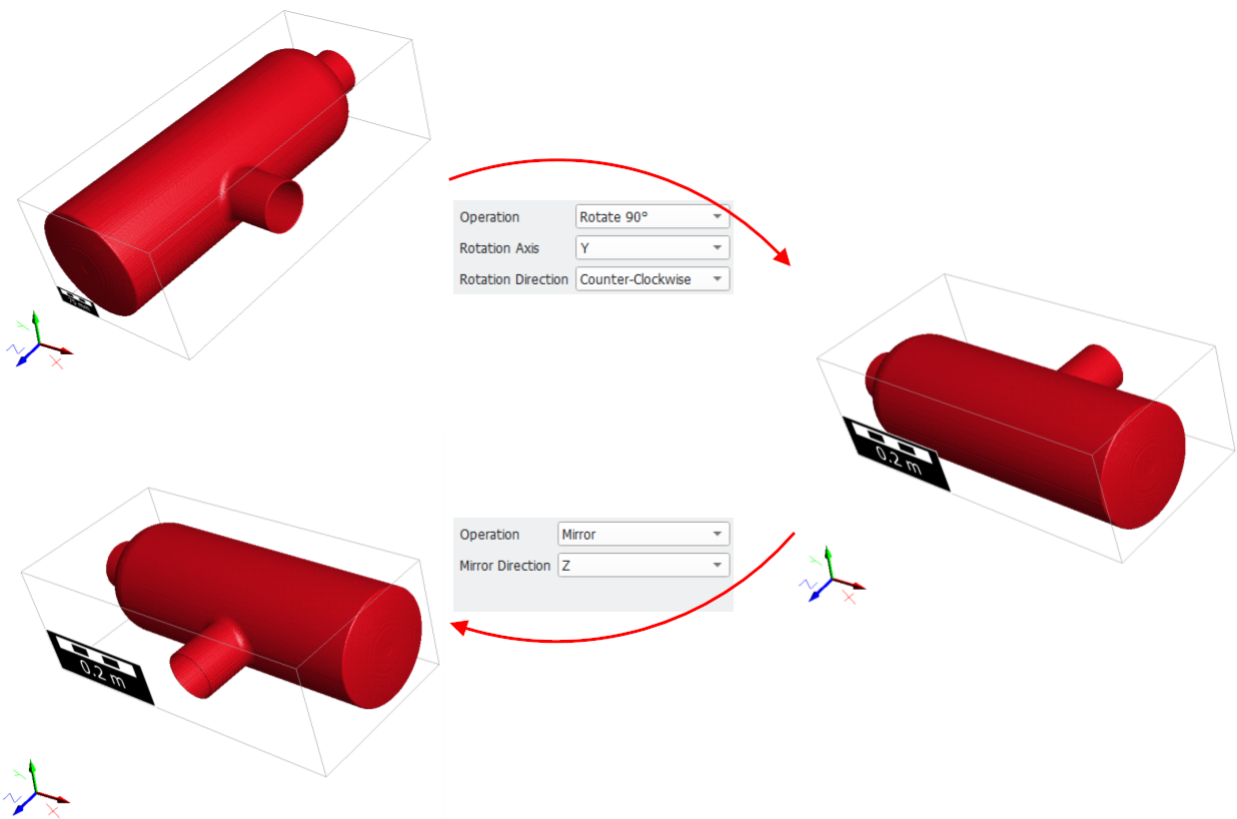
After selecting the desired operation in the dialog, change the corresponding parameters and click **OK**. Then, click **Permute**.

- **Rotate 90°** turns the structure by 90° around the given axis and in the given direction.
- **Mirror** mirrors the whole structure in the selected direction.
- **Permute** changes the allocation of the axis for the current structure.

All operations in **Permute, Rotate & Mirror** keep the analytic information of the structure (GAD data).

