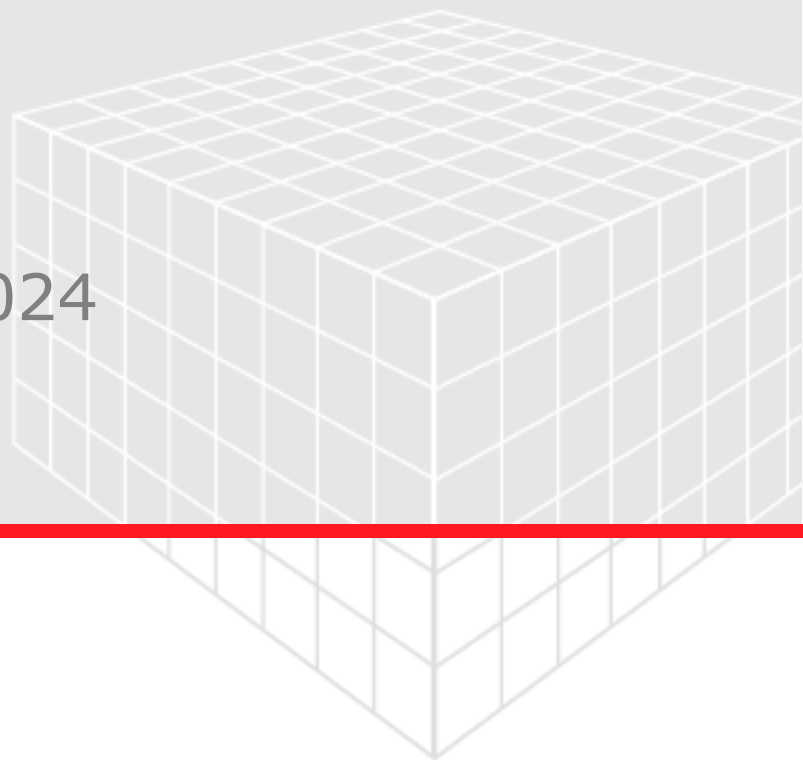


LAYERGEO

User Guide

GeoDict release 2024

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GEO DICT

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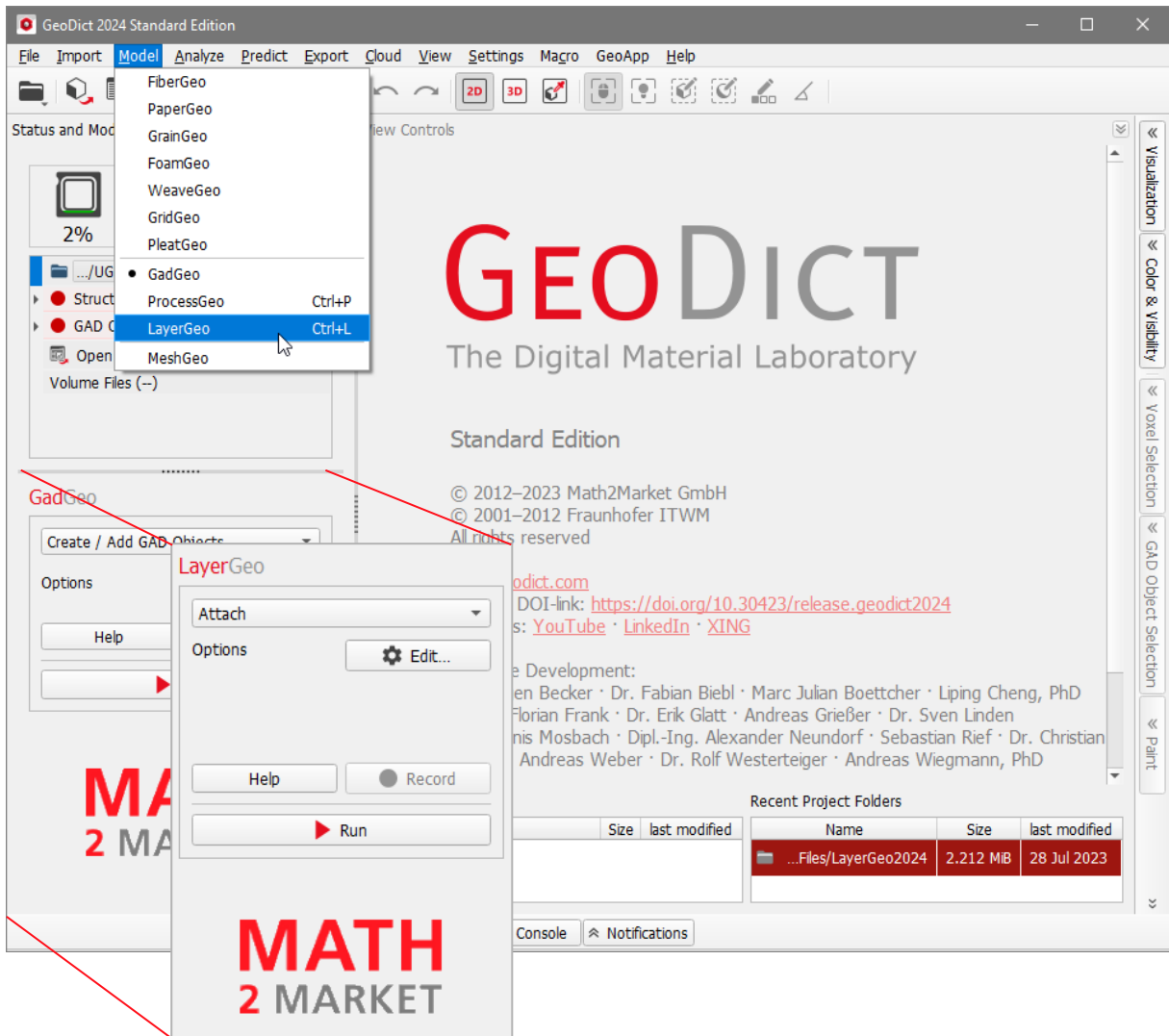
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COMBINING AND LAYERING STRUCTURE MODELS

ProcessGeo and **LayerGeo** are **GeoDict**'s structure modifiers. **LayerGeo** is used to combine structures in **GeoDict**.

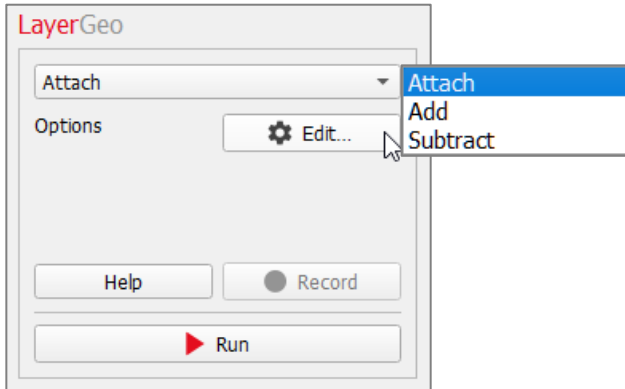
Often **ProcessGeo** and **LayerGeo** are used sequentially, together with **GeoDict**'s structure generators or with **ImportGeo** to create complex structures. The imported or generated structures are modified with **ProcessGeo** and then combined using **LayerGeo**.

