

newFASANT

Materials User Guide

Software Version: 6.3

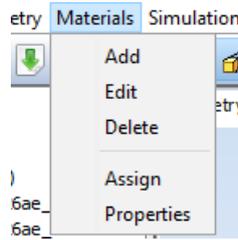
Date: July 24, 2020

Index

1. MATERIALS MENU (MOM AND MONCROS MODULES)	3
1.1. ADD	3
1.2. EDIT	6
1.3. DELETE	7
1.4. ASSIGN	7
1.5. MATERIAL PROPERTIES	8
2. MATERIALS MENU (PO MODULE)	8
2.1. ADD	9
2.2. EDIT	13
2.3. DELETE	13
2.4. ASSIGN	13
2.5. MATERIAL PROPERTIES	14
3. MATERIALS MENU (GTD AND GTD-PO MODULES)	15
3.1. ADD	15
3.2. EDIT	19
3.3. DELETE	20
3.4. ASSIGN	20
3.5. MATERIAL PROPERTIES	21
4. MATERIALS MENU (PERIODICAL STRUCTURES MODULE)	22
4.1. ADD	22
4.2. EDIT	23
4.3. DELETE	24
5. MATERIALS MENU (US MODULE)	24
5.1. ADD	24
5.2. EDIT	27
5.3. DELETE	27
5.4. ASSIGN	28
5.5. PROPERTIES	29
6. APPENDIX A: COLOR SELECTION	29

1. Materials Menu (MOM and MONCROS Modules)

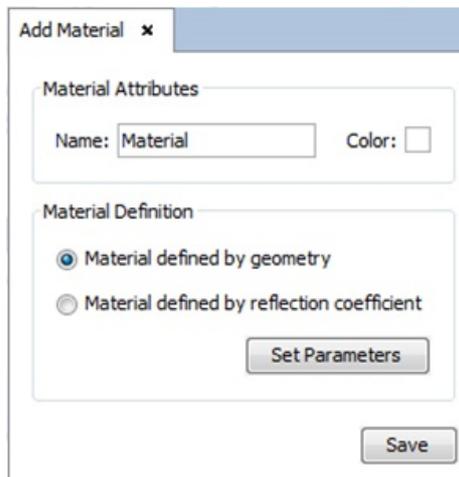
In the following sections, all the options of the materials menu will be discussed:



Materials Menu

1.1. Add

After selecting the Add option the following panel will be shown on the right side of the window:



Add Material panel

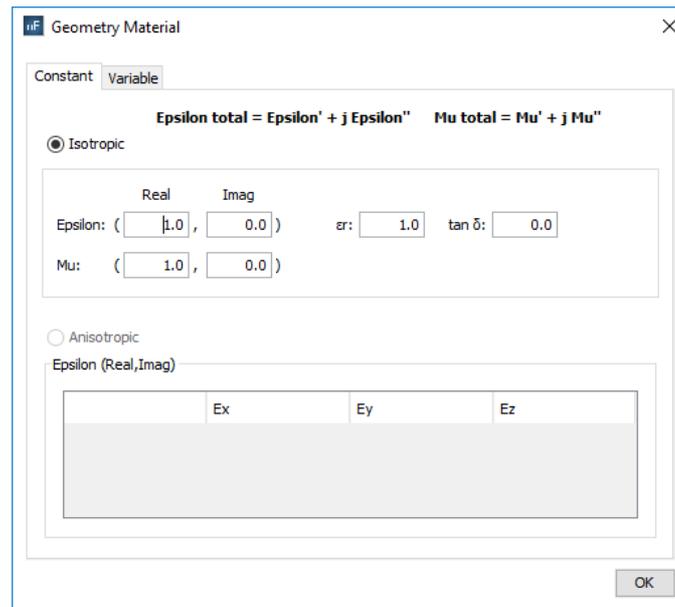
This option allows the user to create a new material. The following options are available

Material Attributes-Name. The user may want to provide a name for this material for future reference.

Material Attributes-Color. For more information, see [APPENDIX A: Color Selection](#)

Material Definition - Material defined by geometry: Used to define a material according to its physical properties. After clicking on the Set Parameters button, two different options are available in the *Material defined by Geometry* window:

- Constant



Material defined by geometry

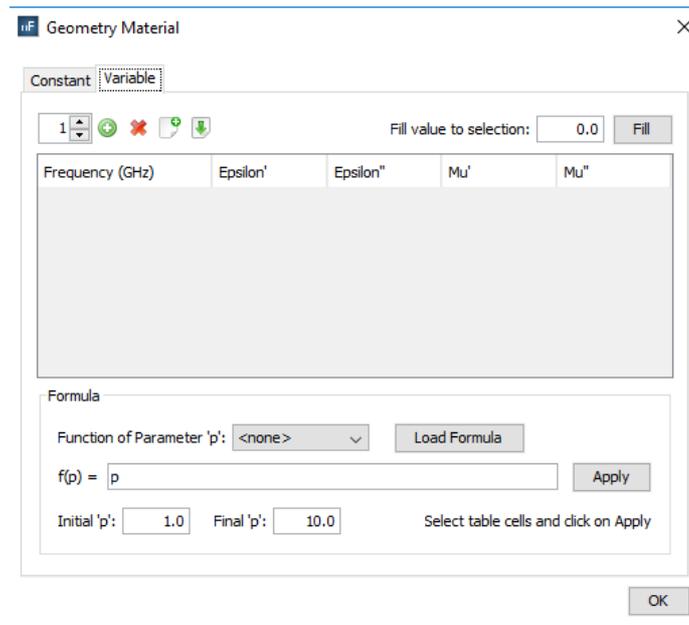
§ **Real part:** common values are greater than or equal to 1.0.

§ **Imaginary part:** if the imaginary part is negative, the material is considered to have losses; otherwise it would be equivalent to a material with gain.

o **Isotropic:** Selecting this option sets the epsilon (ϵ' - permittivity) and mu (μ' - permeability) properties immutable. The user will need to specify both real and imaginary components of both properties or loss tangent and relative permittivity. Common real values for epsilon and mu are greater of equal to 1.0. If the imaginary part is negative, the material is considered to have losses; otherwise, it's considered to be a material with gain.

o **Anisotropic:** This option allows the user to set the material properties depending on the volumetric subdomain direction (i.e. the dielectric coefficient may change depending on the direction of the subdomains). The epsilon parameter consists of a 3x3 matrix where all Cartesian combinations can be modified. The materials using this option are only designed to be applied to volumes.

- **Variable**



Material defined by geometry, tab 'Variable'

To assign the physical properties of the material according to the frequency.

§ **Frequency (in GHz):** Sets the associated frequency to the physical properties. The frequency values for each material are interpolated when the simulation is launched in order to use the most suitable one for the working frequency.

§ **Real part (')**: common values are greater than or equal to 1.0.

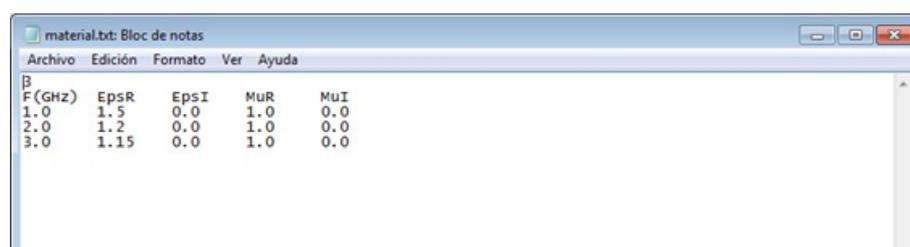
§ **Imaginary part (")**: if the imaginary part is negative, the material is considered to have losses; otherwise it would be equivalent to a material with gain.



§ **Add:** to add new frequencies to the material properties.

§ **Remove:** to remove existing frequencies to the material properties

§ **Import/Export :** to import table with values from a text file or export the table into a text file.



File Format

The information of this file can be modified by the user. Be sure not to modify the format and not to introduce any additional line break.

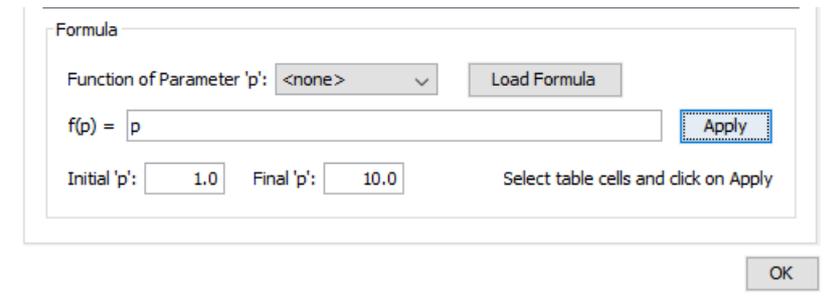


§ **Fill value to selection:** This option allows the user to automatically change the value of the selected cells of the table with the inserted

value

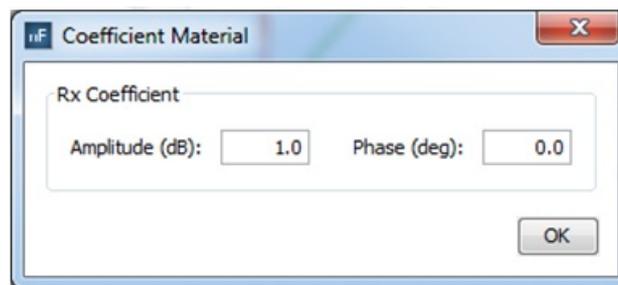
These parameters can also be set using formulas in function of the frequency values.