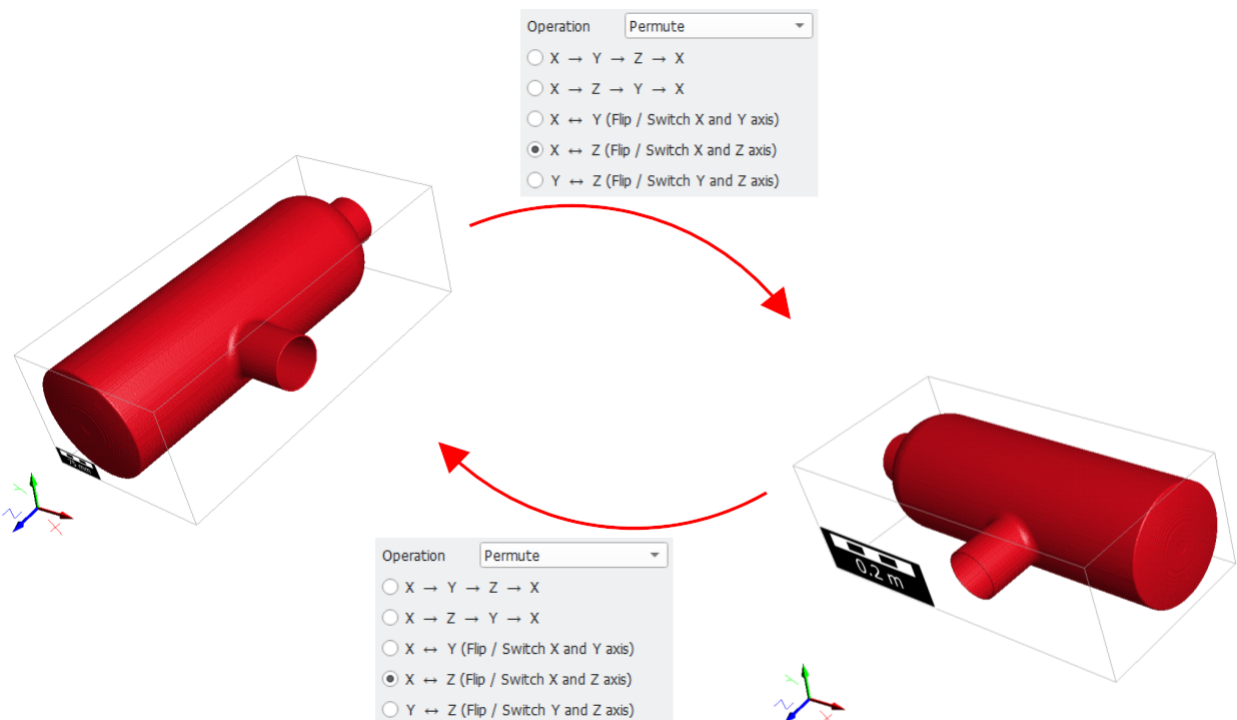


Observe the effect of the following permutations on the position of a structure depicting the casing of a filter. First, the structure is simply rotated counter-clockwise by 90° around the Y-axis. Then, it is mirrored in the Z-direction.



The permutations $X \leftrightarrow Z$, $Y \leftrightarrow Z$, and $X \leftrightarrow Y$ flip or switch the axes. The shape of the domain changes accordingly. In the example below, the side opening of the filter casing that initially opens towards the X-axis, changes to the Z-axis after the permutation.

If the same permutation is applied two times, the original state is achieved again.

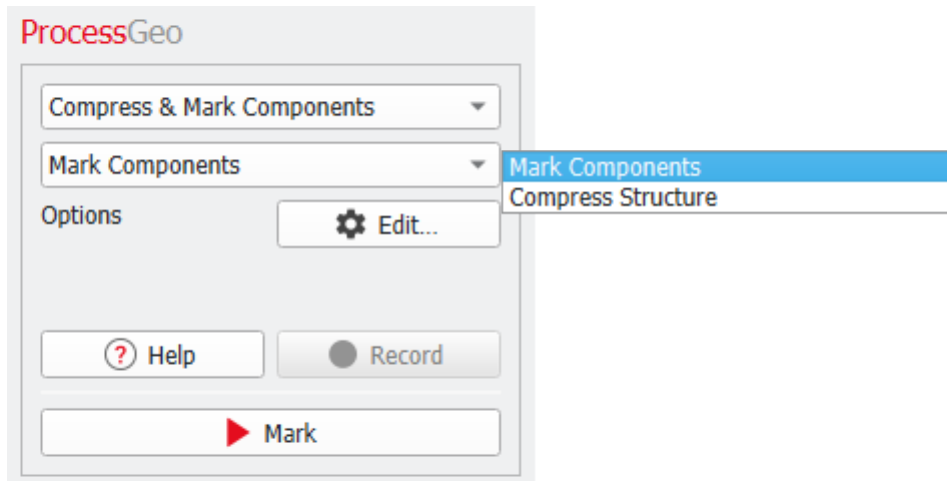


Observe that the flipping of the axes is the same as first rotating and then mirroring the structure as it is shown above.

1.8 Compress & Mark Components

This menu contains two different commands. **Mark Components** analyzes the connectivity of pore and solid materials. **Compress Structure** is a much simplified geometrical version of a compression process simulation.

Click the Options' **Edit...** button to modify the parameters of the selected command.