The **LayerGeo** module is accessed by selecting **Model** → **LayerGeo** in the menu bar. After selecting **LayerGeo** from the menu bar, the module section to the left of the Visualization area changes to the **LayerGeo** section.



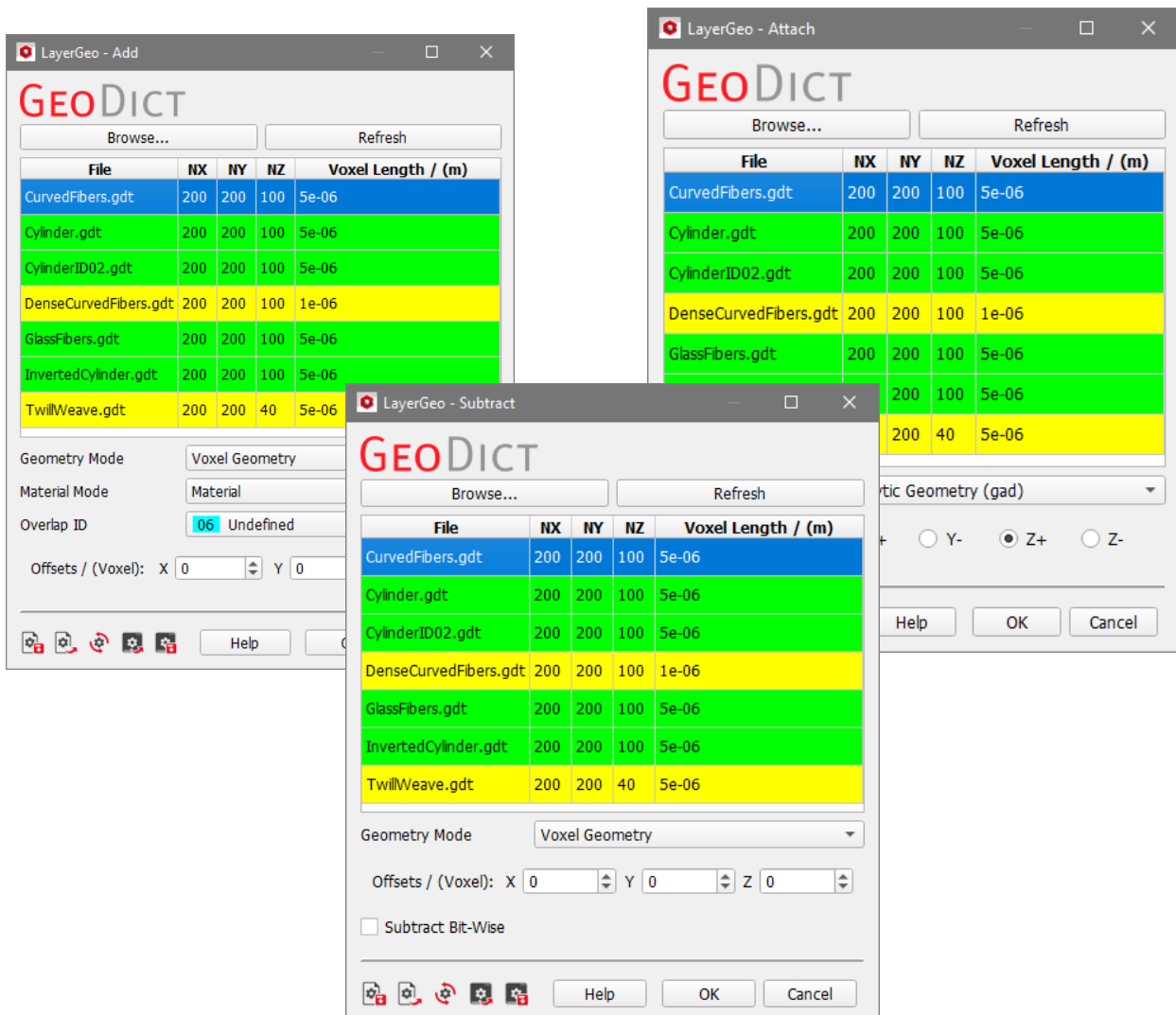
LAYERGEO SECTION

Depending on which functionality of LayerGeo is required, the user can choose from the dropdown menu either to **Attach** to the current structure, to **Add** to the current structure, or to **Subtract** from the current structure.



After selecting one of these modes, clicking **Edit...**, opens the **LayerGeo – Attach**, **LayerGeo – Add**, or **LayerGeo – Subtract** dialogs.

All of them show a table with the files in GDT, GAD, and .leS formats present in the current project folder. To choose a project folder, select **File → Choose Project Folder → Select Project Folder...**



After clicking **Browse...**, choose files from another directory. Clicking **Refresh** updates the table, i.e. after a new file is added to the chosen project folder.

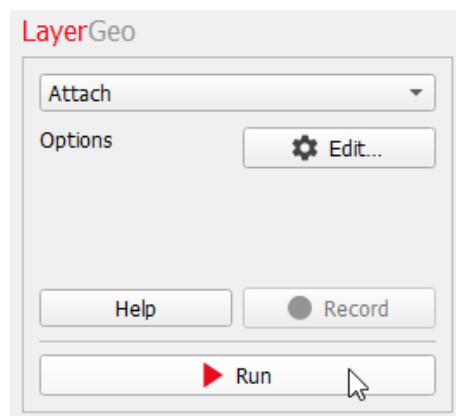
When a structure is in memory, the rows with the files names in the table take colors depending on their size and voxel length in relation to the structure in memory:

- Green: Names of files containing a structure whose dimensions match in all three directions (NX, NY and NZ) **and** in the voxel length.
- Yellow: The names of files containing a structure whose dimensions match in only two directions, or do not have a matching voxel length.
- Not highlighted: Non-matching structures are not highlighted.

To select a structure, click on its name. The name of the selected structure is then highlighted in blue.

Located under the table are the parameters to be set to attach, add, or subtract layers. These parameters are explained in more detail below, starting on page [4](#).

After the selection of parameters for **Attach**, **Add**, or **Subtract** is completed, confirm with **OK**. The layered structure is generated by clicking on **Run** at the bottom of the LayerGeo section.