§ Formula:



This option serves for completing the selected cells of the table with values depending on the selected function. After choosing the function that we want to apply, pressing the Load Formula button will load the formula $f(p)$ in the field. The next step is choosing the initial and the final value for the function. The final step is selecting the cells that we want to apply the function to and press the button Apply. The cells will be autocompleted with the values created by the chosen function starting with the initial value and ending with the final one.

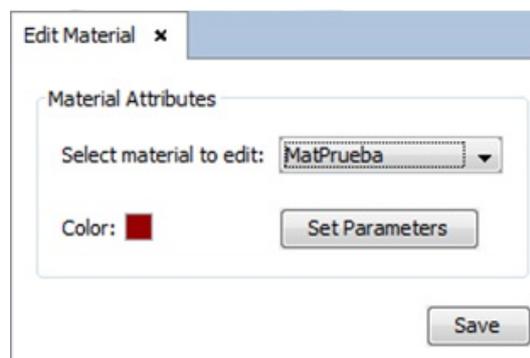
Material Definition - Material defined by reflection coefficient: Used to define a material according to its reflection coefficient. After clicking on the Set Parameters button, a window appears to define the reflection coefficient:



Material defined by reflection coefficient

1.2. Edit

When this option is selected, a panel similar to the Add panel will be shown:

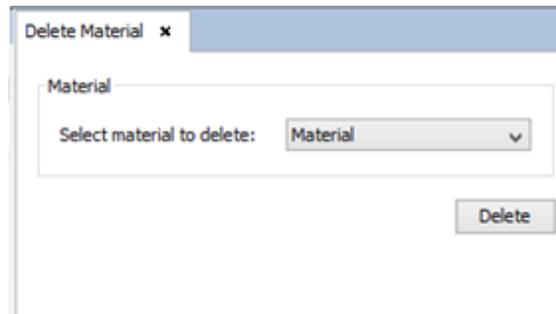


Edit Material panel

This panel allows the user to select an existing material to edit its properties. Refer to [Section 2.1](#) for details on setting the color and physical parameters of materials.

1.3. Delete

Selecting this option shows the following panel on the right side of the window:

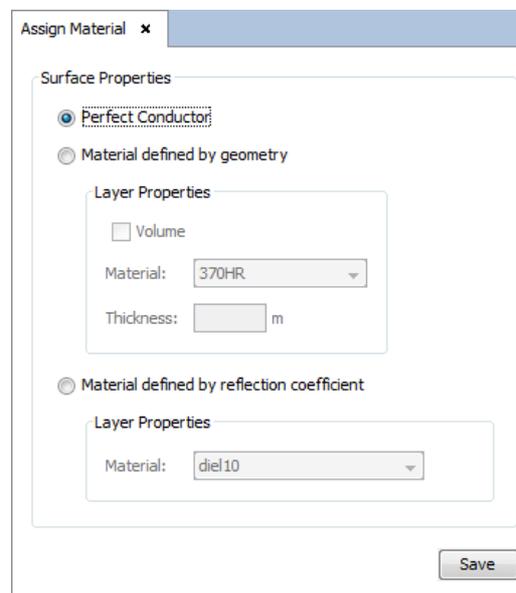


Delete Material panel

In this panel, the user may select the name of the material to remove and then left-click the Delete button.

1.4. Assign

This option allows the user to assign existing materials to objects and surfaces previously selected from the geometry tab. Selecting this option shows the following panel on the right side of the screen.



Assign Material panel

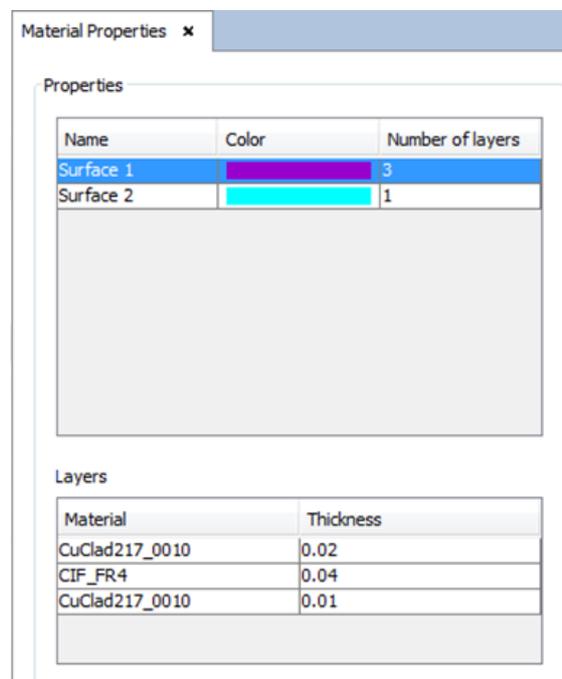
The following operations can be applied to surfaces:

- **Perfect Conductor:** Type of material that is selected by default. It corresponds to the metallic material.
- **Material defined by geometry:** This option allows the user to select a custom material and a thickness value for the selected objects and/or surfaces. If the 'Volume' option is selected, the objects (not surfaces) will be transformed to a volume and this property will be considered for the meshing and simulation.
- **Material defined by reflection coefficient:** This option allows the user to select a custom material for the selected objects and/or surfaces.

In order to assign a material to a surface or an object, first, select this one on the screen and then choose the material to be assigned. Finally, click on *Save* button.

1.5. Material Properties

This option displays the material assigned to different surfaces. The first table shows the selected surfaces, the color of the assigned material and the number of layers. The second table shows the selected surface of the first table with the materials of each layer.

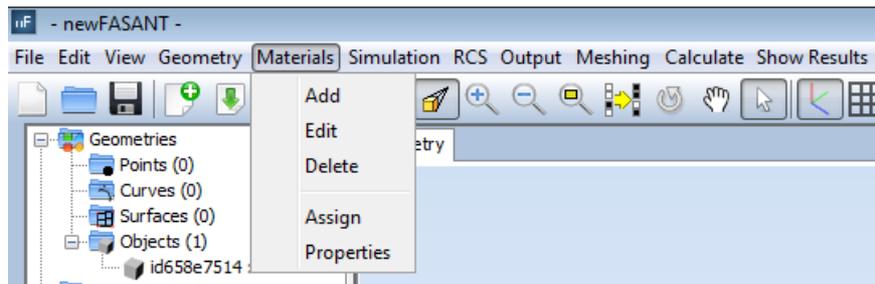


Material properties

PO module supports the multilayer material. Other modules only have one layer of a material.

2. Materials Menu (PO Module)

In this section, all the features available in the PO (Physical Optic) module Materials menu are explained. The available options in the Materials menu are shown in the next Figure.

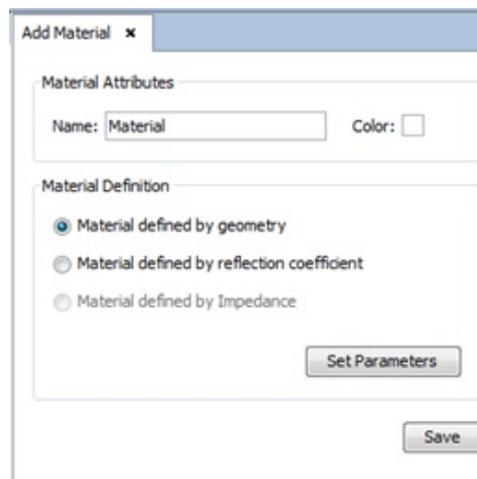


Materials Menu

In the following sections, all the options of the Materials Menu are detailed.

2.1. Add

When Add is selected, the Add Material window appears, as shown in the next Figure.



Add Material panel

Select the required parameters and click on Save. When clicking on this button, if the material exists, then a message is displayed informing the user that the material has already been defined. Otherwise, the material definitions are saved.

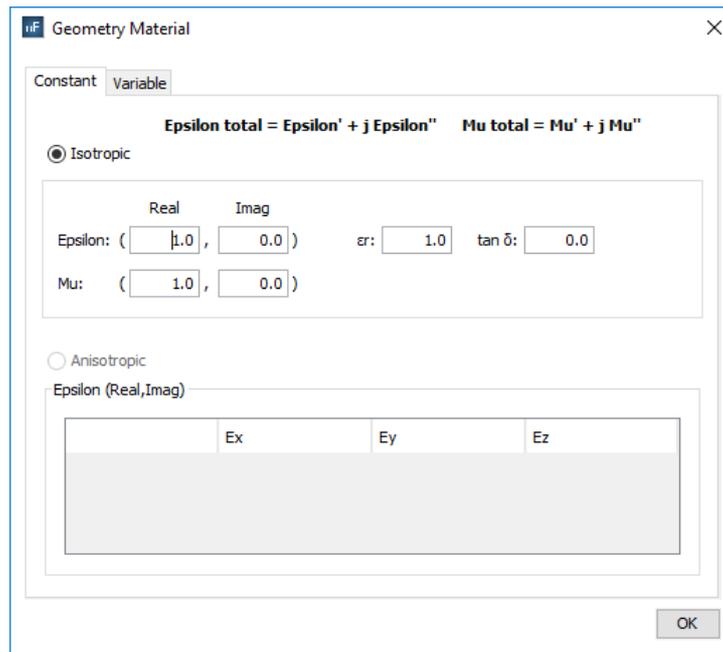
In the Add Material window, the following options are available:

Material Attributes - Name: The user specifies the desired name for the new material.

Material Attributes - Color: For more information, see [APPENDIX A: Color Selection](#).