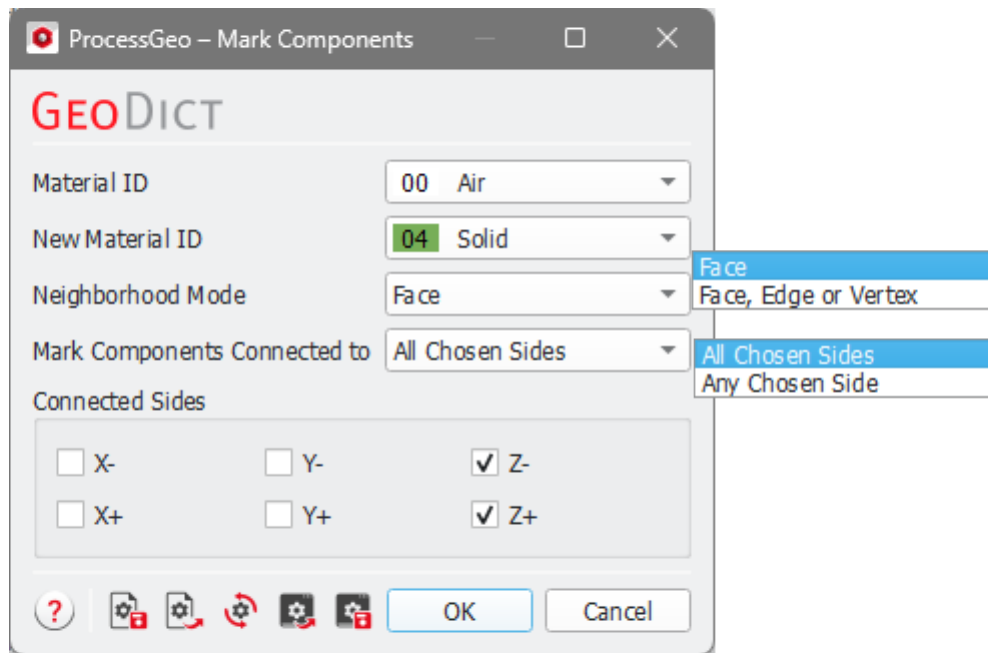


Commands available in the drop-down menu

- [Mark Components](#)⁵¹
Mark all solid components or pores connected to chosen domain sides.
- [Compress Structure](#)⁵³
Compact the structure in the Z-direction.

1.8.1 Mark Components

The **Mark Components** command finds all voxels of a specified Material ID that are connected to each other and to the selected boundaries. The connected voxels are then reassigned to a new Material ID selected by you. **Mark Components** can be used, for example, to validate that the structure model has a through-pore in the flow direction.



The **Material ID** defines the material for which the connected component analysis should be done.

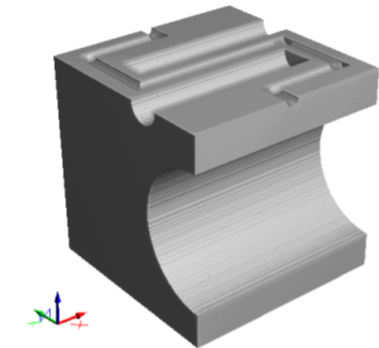
The found connected components are then assigned to the selected **New Material ID**.

The selections in the **Neighborhood Mode** follow the rules explained in detail on the [Cleanse Structure](#) ²¹ page.

Mark Components Connected to defines how the selection made in the **Connected Sides** panel is interpreted. When set to **All Chosen Sides**, only those connected components that are touching all boundaries selected in the **Connected Sides** panel are marked. If **Mark Components Connected to** is set to **Any Chosen Side**, the connected components only need to touch one of the boundaries chosen in the **Connected Sides** panel to be marked.

The following example uses a model generated with the GadGeo module of GeoDict to show the effect of several combinations of **Mark Components Connected to** and **Connected Sides**.

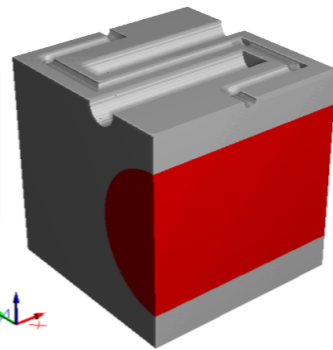
Original Structure



Mark Components Connected to **All Chosen Sides**

Connected Sides

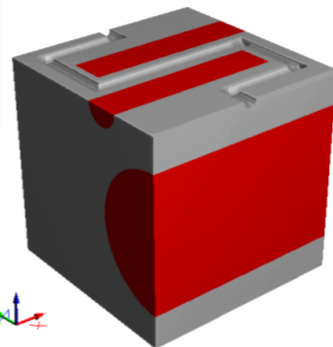
☒ X-	☐ Y-	☐ Z-
☒ X+	☐ Y+	☐ Z+



Mark Components Connected to **Any Chosen Side**

Connected Sides

☒ X-	☐ Y-	☐ Z-
☒ X+	☐ Y+	☐ Z+



Mark Components Connected to **All Chosen Sides**

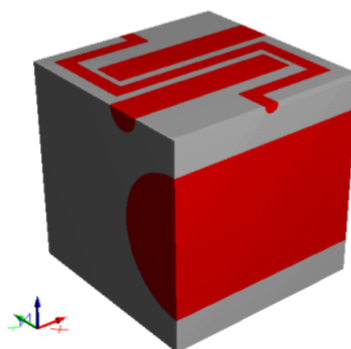
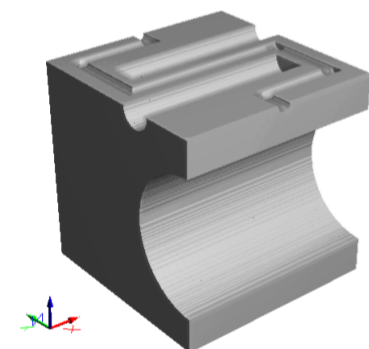
Connected Sides