ATTACH

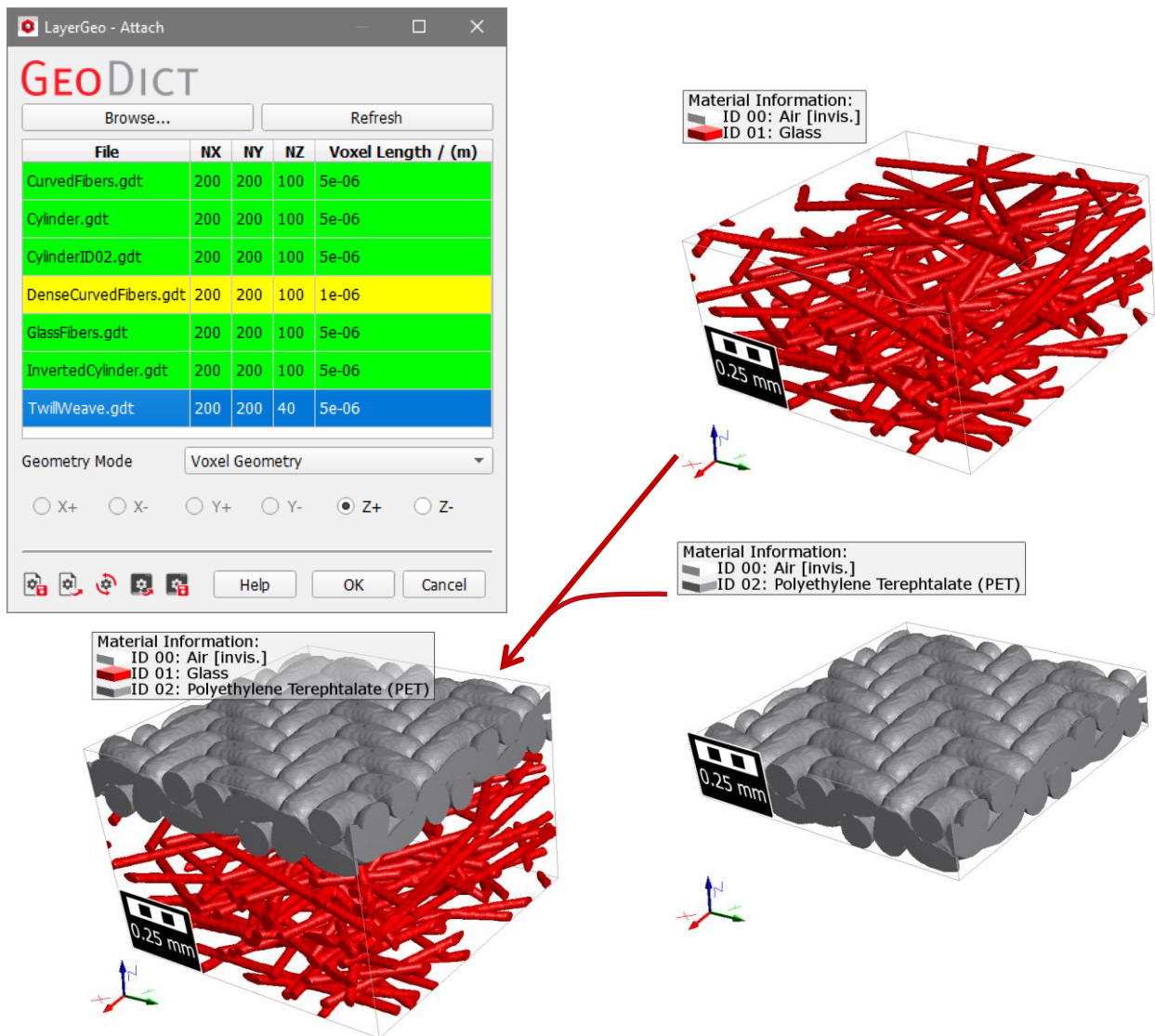
Structures that fit in at least two dimensions in relation to the current structure can be attached to one side of the model. Those structures are highlighted in green and in yellow in the table.

Below the table, the choice of **Geometry Mode** defines if the analytic data or the voxel geometry is used. As default mode, the **Voxel Geometry** is chosen. In this mode, the files are added based on the voxel information alone. If analytic data was present in the geometry files before, this data is discarded.

At the bottom of the dialog, the direction in which the structures will be attached must be selected. Directions that are not selectable are greyed out.

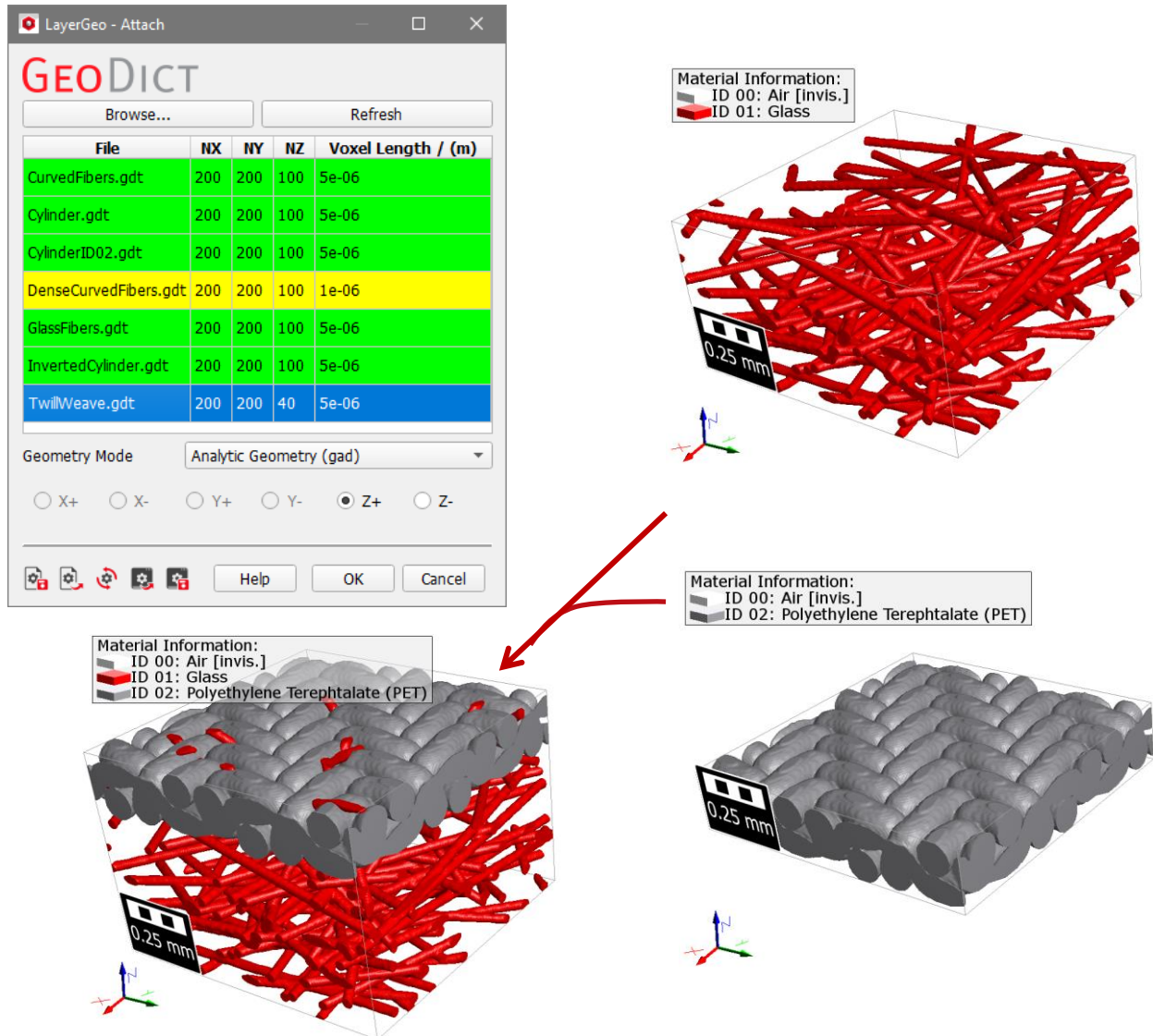
For example, with the GlassFibers.gdt in memory (original structure, with a grid size of 200 x 200 x 100 voxels), the TwillWeave.gdt, with a grid size of 200 x 200 x 40 voxels, appears in yellow. This means only two dimensions, the X- and the Y-dimension, fit to the loaded structure. Thus, the TwillWeave.gdt file can be selected (highlighted blue) and can be attached in either the Z+ or Z- direction.