Material definition - Material defined by geometry: Used to define a material according to its physical properties. After clicking on the Set Parameters button, two different options are available in the Material defined by Geometry window:

- **Constant**



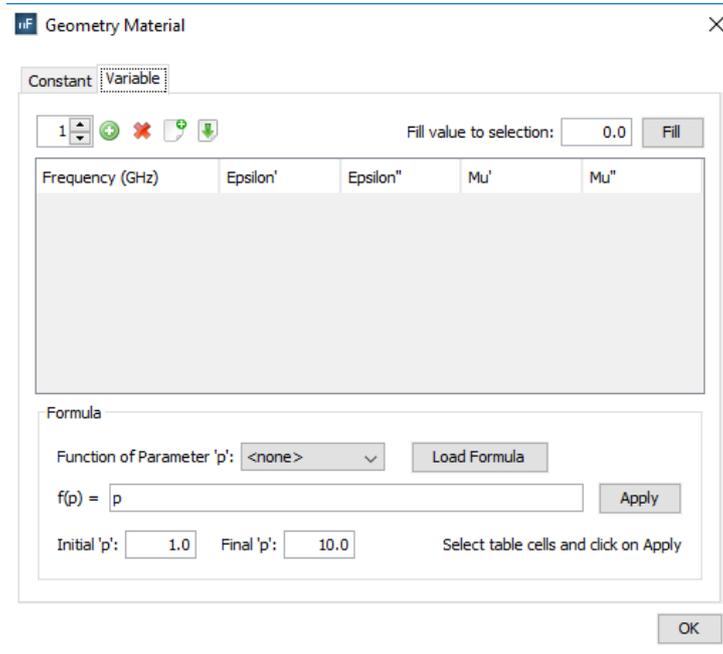
Material defined by geometry, tab 'Constant'

To set the material properties immutable. Epsilon (ϵ') and Mu (μ') are defined with the same restrictions.

§ **Real part:** common values are greater than or equal to 1.0.

§ **Imaginary part:** if the imaginary part is negative, the material is considered to have losses; otherwise it would be equivalent to a material with gain.

- **Variable**



Material defined by geometry, tab 'Variable'

To assign the physical properties of the material according to the frequency.

§ **Frequency (in GHz):** Sets the associated frequency to the physical properties. The frequency values for each material are interpolated when the simulation is launched in order to use the most suitable one for the working frequency.

§ **Real part ('):** common values are greater than or equal to 1.0.

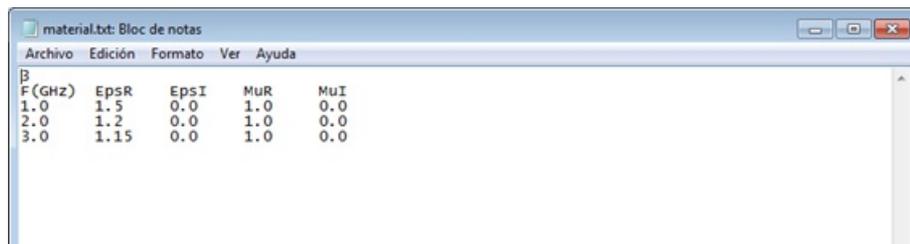
§ **Imaginary part ("):** if the imaginary part is negative, the material is considered to have losses; otherwise it would be equivalent to a material with gain.



§ **Add:** to add new frequencies to the material properties.

§ **Remove:** to remove existing frequencies to the material properties

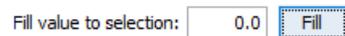
§ **Import/Export :** to import table with values from a text file or export the table into a text file.



F (GHz)	EpsR	EpsI	MuR	MuI
1.0	1.5	0.0	1.0	0.0
2.0	1.2	0.0	1.0	0.0
3.0	1.15	0.0	1.0	0.0

File Format

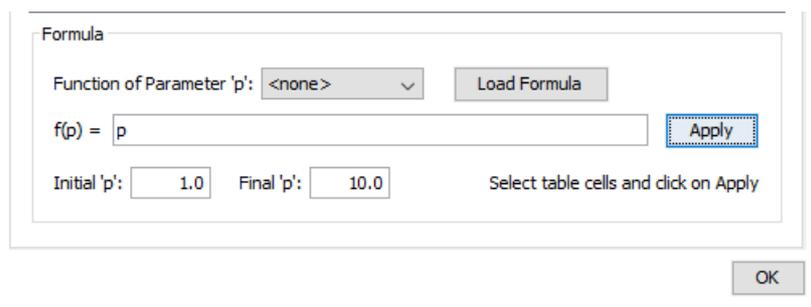
The information of this file can be modified by the user. Be sure not to modify the format and not to introduce any additional line break.



§ **Fill value to selection:** This option allows the user to automatically change the value of the selected cells of the table with the inserted value

These parameters can also be set using formulas in function of the frequency values.

§ **Formula:**



Formula

Function of Parameter 'p':

f(p) =

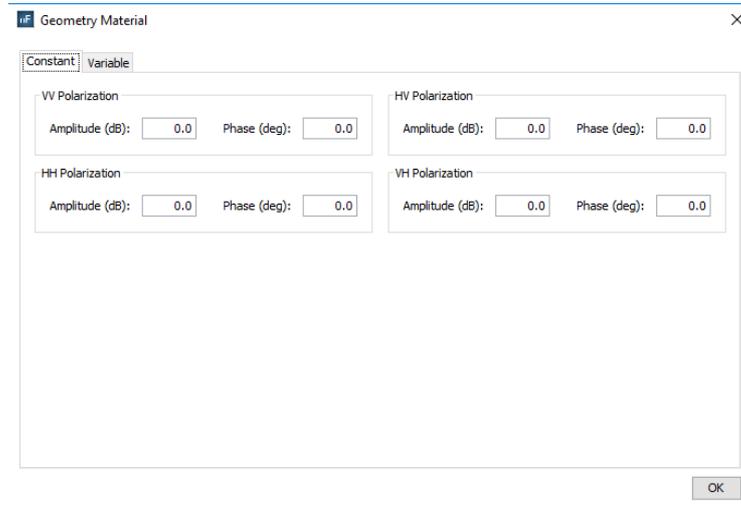
Initial 'p': Final 'p':

This option serves for completing the selected cells of the table with values depending on the selected function. After choosing the function that we want to apply, pressing the Load Formula button will load the formula f(p) in the field. The next step is choosing the initial and the final value for the function. The final step is selecting the cells that we want to apply the function to and press the button Apply. The cells will be autocompleted with the values created by the chosen function starting with the initial value and ending with the final one.

Material Definition - Material defined by reflection coefficient. Used to define a material according to its reflection coefficient. After

clicking on the Set Parameters button, two different options are available in the Material defined by reflection window (the following Figure):

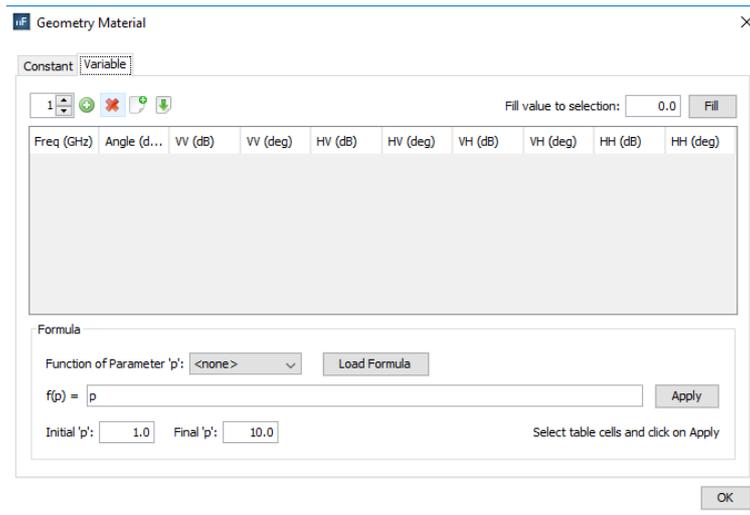
- **Constant**



Material defined by coefficient, tab 'Constant'

To set the material properties invariable. Amplitude and Phase are defined using decibels (dB) and degrees (degrees).

- **Variable with frequency and angle**



Material defined by coefficient, tab 'Variable'

To assign the refraction properties of the material according to the frequency and angle.

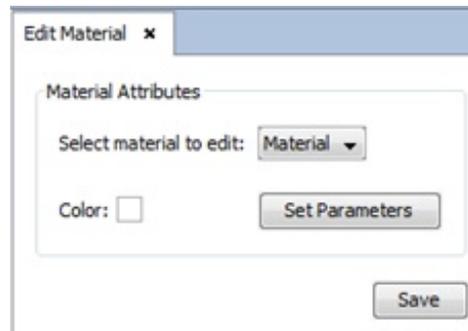
§ **Frequency (in GHz):** Sets the associated frequency to the physical properties. The frequency values for each material are interpolated when the simulation is launched in order to use the most suitable one for the working frequency.

§ **Angle (in degrees):** Sets the associated angle to the physical properties.

To view further explanation about all the options given in the previous picture, refer to the **Material defined by geometry- Variable** section of this guide.

2.2. Edit

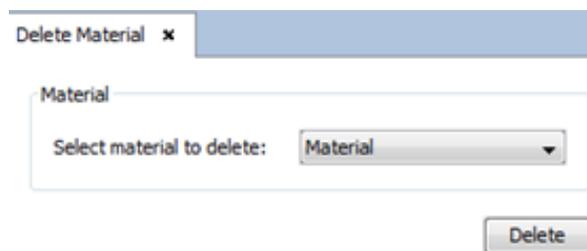
This option allows the user to modify a previously defined Material. When the Materials –Edit option is selected the Edit Material window (following Figure) appears. When the material to be edited has been selected in the Select material combo box, its color can be modified. It is important to remark that the properties of the materials may be modified, but not their type (defined by geometry, defined by electrical impedance, or defined by reflection coefficient). To edit the material parameters, click on the Set Parameters button and the corresponding window (following Figure) will appear. The rest of the editing process may continue as explained in section [“2.1 Add: Material Definition – Material Defined by geometry”](#).