☒ X-	☒ Y-	☐ Z-
☒ X+	☒ Y+	☐ Z+

Mark Components Connected to **Any Chosen Side**

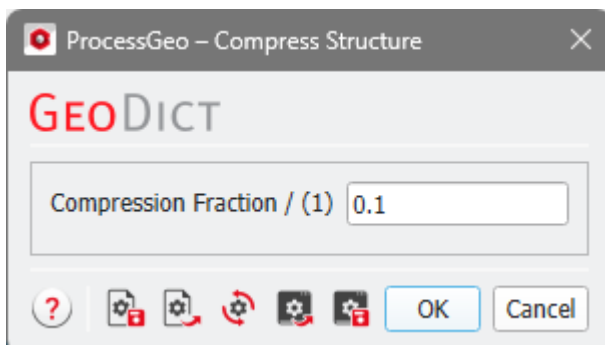
Connected Sides

☒ X-	☒ Y-	☐ Z-
☒ X+	☒ Y+	☐ Z+

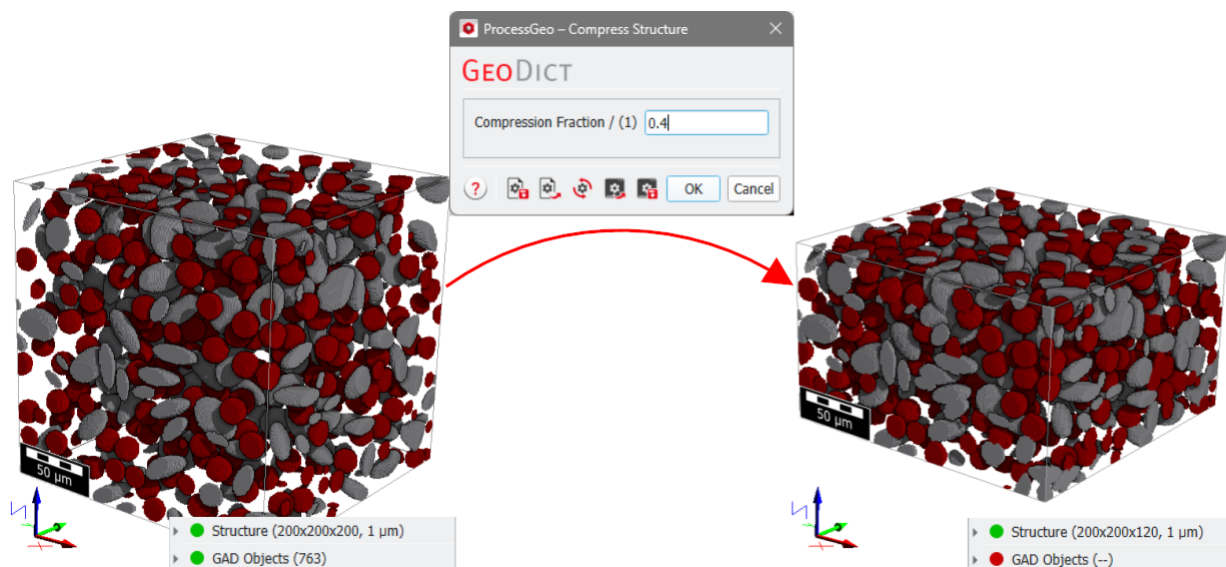


1.8.2 Compress Structure

The **Compress Structure** command compacts the structure in **Z**-direction by the value entered in **Compression Fraction**. Values must be between 0 and 1, where the extremes (0 [0% compression] and 1 [100% compression]) are not feasible.



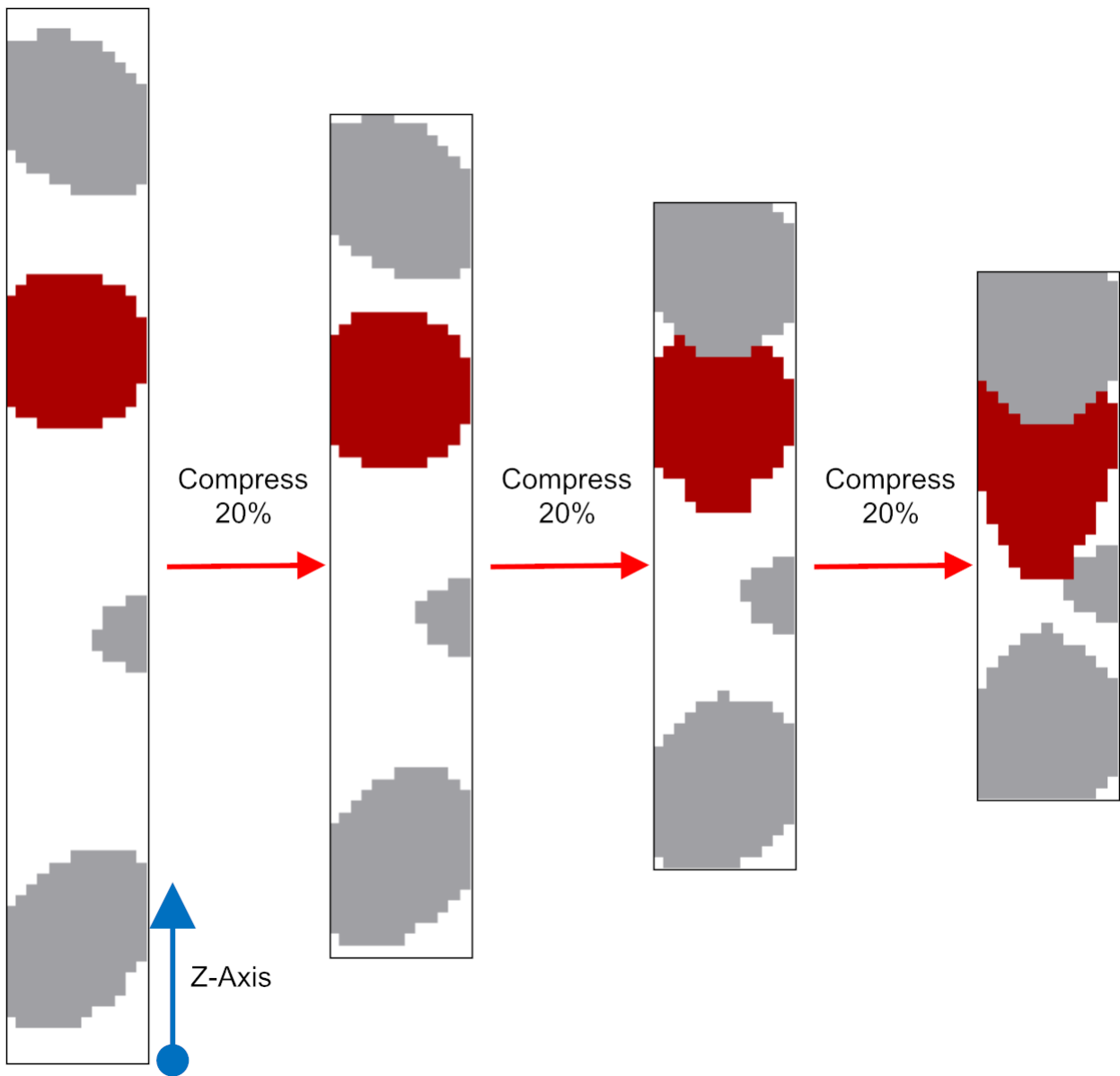
For instance, a value of 0.4 (40%) compresses the structure to 60% of its original thickness in **Z**-direction. This is shown in the next example, where the structure size in Z-direction is reduced from 200 voxels to 120 voxels. If analytical (GAD) data was present before, this information gets lost during the compression.