The other directions (X+, X-, Y+, and Y-) are greyed out and not selectable.



If the loaded structure contains analytic data, the **Analytic Geometry (gad)** mode becomes available. Here, the analytic objects are attached, and the overlap rules defined by the Domain (See **GadGeo – Edit Domain** in the [GadGeo handbook](#)) are used. This works only when the files of both structures (the chosen file and the current structure) contain analytic information.

Below, the same structures as before are attached, but now with the Geometry Mode **Analytic Geometry (gad)**. Some of the glass fibers leave the original domain and become visible in the extended domain.



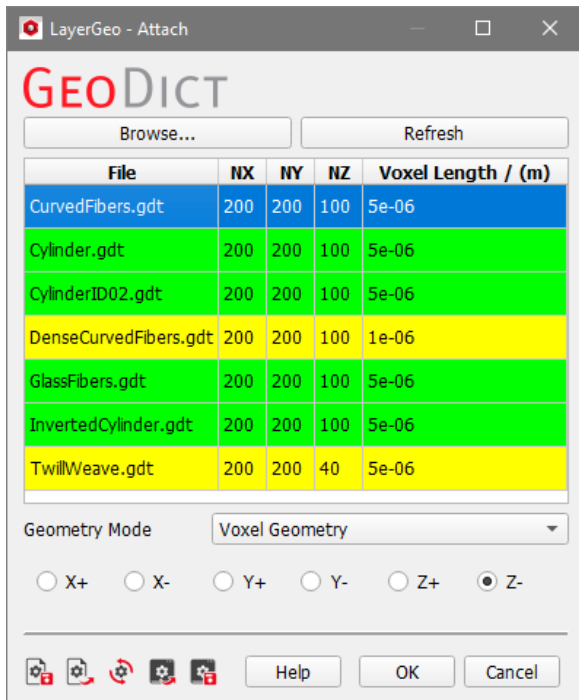
If the direction is erroneously selected, click the **Undo** icon , in the menu bar, and attach the structure again in the correct direction.

Combining and layering structure models

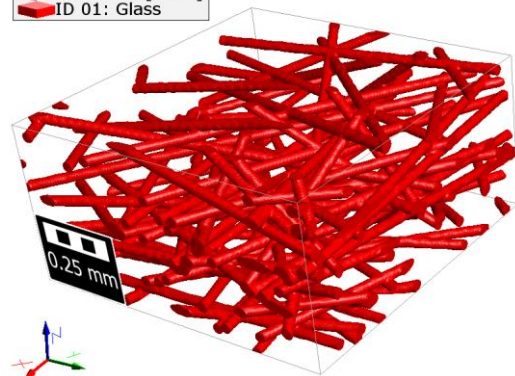
If the original structure and the attached structure contain objects with the same Material ID number, the constituent material of the original structure is kept.

For example, GlassFibers.gdt, containing glass fibers, is used as original structure and CurvedFibers.gdt, containing PET fibers, is attached to it. Individually, the glass fibers and the PET fibers in both structures are assigned to **Material ID 01**.

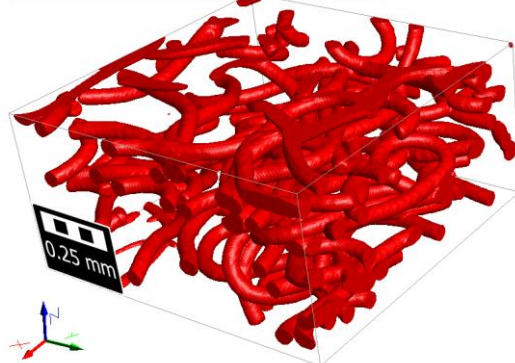
The combined structure uses the constituent material information of the original structure (GlassFibers.gdt), and so, takes on **Glass** as the constituent material of Material ID 01.



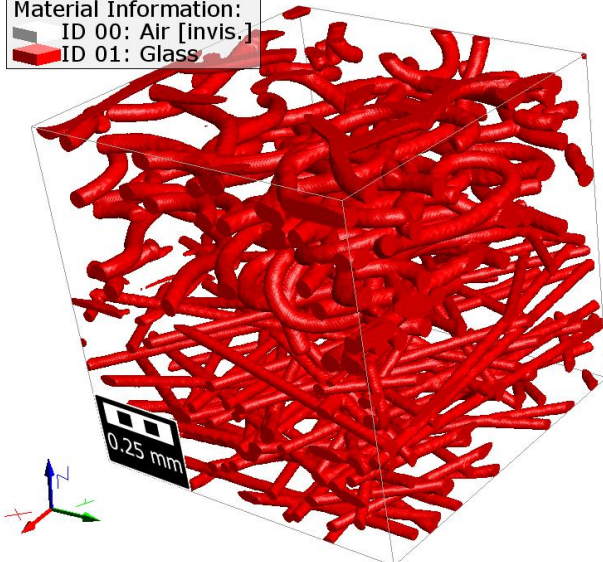
Material Information:
ID 00: Air [Invis.]
ID 01: Glass



Material Information:
ID 00: Air [Invis.]
ID 01: Polyethylene Terephthalate (PET)



Material Information:
ID 00: Air [Invis.]
ID 01: Glass



ADD

The **Add** mode allows to combine a structure with the original structure in such a way that both occupy the same domain. Adding structures commonly results in overlap between the original and the added structure.

Below the table, the choice of **Geometry Mode** defines if the analytic data or the voxel geometry is used. As default mode, the **Voxel Geometry** is chosen. In this mode, the files are added based on the voxel information alone. If analytic data was present in the geometry files before, this data is discarded.

If the loaded structure contains analytic data, the **Analytic Geometry (gad)** mode becomes available. Here, the analytic objects are attached, and the overlap rules defined by the Domain (See **GadGeo – Edit Domain** in the [GadGeo handbook](#)) are used. This works only when the files of both structures (the chosen file and the current structure) contain analytic information.

The **Material Mode** defines the overlap behavior between the original and the added voxel structure.

If **Material** is chosen, the material ID of the overlap can be defined through the given **Overlap ID**. Here, the material ID 06 with the color cyan is chosen.

The image shows two screenshots of the LayerGeo - Add dialog box. The left screenshot shows the 'Material' mode selected, with a dropdown menu for 'Overlap ID' showing '06' selected. The right screenshot shows the 'Voxel Geometry' mode selected, with a dropdown menu for 'MaterialID' showing '06' selected.