Edit Material panel

2.3. Delete

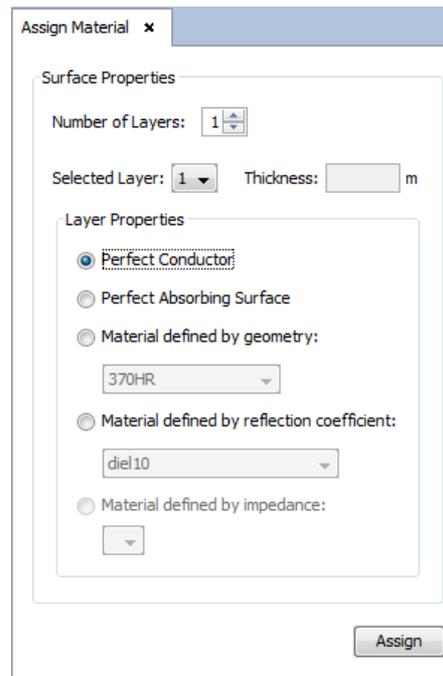
This option allows the user to remove a previously defined Material. When the Materials –Delete option is selected, the Delete Material window (following Figure) appears. When the material to be deleted has been selected in the Select material combo box, the action can be confirmed by clicking on Delete.



Delete Material panel

2.4. Assign

The geometry properties assigned to materials can be edited by clicking on Materials Assign. After selecting this option, the surfaces/objects assigned to specific materials must be selected, and confirm the selection with the “Assign” button as shown in next Figure.



Assign Material panel

The following material assignment options can be applied to surfaces:

- **Number of Layers:** to specify the number of layers to be considered in this object.
- **Selected Layer:** to select the layer that is being edited.
- **Thickness:** to assign a thickness to each layer.

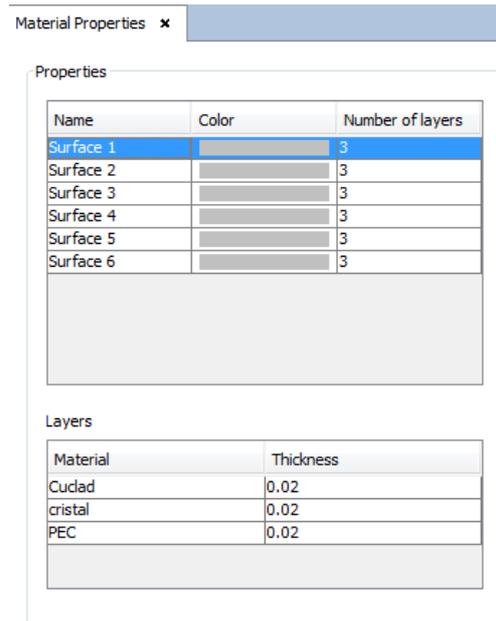
For each layer, the user can select one of the following material types but can't assign material properties defined by geometry, material properties defined by reflection coefficient, and material properties defined by electrical impedance to the same surface.

- **Perfect Conductor.** The objects of this type of material are metallic or PEC (Perfect Electrical Conductor). This is the material selected by default.
- **Perfect Absorbing Surface.** The objects of this type of material are perfectly absorbing.
- **Material defined by geometry.** If there are materials defined with this type, it is possible to assign them by selecting from the combo box.
- **Material defined by reflection coefficient.** If there are materials defined with this type, it is possible to assign them by selecting from the combo box.
- **Material defined by electrical impedance.** If there are materials defined with this type, it is possible to assign them by selecting from the combo box. (Note: This feature is under development at this moment.)
- **Assign button.** To confirm the changes.

In order to assign a material to a surface or an object, first, select this one on the screen and then choose the material to be assigned. Finally, click on *Save* button.

2.5. Material Properties

This option displays the material assigned to different surfaces. The first table shows the selected surfaces, the color of the assigned material and the number of layers. The second table shows the selected surface of the first table with the materials of each layer.

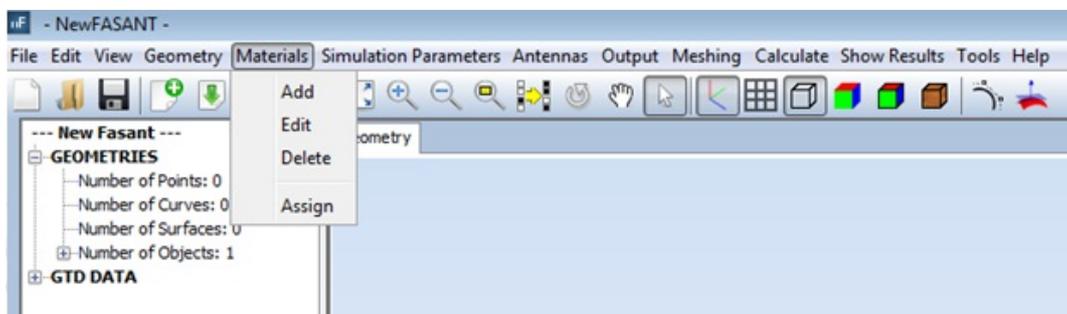


Material properties

PO module supports the multilayer material. Other modules only have one layer of a material.

3. Materials Menu (GTD and GTD-PO Modules)

In this section all the features available in the GTD (Geometrical Theory of Diffraction) module Materials menu are explained. The available options in the Materials menu are shown in the next Figure.

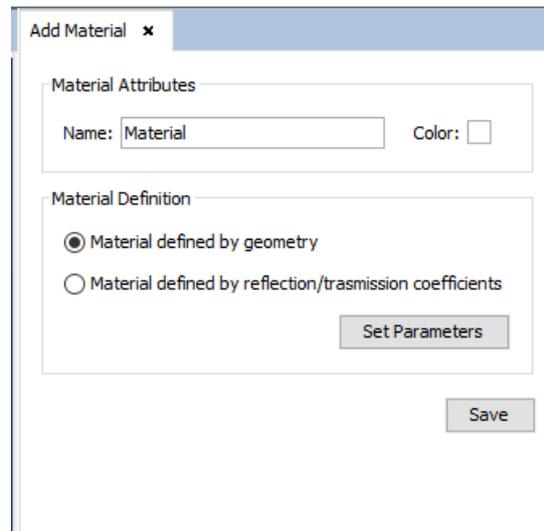


Materials Menu

In the following sections all the options of the Materials Menu are detailed.

3.1. Add

When Add is selected, the Add Material window appears, as shown in the next Figure.



Add Material panel

Select the required parameters and click on Save. When clicking on "save" to save the material, if it exists, then a message is displayed informing the user that the material has already been defined. If not, then the material definitions are saved.

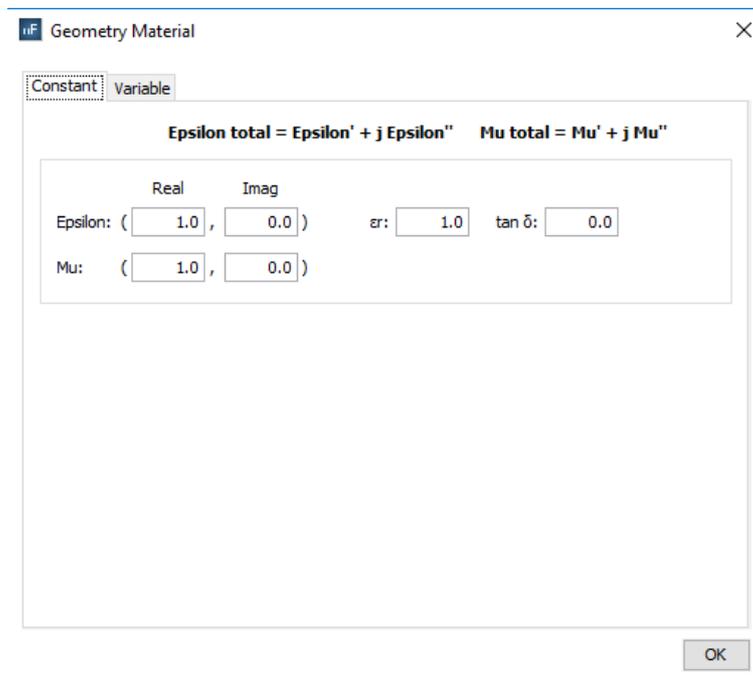
In the Add Material window, the following options are available:

Material Attributes - Name. The user specifies the desired name for the new material.

Material Attributes - Color. For more information, see [APPENDIX A: Color Selection](#).