Compression Algorithm

The compression algorithm is purely geometrical. Each Z pillar is compressed independently. All solid components in the pillar are placed nearer to each other according to the compression fraction, and the pore space is removed. The solid components do not overlap. When only one connected component is left, and the structure should be further compressed the pillar is scaled down and the mass is no longer preserved.

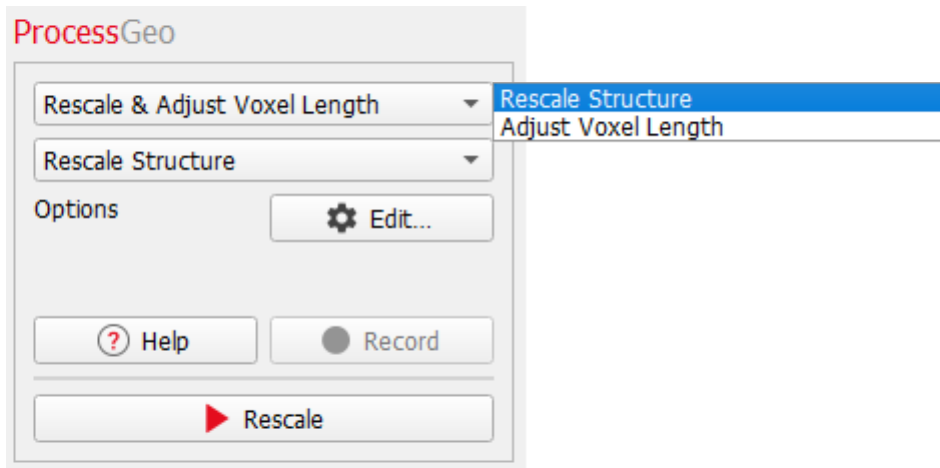
Observe how the solid components move closer to each other while they keep their original size. Each Z-column is computed independent from its neighboring Z-columns. This means, that the shape of an objects (e.g., the circular cross section of a fiber) is not preserved once the object gets in contact with either the boundary or another object. This can be observed in the last two steps of the example below: each Z-Column of the red material is shifted independently from its neighbors, which results in a distorted shape as soon as it gets in contact with the object above.



1.9 Rescale & Adjust Voxel Length

With **Rescale & Adjust Voxel Length**, you can change the resolution of the structure while maintaining the physical size (**Rescale Structure**) or change the physical size of the structure while maintaining the voxel size (**Adjust Voxel Length**).

Click the Options' **Edit...** button to set the parameters.

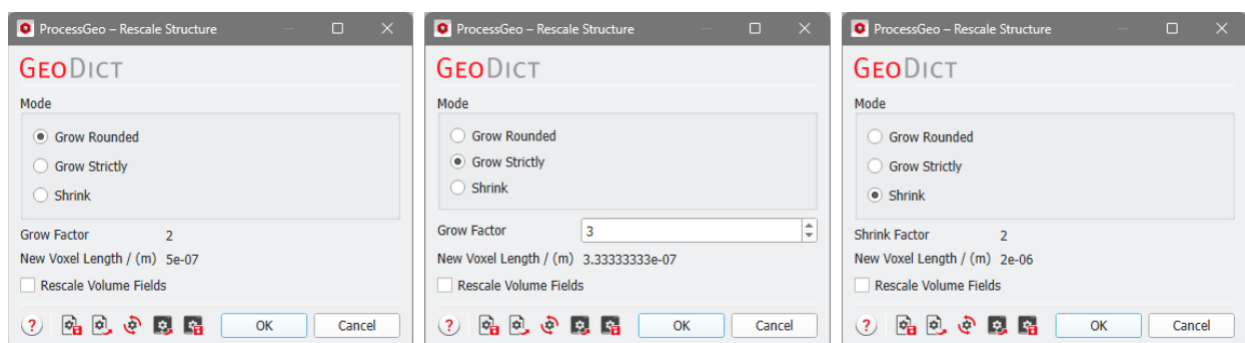


Commands available in the drop-down menu

- [Rescale Structure](#)⁵⁶
Change the resolution of the structure.
- [Adjust Voxel Length](#)⁵⁹
Change the voxel length of the currently loaded structure.