File	NX	NY	NZ	Voxel Length / (m)
CurvedFibers.gdt	200	200	100	5e-06
Cylinder.gdt	200	200	100	5e-06
CylinderID02.gdt	200	200	100	5e-06
DenseCurvedFibers.gdt	200	200	100	1e-06
GlassFibers.gdt	200	200	100	5e-06
InvertedCylinder.gdt	200	200	100	5e-06
TwillWeave.gdt	200	200	40	5e-06

Geometry Mode: Voxel Geometry
Material Mode: Material
Overlap ID: 06 Undefined
Offsets / (Voxel): X 0 Y 0 Z 0


MaterialID dropdown options:
Analytic Geometry (gad)
Voxel Geometry
Material
MaterialID
00 Air (Fluid)
01 Glass (Solid)
02 Undefined
03 Undefined
04 Undefined
05 Undefined
06 Undefined
07 Undefined

If **Material ID** is chosen, there is no choice of Overlap ID.

Instead, the material ID of the overlap is computed by a bitwise OR operation on the ID numbers.

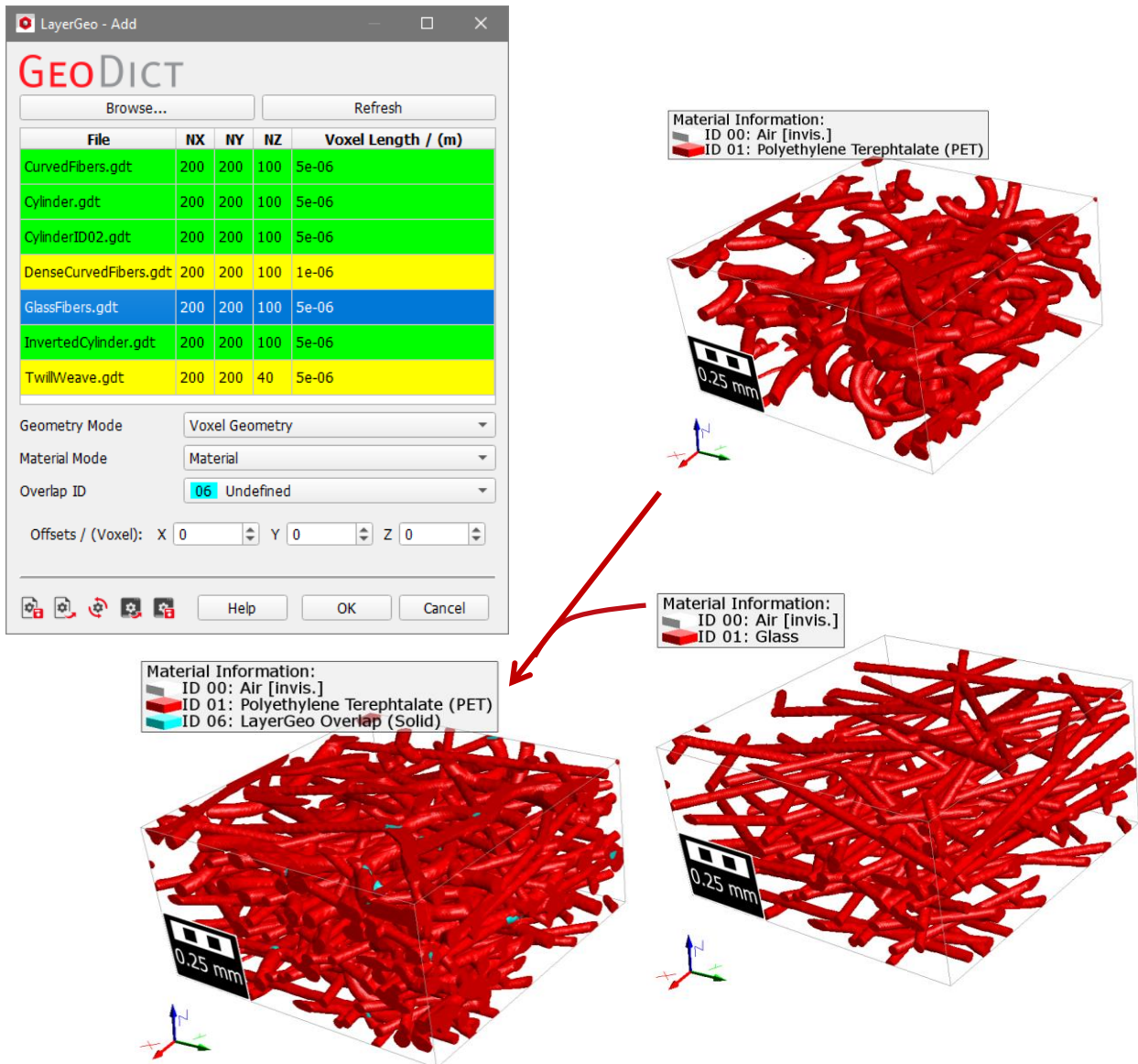
In this mode, adding ID 02 and ID 04 leads to ID 06 ($0010+0100=0110$) and adding ID 03 and ID 01 leads to ID 03 ($0011+0001=0011$).

Combining and layering structure models

The color assigned to a material ID can be changed by selecting it through **Settings** → **Color & Visibility Settings** in the menu bar, its icon  in the toolbar, or the **Color & Visibility** tab at the right edge of the GeoDict GUI. The visibility of a material ID can also be set in the **Color & Visibility Settings** dialog. For more details see the [Visualization handbook](#).

As seen above for the **Attach** layer mode, the combined structure keeps the constituent material information from the original structure in case of same material IDs.

Here, the structure with curved PET fibers (original) and the structure with straight glass fibers are added. The combined Material ID 01 is Polyethylene (PET), as was for the original structure with curved fibers, and not glass.