Material Definition - Material defined by geometry. Used to define a material according to its physical properties. After clicking on the Set Parameters button, two different options are available in the Material defined by Geometry window:

- Constant



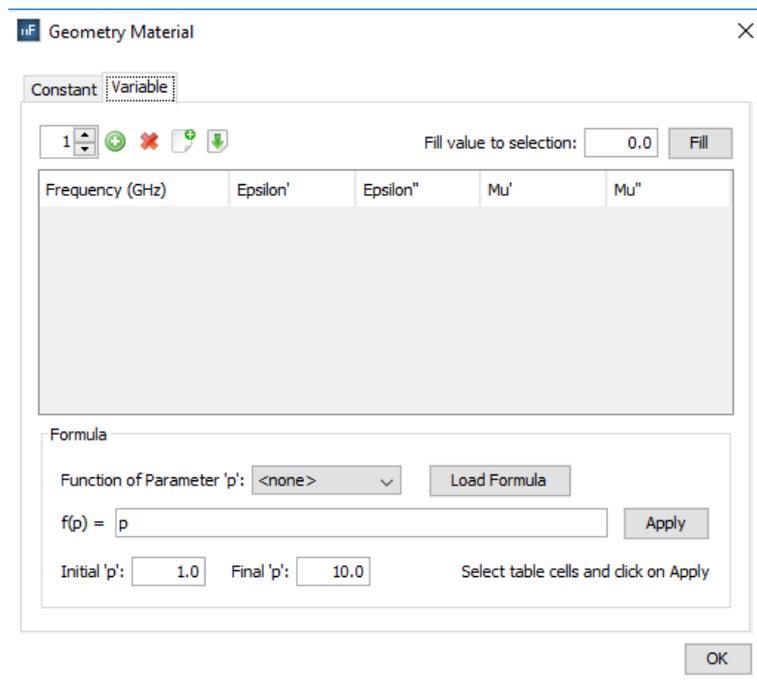
Material defined by geometry, tab 'Constant'

To set the material properties invariable. Epsilon (ϵ') and Mu (μ') are defined with the same restrictions.

§ **Real part:** common values are greater than or equal to 1.0.

§ **Imaginary part:** if the imaginary part is negative, the material is considered to have losses; otherwise it would be equivalent to a material with gain.

- **Variable**



Material defined by geometry, tab 'Variable'

To assign the physical properties of the material according to the frequency.

§ **Frequency (in GHz):** Sets the associated frequency to the physical properties. The frequency values for each material are interpolated when the simulation is launched in order to use the most suitable one for the working frequency.

§ **Real part ('):** common values are greater than or equal to 1.0.

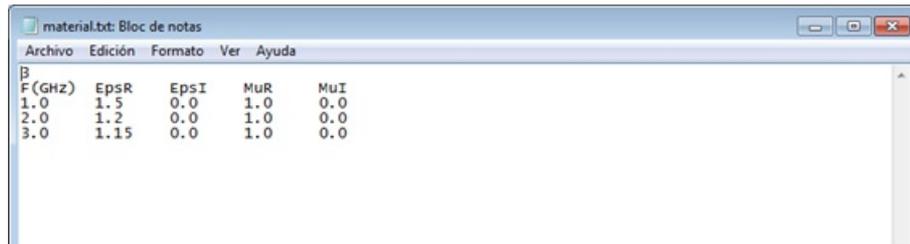
§ **Imaginary part (''):** if the imaginary part is negative, the material is considered to have losses; otherwise it would be equivalent to a material with gain.



§ **Add:** to add new frequencies to the material properties.

§ **Remove:** to remove existing frequencies to the material properties

§ **Import/Export :** to import table with values from a text file or export the table into a text file.



F (GHz)	EpsR	EpsI	MuR	MuI
1.0	1.5	0.0	1.0	0.0
2.0	1.2	0.0	1.0	0.0
3.0	1.15	0.0	1.0	0.0

File Format

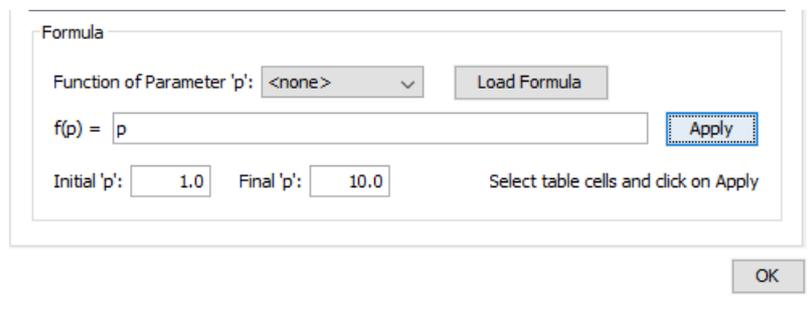
The information of this file can be modified by the user. Be sure not to modify the format and not to introduce any additional line break.

Fill value to selection:

§ **Fill value to selection:** This option allows the user to automatically change the value of the selected cells of the table with the inserted value

These parameters can also be set using formulas in function of the frequency values.

§ Formula:



Formula

Function of Parameter 'p':

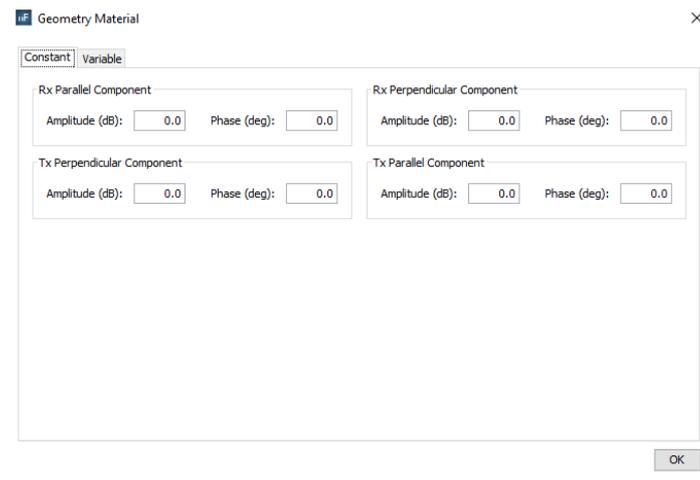
f(p) =

Initial 'p': Final 'p': Select table cells and click on Apply

This option serves for completing the selected cells of the table with values depending on the selected function. After choosing the function that we want to apply, pressing the Load Formula button will load the formula $f(p)$ in the field. The next step is choosing the initial and the final value for the function. The final step is selecting the cells that we want to apply the function to and press the button Apply. The cells will be autocompleted with the values created by the chosen function starting with the initial value and ending with the final one.

Material Definition - Material defined by reflection/transmission coefficient. Used to define a material according reflection coefficient. After clicking on the Set Parameters button, three different options are available in the Material defined by reflection window (following Figure):

- Constant



Material defined by coefficient, tab 'Constant'

To set the material properties invariable. Amplitude and Phase are defined with decibels (dB) and degrees (degrees).

- Variable with frequency and angle



Material defined by coefficient, tab 'Variable'

To assign the refraction and transmission properties of the material according to the frequency and angle.

§ **Frequency (in GHz):** Sets the associated frequency to the physical properties. The frequency values for each material are interpolated when the simulation is launched in order to use the most suitable one for the working frequency.

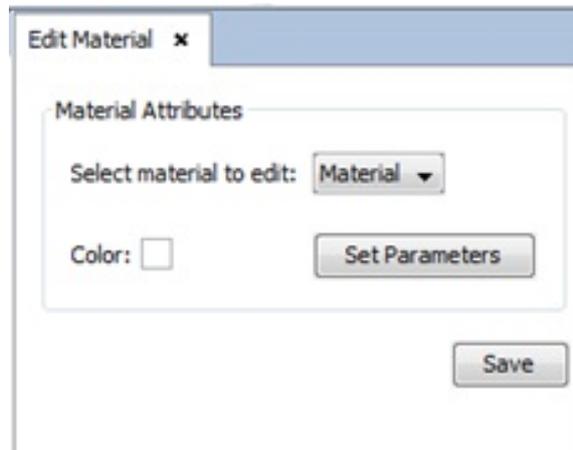
§ **Angle (in degrees):** Sets the associated angle to the physical properties.

To view further explanation about all the options given in the previous picture, refer to the **Material defined by geometry- Variable** section of this guide.

3.2. Edit

This option allows the user to modify a previously defined Material. When the Materials –Edit option is selected the Edit Material window (following Figure) appears. When the material to be edited has been selected from the Select material combo box, its color can be modified. It is important to remark that the properties of the materials may be modified, but not their type (defined by geometry, defined by electrical impedance, or defined by reflection coefficient). To edit the material parameters, click on the Set Parameters button and the corresponding window (following Figure) will appear. The rest of the editing process may continue as explained in section [“3.1 Add:](#)

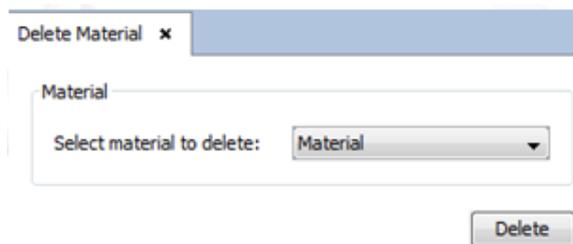
[Material Definition – Material Defined by geometry”.](#)



Edit Material panel

3.3. Delete

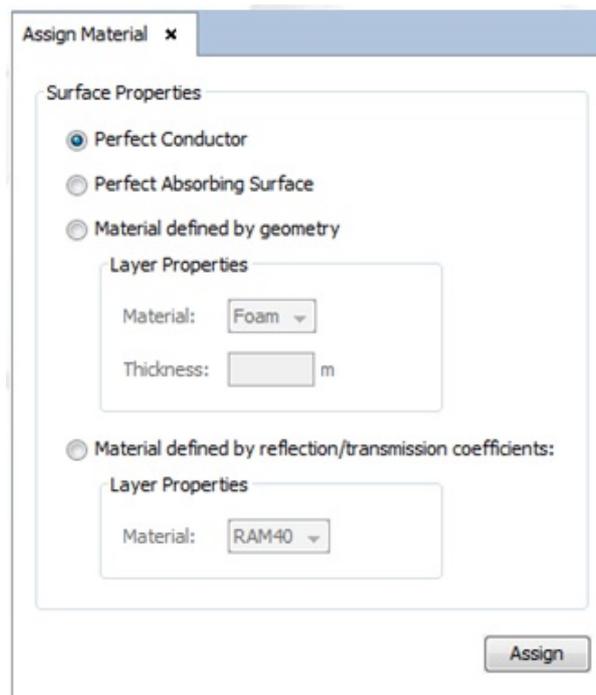
This option allows the user to remove a previously defined Material. When the Materials –Delete option is selected, the Delete Material window (following Figure) appears. When the material to be deleted has been selected in the Select material combo box, the action can be confirmed by clicking on Delete.