1.9.1 Rescale Structure

The **Rescale Structure** operation changes the resolution of a structure, which means the voxel number and the voxel length are changed, while the physical size of the structure stays the same. The voxel count in the domain is changed according to the entered **Grow Factor** (increase number of voxels) or **Shrink Factor** (decrease number of voxels), while the voxel length is changed accordingly (decrease for Grow and increase for Shrink). Thus, there is a smoothing of the structure when applying **Grow Rounded** or **Grow Strictly**, and a coarsening when applying **Shrink**.



Rescale Options

Three **Rescale Modes** are available to rescale the structure:

- **Grow Rounded**, which is always applied with a **Grow Factor** of 2,
- **Grow Strictly**, that accepts any positive integer as **Grow Factor** (for example 3),
- **Shrink**, which is always applied with a **Shrink Factor** of 2.

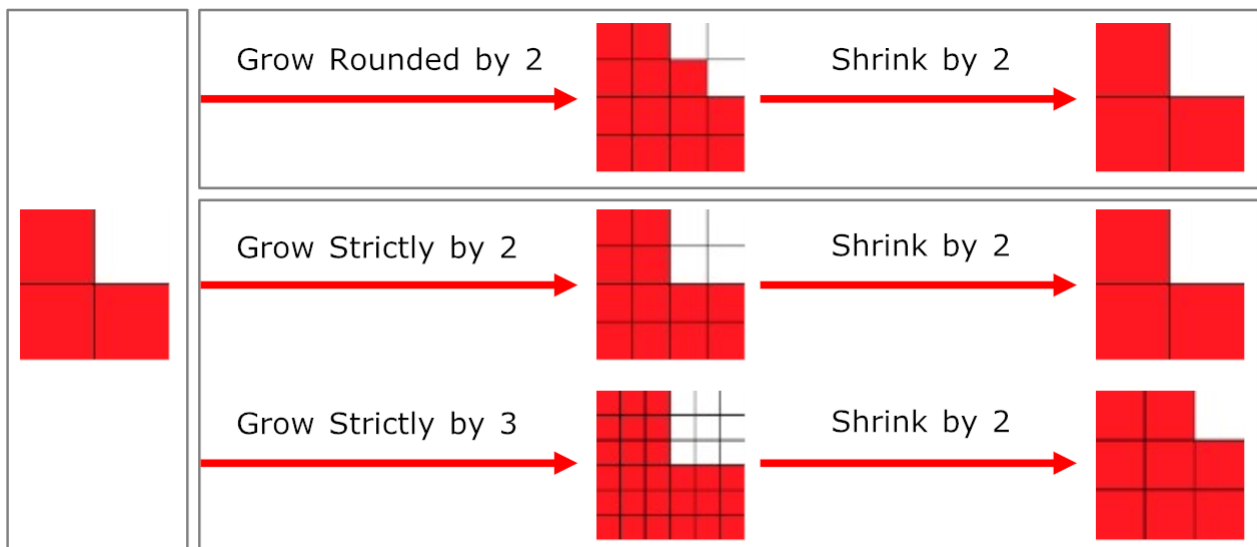
The **Grow Factor** or **Shrink Factor** is shown below the Mode panel, for the mode **Grow Strictly** change the value here.

Below, the **New Voxel Length** (in meters) after the rescale is displayed as information.

Check **Rescale Volume Fields** to apply the rescaling to the volume fields that are currently loaded in GeoDict.

How do the Rescale Modes work?

The different rescaling processes are illustrated in the example below, considering a group of four voxels. The red squares represent solid structure voxels, and the white squares represent empty background voxels.



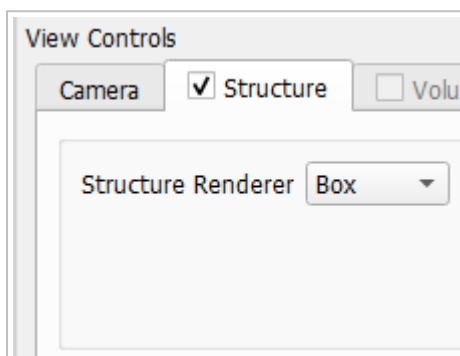
In the **Grow Rounded** method, 2^3 voxel with the same ID are created from each voxel (voxels are doubled per direction). Then, the neighboring voxels (common faces, edges, and vertices, including the voxel itself) are compared and the majority of Material IDs will be assigned to this voxel. If possible, the analytic data is used for **Grow Rounded** to achieve even better results.

Grow Strictly discards the analytic data instead as only the first step of the grow rounded algorithm is performed (doubling the voxels).

The **Shrink** method reduces 2^3 voxels to one voxel, where the majority of the previous Material IDs will be used for the new voxel. In case of equality, the solid Material ID is preferred over the "empty" pore Material ID.