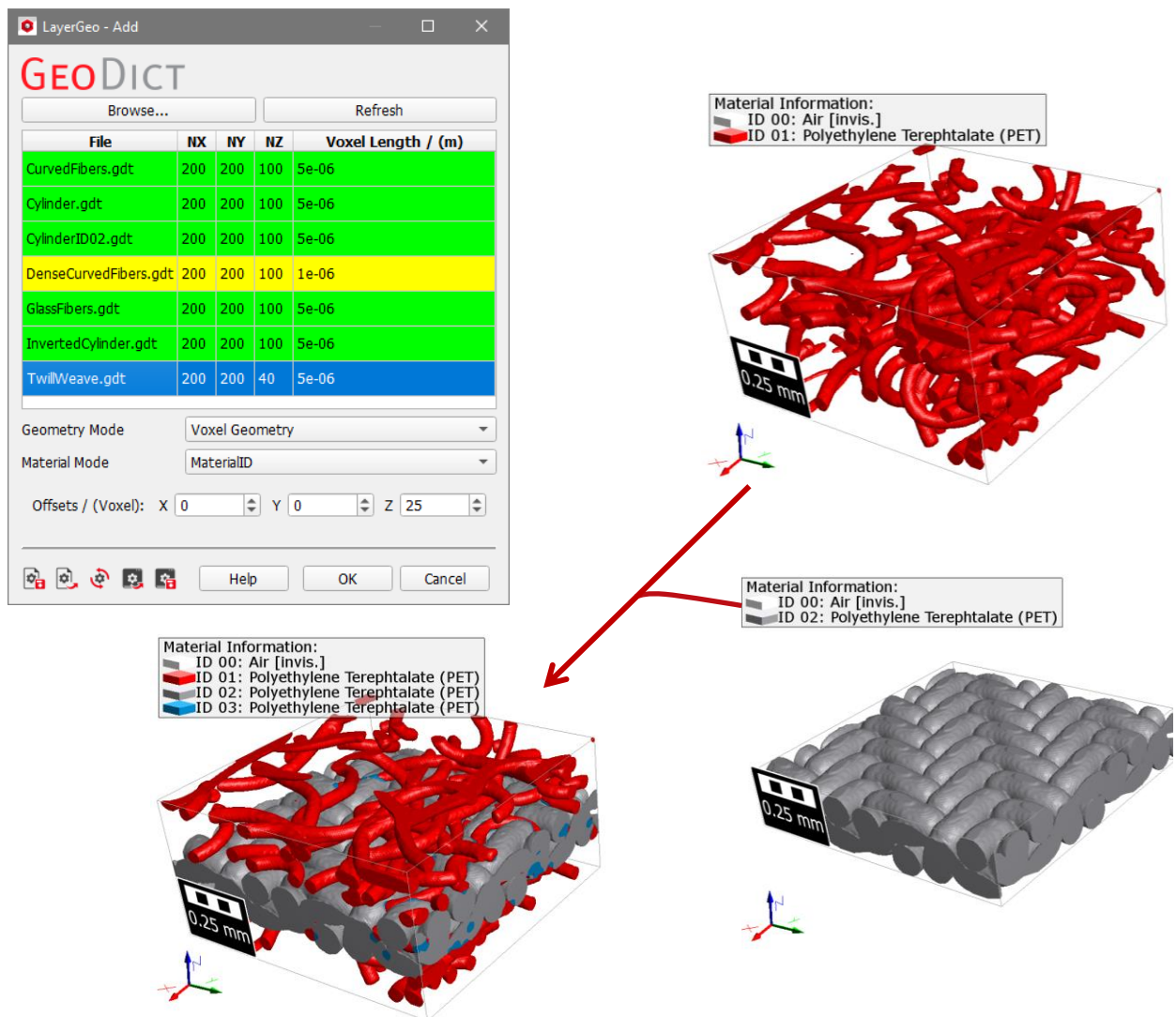


At the bottom of the dialog, the user can define an offset for the position of the added structure. The default zero **Offsets** places the added structure starting at the (0, 0, 0) position of the original structure.

By setting non-zero **Offsets** in any of the three directions, a structure can be added to the original structure at any position in the given direction(s). If the offset forces the chosen structure to leave the domain of the current structure, the resulting structure will be enlarged.

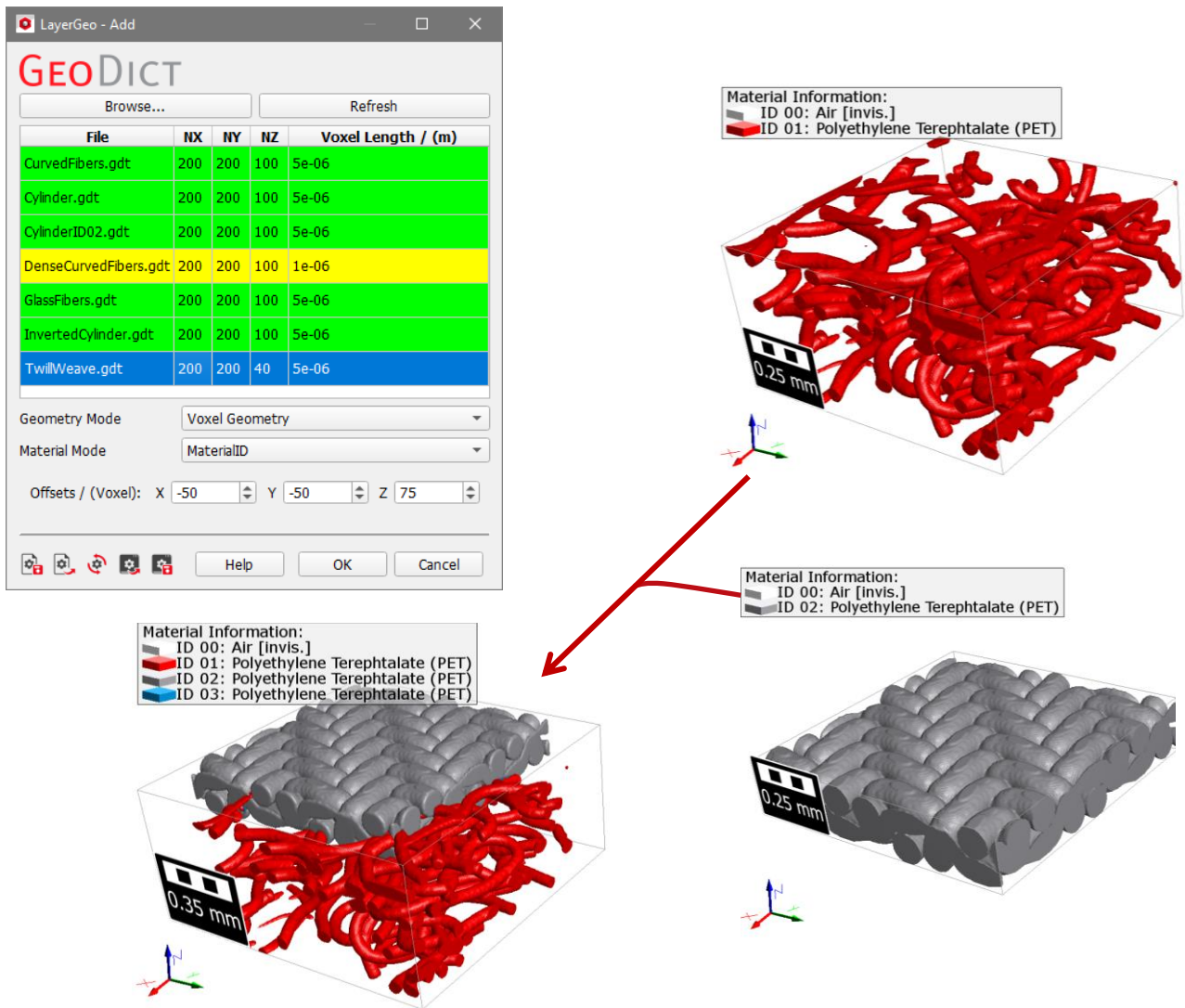
For example, a woven mesh (TwillWeave.gdt) is added to the CurvedFibers.gdt (original structure) with an offset of 25 voxels in Z-direction and the **Material Mode MaterialID**.

The combined structure shows the mesh embedded into the curved fibers.