Delete Material panel

3.4. Assign

The geometric properties assigned to materials can be edited by clicking on Materials - Assign. After selecting this option, the surfaces/objects assigned to specific materials must be selected, and confirm the selection with the “Assign” button as shown in next Figure.



Assign Material panel

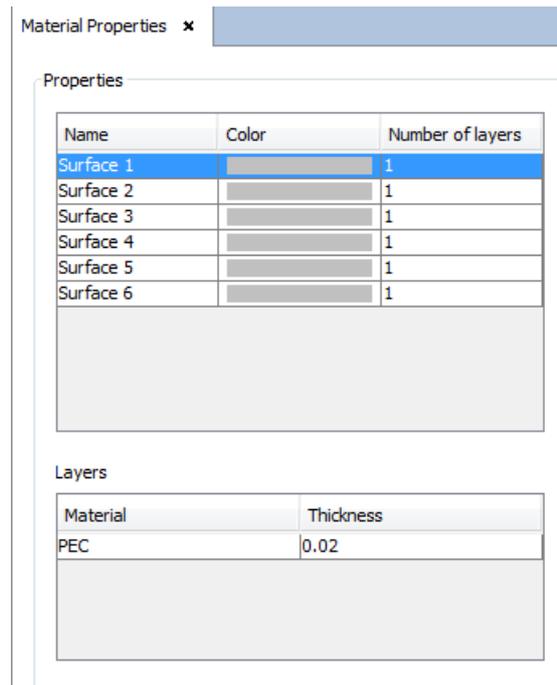
The following material assignment options can be applied to surfaces:

- **Perfect Conductor.** The objects of this type of material are metallic, or PEC (Perfect Electrical Conductor). This is the material selected by default.
- **Perfect Absorbing Surface.** The objects of this type of material are perfectly absorbing.
- **Material defined by geometry.** If there are materials defined with this type, it is possible to assign them by selecting from the combo box and to specify the thickness.
- **Material defined by reflection/transmission coefficient.** If there are materials defined with this type, it is possible to assign them by selecting from the combo box.
- **Assign button.** To confirm the changes.

In order to assign a material to a surface or an object, first, select this one on the screen and then choose the material to be assigned. Finally, click on *Save* button.

3.5. Material Properties

This option displays the material assigned to different surfaces. The first table shows the selected surfaces, the color of the assigned material and the number of layers. The second table shows the selected surface of the first table with the materials of each layer. This options is only available in GTD module.

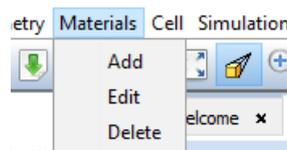


Material properties

PO module supports the multilayer material. Other modules only have one layer of a material.

4. Materials Menu (Periodical Structures Module)

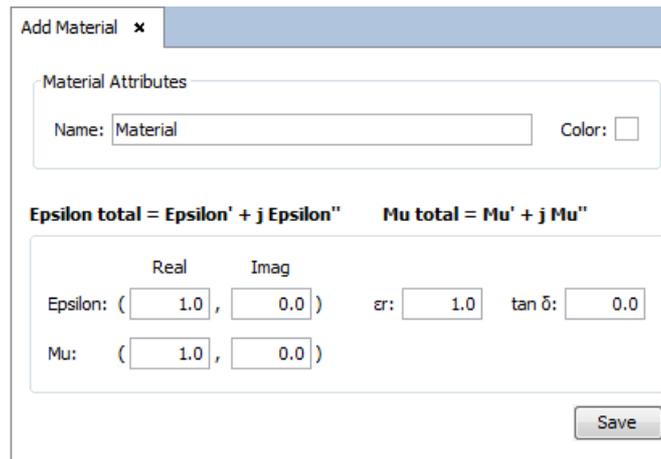
In this section, the different options of the "Materials" menu from the Periodical Structures module will be detailed. The following figure shows the "Materials" menu of this module:



"Materials" menu of the Periodical Structures module

4.1. Add

The "Add" option of the materials menu allows the user to add a new material to the list of materials. When this option is selected, the following tab will appear:



"Add Material" tab

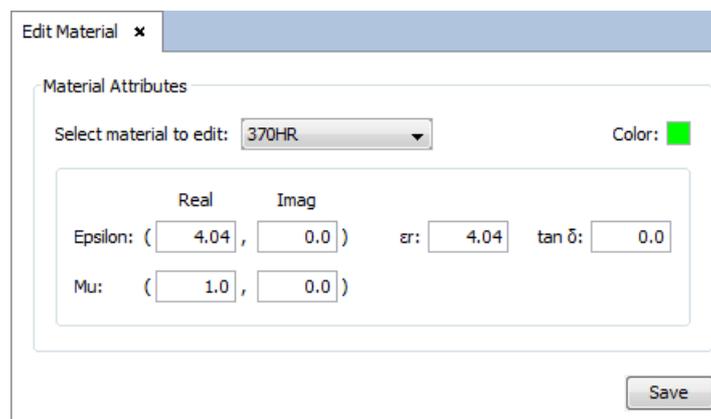
In this tab, the user can set the parameters for the material they want to create. The "Material Attributes - Name" option allows the user to give a name for the created material for future reference, and the "Material Attributes - Color" allows to give the material a representative color by clicking the small rectangle with the current material color (white, by default). On more details about color selection for a material, consult ["Appendix A: Color selection"](#).

The user should modify the Epsilon (permittivity) and Mu (permeability) values associated with the material, specifying their real parts (on the left text field) and imaginary parts (on the right text field), or the loss tangent and relative permittivity values. Common real parts for these values are greater or equal to "1.0". Additionally, materials with positive imaginary parts are considered to have gains, while materials with negative imaginary parts are considered to have losses.

When the user is satisfied with the properties given to the material, they should click the "Save" button to confirm the creation of the material.

4.2. Edit

The "Edit" option of the materials menu allows the user to edit the properties of already existing materials. When selected, this option will show the following tab to the user:



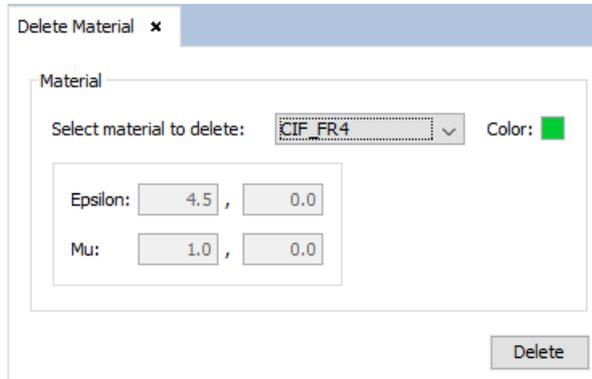
"Edit Material" tab

The user needs to select the material they want to edit in the "Select material to edit" dropdown menu. The user can modify the material color by clicking the small rectangle filled with the material color, as well as modify the Epsilon and Mu values. The meaning of these values is the same as in the "Add Material" tab, detailed in the previous section.

When the user has finished editing the parameters for the material, they need to click the "Save" button in order to confirm the changes.

4.3. Delete

The "Delete" option of the "Materials" menu allows the user to delete already existing materials. When the user clicks on this option, the following tab will be presented:

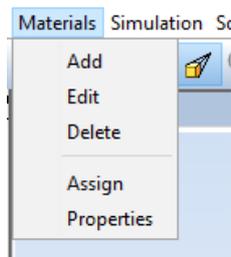


"Delete Material" tab

The user needs to select the material to delete in the "Select material to delete" dropdown menu. The properties of the selected material, that is, the material color and the Epsilon/Mu values, will be shown in this tab. If the user wants to delete the selected material, they only need to click the "Delete" button. Note: the material deletion cannot be undone.

5. Materials Menu (US Module)

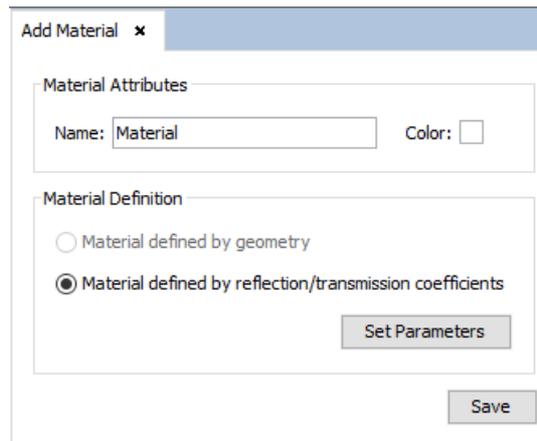
This section describes the options of the Materials menu available in US projects.