Example

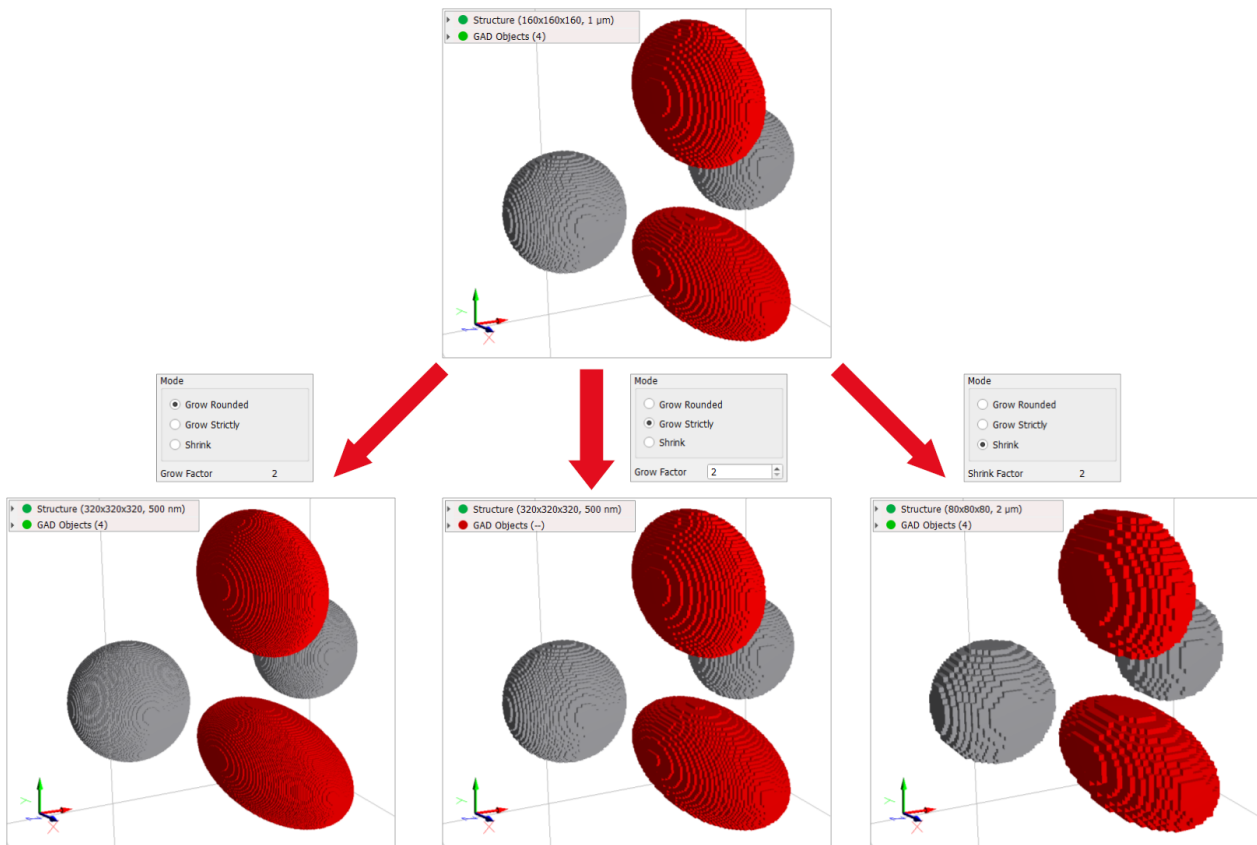
We illustrate the effects of the different rescaling methods on a structure which contains spheres and ellipsoids. The best way to observe the visual effect of rescaling is to use the 3D visualization (select **View** → **3D Rendering** in the menu bar or click the  icon in the toolbar) and set the **Structure Renderer** to **Box**.



With the **Grow Round** mode, the voxel size is divided by 2 (now 0.5 μm) and the domain doubles in each direction (now 320x320x320 voxels). To further (visually) smooth the objects in the structure by rounding, do further **Rescaling** as needed. Moreover, observe that the GAD Data is maintained.

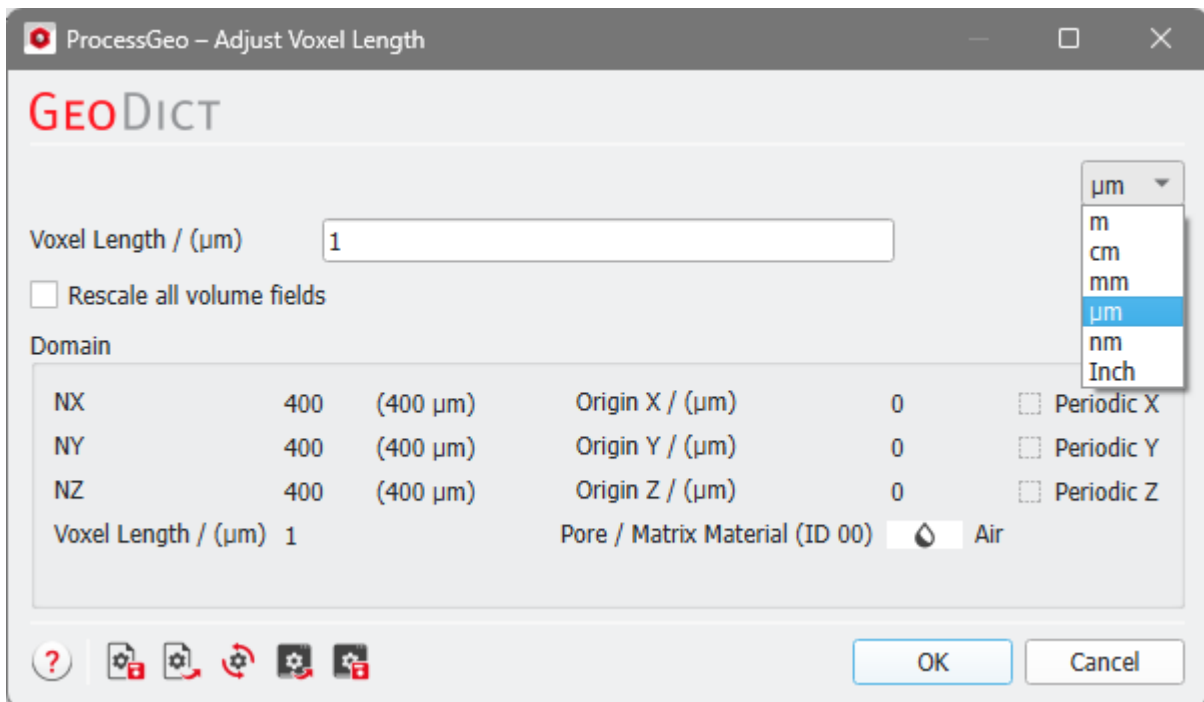
In the **Grow Strictly** mode, you can see no visual smoothing effect of the structure, but the domain size and voxel length have changed as before. Also, in contrast to the other method, the GAD data is lost.