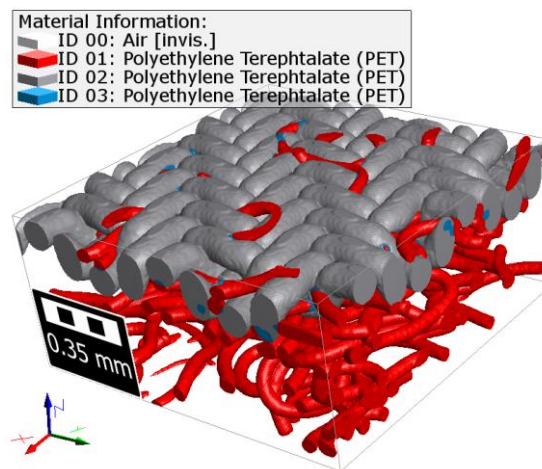


Combining and layering structure models

With offsets of -50, -50, and 75, the mesh appears in the combined structure as follows:



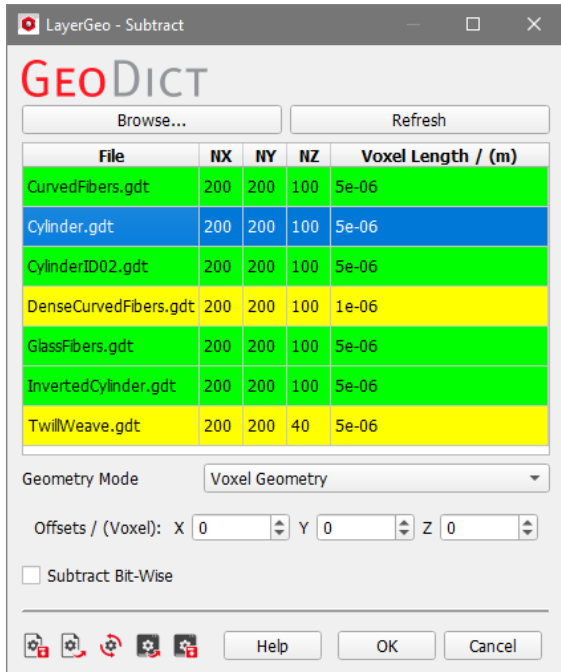
With the same settings as before, but with the Geometry Mode **Analytic Geometry** chosen, the resulting structure will look like this:



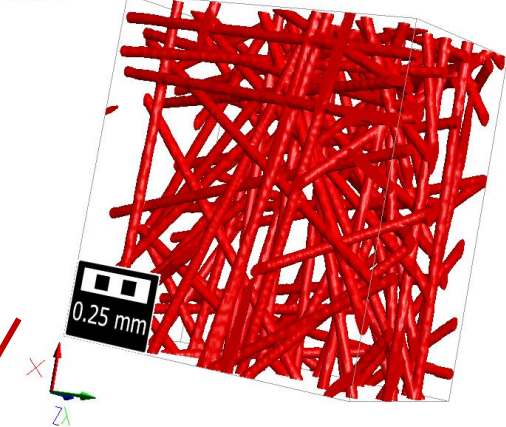
SUBTRACT

The **Subtract** mode allows to remove parts of the original structure by subtracting a structure from it.

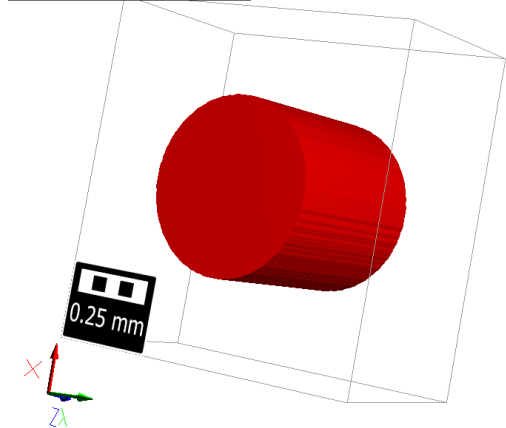
For example, a cylinder is used to remove a portion of the glass fibers, leaving a circular hole in the center of the combined structure.



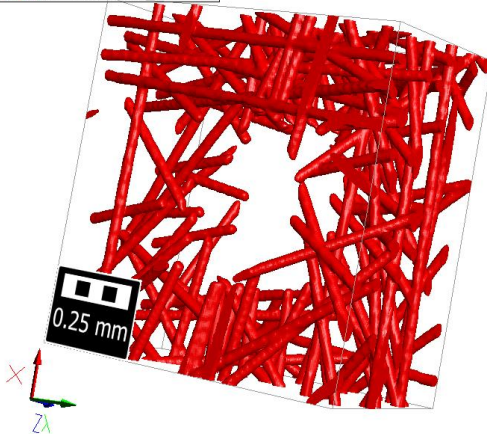
Material Information:
 ID 00: Air [invis.]
 ID 01: Glass