Materials menu (US module)

5.1. Add

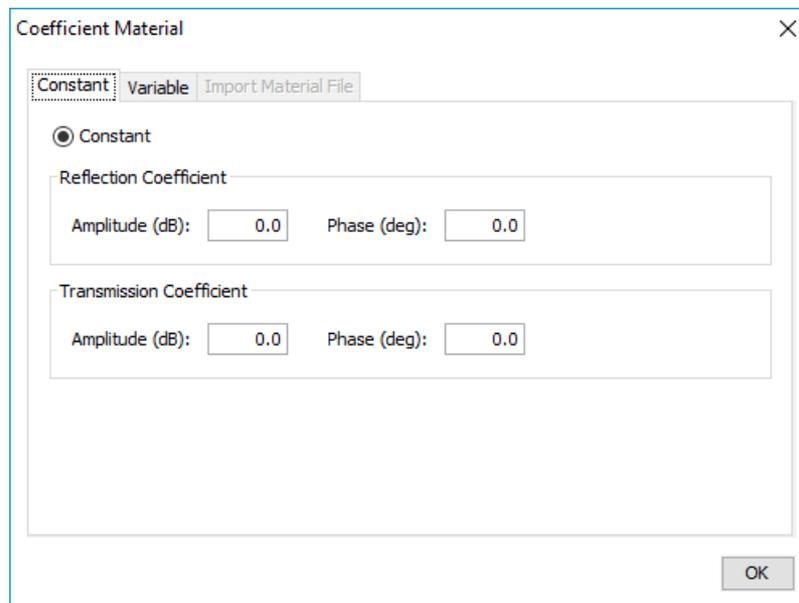
The "Add" option allows the user to create new materials to be assigned to objects and surfaces in the simulation. When the user selects this option, the following panel appears:



Add Material panel

Currently, the only possibility is the creation of materials given by their reflection/transmission coefficients. In this panel, the user can set the name of the new material, as well as the color. To set the color, the user needs to double-click the box next to the "Color:" label. For more information about setting a material's color, check [APPENDIX A: Color Selection](#).

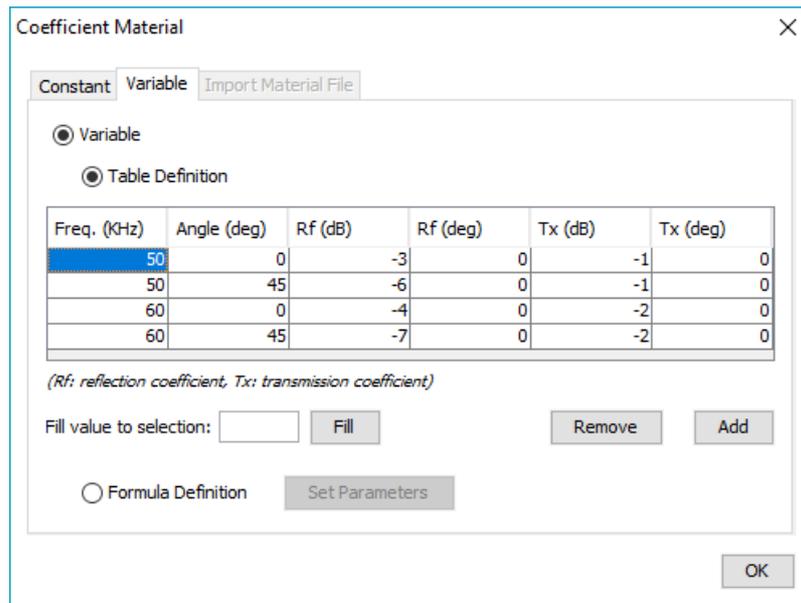
In order to set the parameters of the material, the user needs to press the "Set Parameters" button. The following dialog will appear:



Set Parameters dialog

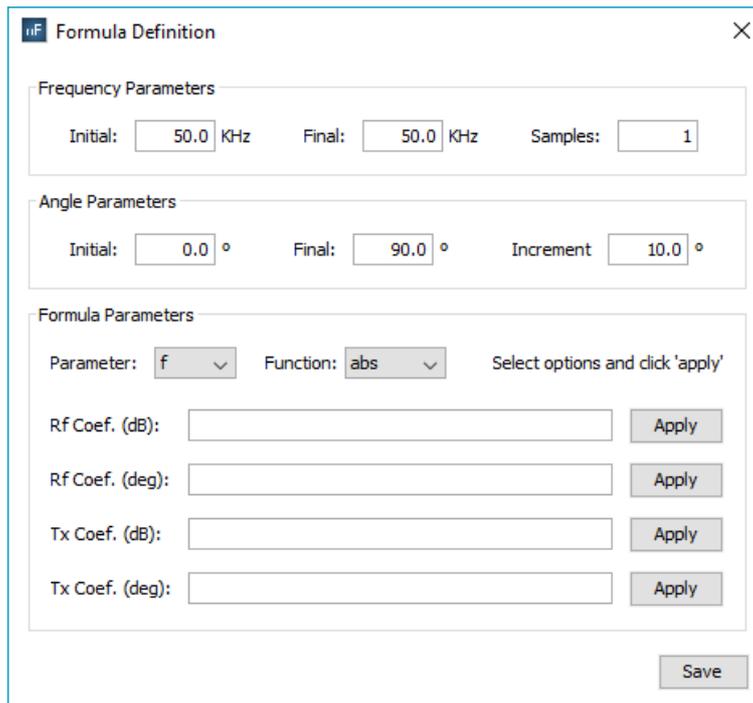
There are two types of coefficient-defined materials:

- *Constant coefficient materials:* These are materials with reflection and transmission coefficients that are constant (not depending on frequency nor angle of incidence). To define this kind of material, it is necessary to check the "Constant" option under the "Constant" tab and introduce the complex values of the coefficients. Please note that the amplitudes of the coefficients cannot be larger than 1.



Set Parameters dialog (variable coefficients)

- **Variable coefficient materials:** These are materials with reflection/transmission coefficients that depend on the simulation frequency and the incidence angle of the ray in the surface. To define this kind of material, the user needs to select the "Variable" option under the "Variable" tab of the "Set parameters" dialog. There are two different ways of creating variable coefficient materials:
 - **Table definition:** This mode of creating variable coefficient materials allows the user to manually specify the reflection and transmission coefficient for different frequencies and angles of incidence. To add and remove rows, the user needs to use the "Add" and "Remove" buttons located below the table. The user can edit the content of the cells of the table directly. However, it is possible to bulk update the value of multiple cells at once. To do that, the user needs to select the cells of the table, introduce the value in the "Fill value to selection" field and then press the "Fill" button.
 - **Formula definition:** This mode allows the user to specify formulas used to generate the values of the amplitudes and phases of the coefficients. In the formula definition mode, the user needs to set a sweep of frequency values and a sweep of angle of incidence values, used to generate the data points where the formulas will be evaluated. The user also needs to specify the formulas for each of the amplitudes and phases of the coefficients. The available parameters and functions are shown in the drop-down lists at the top of the "Formula Parameters" panel. The "Apply" buttons next to the formula boxes allows the user to add the function to the formula.



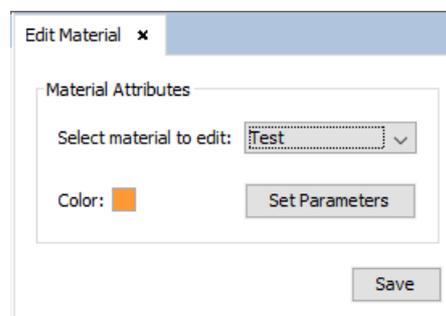
The image shows a 'Formula Definition' dialog box with three main sections: 'Frequency Parameters', 'Angle Parameters', and 'Formula Parameters'.
 - 'Frequency Parameters': Initial: 50.0 KHz, Final: 50.0 KHz, Samples: 1.
 - 'Angle Parameters': Initial: 0.0 °, Final: 90.0 °, Increment: 10.0 °.
 - 'Formula Parameters': Parameter: f, Function: abs. Below this are four rows for coefficients: 'Rf Coef. (dB)', 'Rf Coef. (deg)', 'Tx Coef. (dB)', and 'Tx Coef. (deg)', each with an 'Apply' button. A 'Save' button is at the bottom right.

Set Parameters dialog (formula definition)

Once the parameters has been set, the user needs to press the "OK" button on the "Coefficient Material" dialog and then press the "Save" button in the "Add Material" button in order to save the new material.

5.2. Edit

This option allows the edition of already created materials. When the user selects this option, the following panel appears:



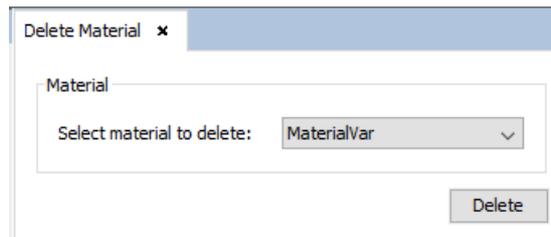
The image shows an 'Edit Material' panel with a title bar and a close button. It contains a 'Material Attributes' section with a 'Select material to edit:' dropdown menu showing 'Test'. Below this is a 'Color:' label with a small orange square and a 'Set Parameters' button. A 'Save' button is located at the bottom right.

Edit Material panel

The user can select the material to edit in the drop-down list next to the "Select material to edit:" label. It is possible to edit the color of the selected material by double-clicking the box next to the "Color" label. The "Set Parameters" button allows the user to modify the reflection/transmission coefficients of the materials. For more details on the edition of the parameters of a material, refer to the "Add" section.