In the **Shrink** mode, the GAD data is maintained and the domain size is half of the original size in each direction (now 80x80x80 voxels), while the voxel length is doubled (now 2 μm).



1.9.2 Adjust Voxel Length

With the **Adjust Voxel Length** command the current voxel length can be changed, whereas the voxel count stays the same.



In the **Adjust Voxel Length** dialog, select the units (m, cm, mm, μm , nm, Inch) for the voxel length from the pull-down menu in the upper right corner.

Enter the new **Voxel Length** in the corresponding field.

The option **Rescale all volume fields** allows to change the voxel length of the currently loaded volume fields accordingly. Thus, a structure and its volume field can still be shown simultaneously in the visualization area and their domain sizes fit together.



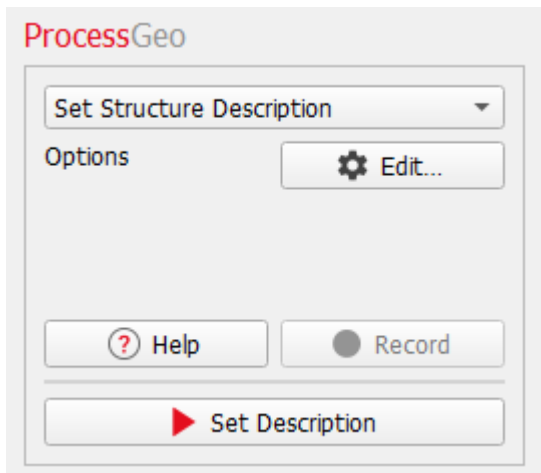
Important! The values inside the volume field are not changed! Thus, the volume field might not fit to the structure anymore, e.g., if a velocity field is loaded.

The **Domain** panel below shows the current domain parameters, nothing can be edited here.

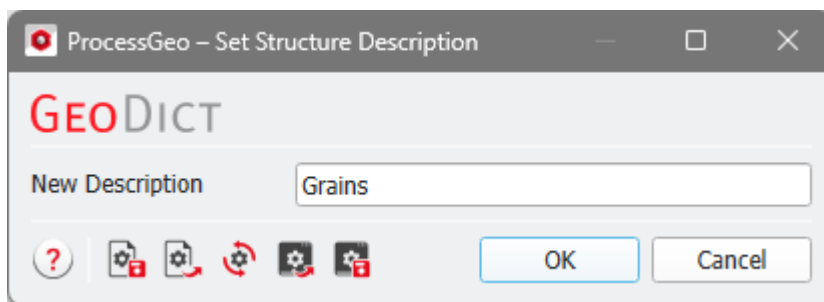
This change in voxel length occurs on the already generated structure (post-processing). To vary voxel length for the generation of a new structure (pre-processing), the value has to be changed through the Options' **Edit...** button in the module section of the corresponding Material Modeling module (FiberGeo, GrainGeo, WeaveGeo, etc.).

1.10 Set Structure Description

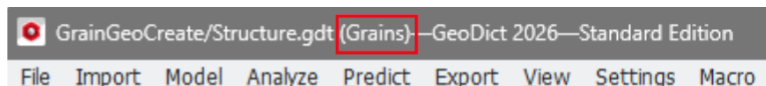
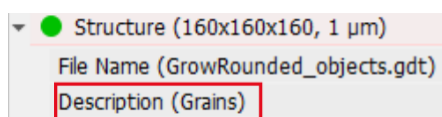
With **Set Structure Description** you can add additional information about the structure to the structure file.



In the **Set Structure Description** dialog, type in the **New Description**.



The description of the structure is shown in the **Structure** menu in the Project Status section on the left and in the GeoDict title bar.



Citation: Math2Market GmbH, 2026: GeoDict 2026 User Guide, ProcessGeo, Math2Market GmbH, Germany, doi.org/10.30423/userguide.geodict



Math2Market GmbH

Richard-Wagner-Str. 1, 67655 Kaiserslautern / Germany
www.math2market.com