Material Information:
 ID 00: Pore [invis.]
 ID 01: Glass

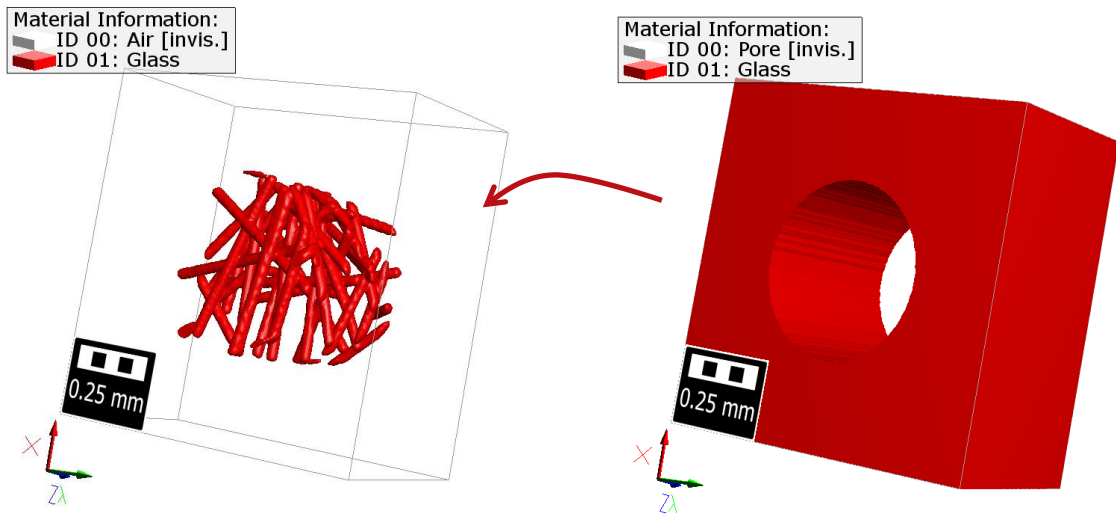


Material Information:
 ID 00: Air [invis.]
 ID 01: Glass

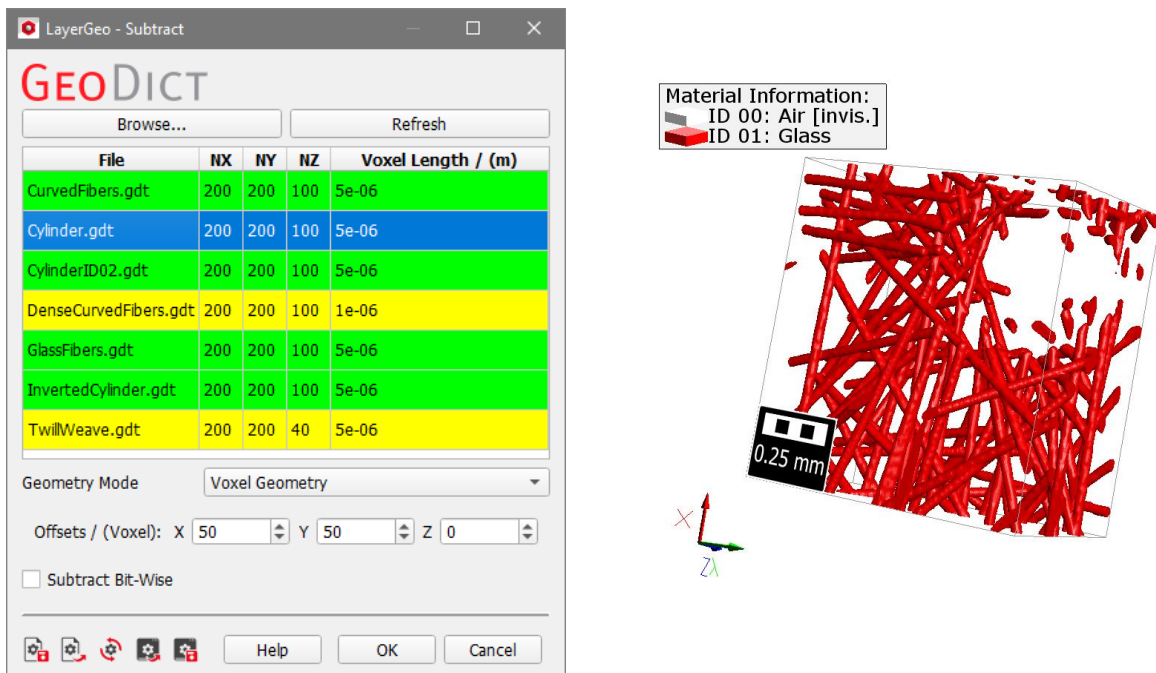


Combining and layering structure models

Or in another case, a cylindrical hole (made by inverting the previous cylinder with **ProcessGeo – Process – Invert**) is used to obtain a cylindrical portion at the center of the glass fibers structure.



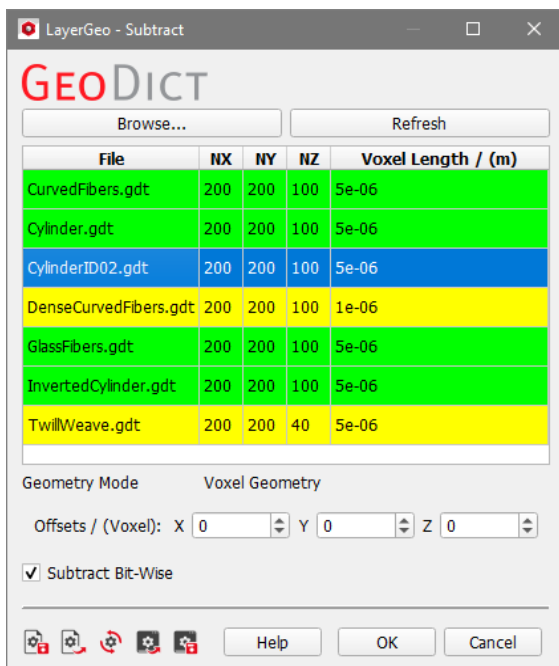
As described on page 8, by setting **Offsets** different from 0, the structure can be subtracted at any location. For example, the previous cylinder is subtracted with an offset of 50 voxels in X direction and a Y offset of 50 voxels, such that the removal of glass fibers is not in the center and the hole appears closer to the corner.



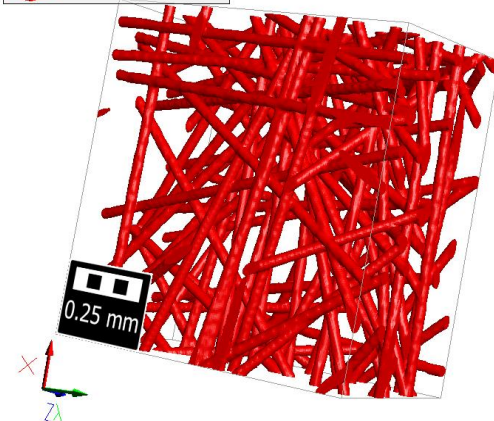
As seen for the **Attach** and the **Add** modes, the combined structure uses the constituent material information of the original structure (here above, GlassFibers.gdt).

With the default setting, the subtraction process sets all material overlap between the two structures to material ID 0. When **Subtract Bit-Wise** is checked, material IDs are subtracted bitwise.

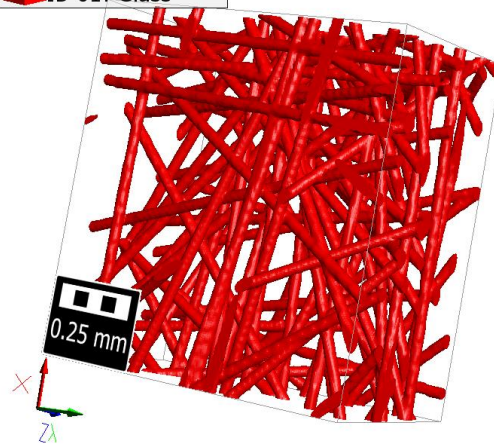
For example, with **Subtract Bit-Wise**, subtracting an object with material ID 02 (CylinderID02.gdt) from the original structure (GlassFibers.gdt), containing only objects with material ID 01, does not produce the combined structure with the hole (since $0001-0010=0001$).



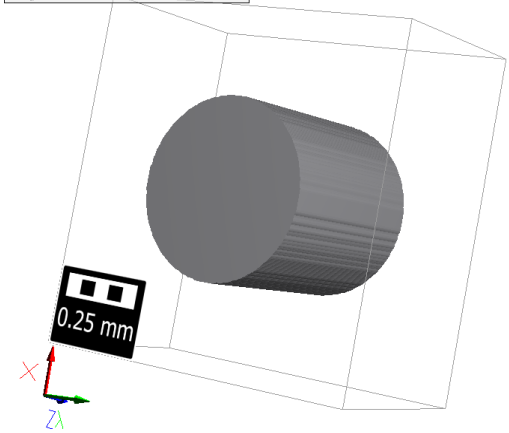
Material Information:
 ID 00: Air [invis.]
 ID 01: Glass



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



Material Information:
 ID 00: Pore [invis.]
 ID 02: Glass



If **Analytic Geometry (gad)** is chosen as Geometry Mode, the analytic objects are subtracted, and an overlap rule which sets any overlap to material ID 00 is used. This works only when both structures (the chosen file and the current structure) have analytic information. The result is the same compared to the voxel method without subtracting bit-wise but the analytic objects remain intact.

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