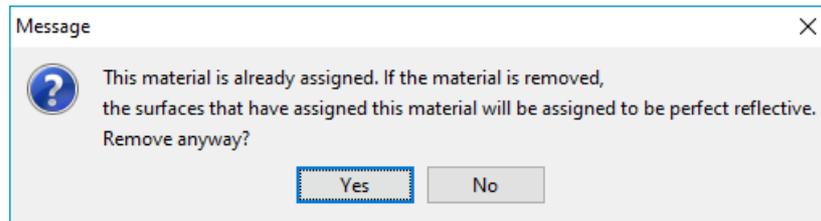
5.3. Delete

This option allows the user to delete a material. When the user selects this option, the following panel appears:



Delete Material panel

To delete a material, the user needs to select the material's name from the drop-down list and then press the "Delete" button. Please note that, if the material to delete is already assigned to at least one object or surface, the following warning will appear:

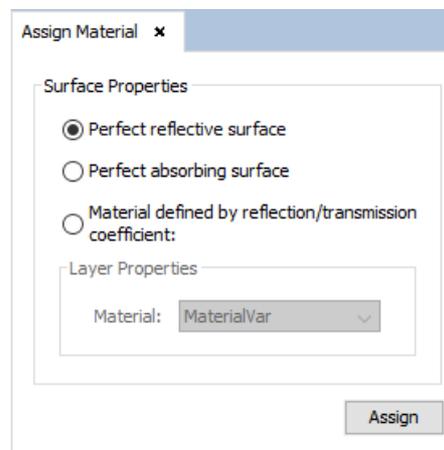


Warning when deleting an assigned material

If the user selects "Yes", the material will be deleted and the surfaces that had the material assigned will be assigned a perfect reflective material instead. If the user selects "No", the material won't be deleted and no action will be performed.

5.4. Assign

This option allows the user to assign a material to one or more surfaces. When this option is selected, the following panel appears:



Assign Material panel

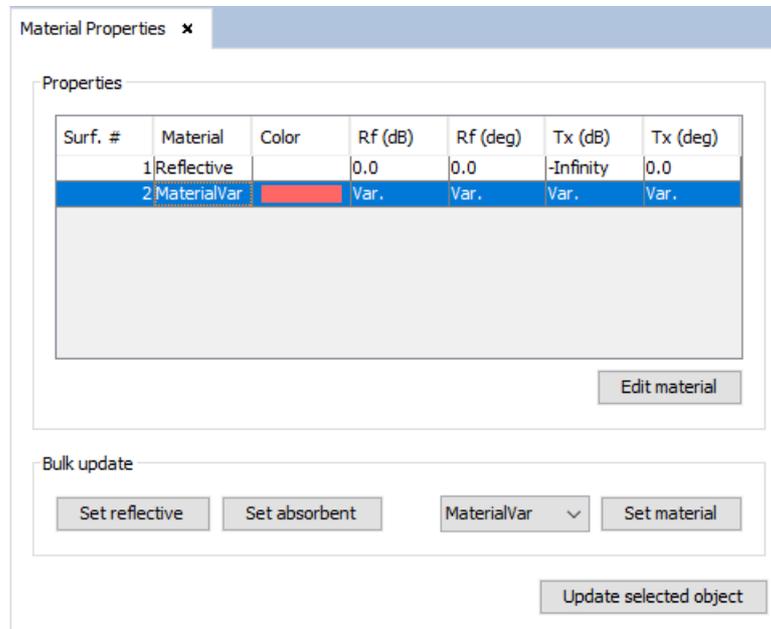
There are several options when assigning materials:

- *Perfect reflective surface*: Represents a material that perfectly reflects any wave that gets into it (that is, without attenuation).
- *Perfect absorbing surface*: Represents a material that perfectly transmits any wave that gets into it (that is, without attenuation).
- *Material defined by reflection/transmission*: This option allows the user to select a user-defined material to be assigned to a surface or object.

To assign a material, the user needs to select (in the geometry panel) the objects and surfaces they want to assign the material to, and then press the "Assign" button.

5.5. Properties

This option allows the user to visualize the materials assigned to surfaces, as well as bulk assign materials and visualize the coefficients of the assigned materials. The user needs to select the objects and surfaces in the geometry panel and then select the "Properties" option. The following panel will appear:



Material Properties panel

It is possible to edit the material of the selected surface in the table (only if it isn't a perfectly reflective or absorbent material) by pressing the "Edit material" button. For more details on how to edit the parameters of a material, refer to the "Add" section.

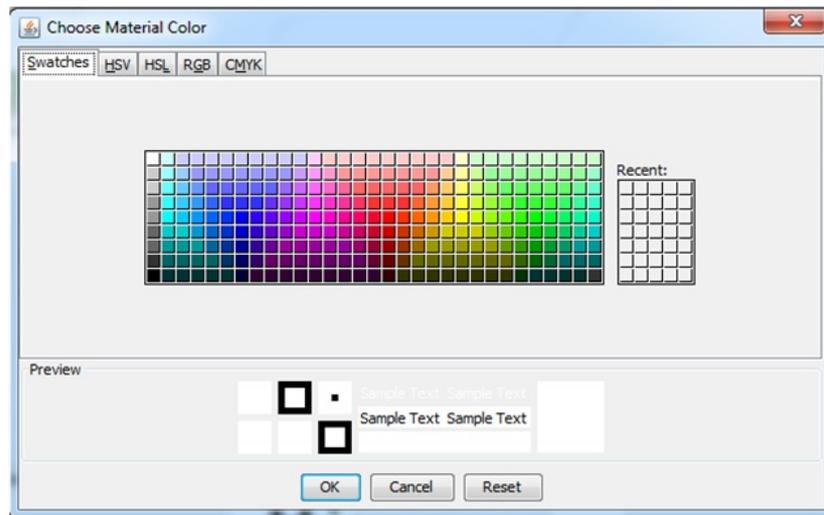
The "Set reflective", "Set absorbent" and "Set material" buttons allow the user to bulk-assign a material to multiple surfaces (to select multiple surfaces in the table, hold the Ctrl key while clicking surfaces). The "Set material" allows to assign a user-defined material to one or multiple surfaces. The material that is assigned corresponds to the one selected in the drop-down list next to the button.

If the user wants to update which surfaces appear in the table, they need to select the appropriate objects and surfaces in the geometry panel and then press the "Update selected object" button.

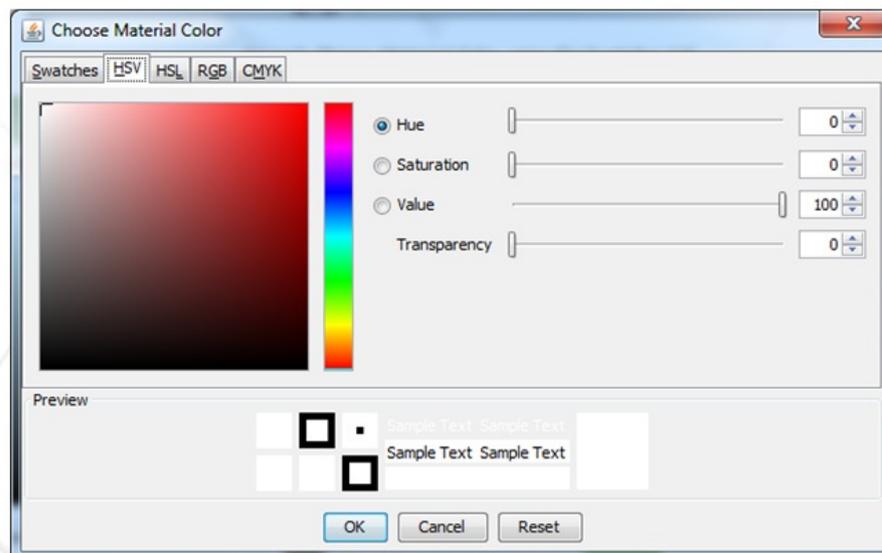
6. APPENDIX A: Color Selection

The box shows the currently selected color for the material. Left-clicking the box will originate the Choose Material Color dialog, which allows the user to select a color in a variety of color modes:

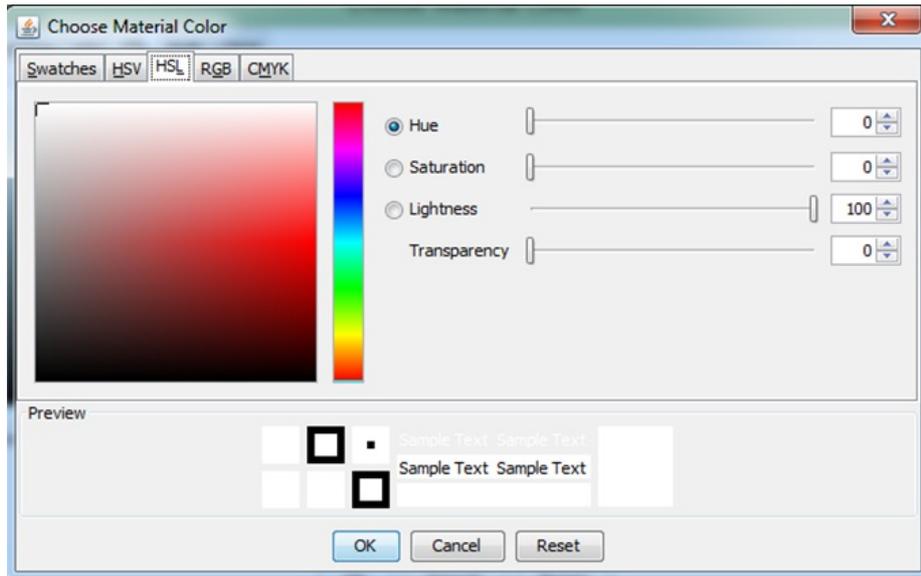
- **Swatches:** This tab shows a grid of predefined colors from which the user can choose.
- **HSV:** In this tab the user can pick a color specifying its hue, saturation, and value (HSV) properties. The user can also specify a transparency or alpha value for the color.
- **HSL:** Likewise, in this tab the user can pick a color specifying its hue, saturation, and lightness (HSL) values and also a transparency value.
- **RGB:** This tab allows the user to pick a color specifying its RGBA (red, green, blue, and alpha) components.
- **CMYK:** This tab allows the user to pick a color specifying its CMYK (cyan, magenta, yellow, and black) components, and also an alpha component.



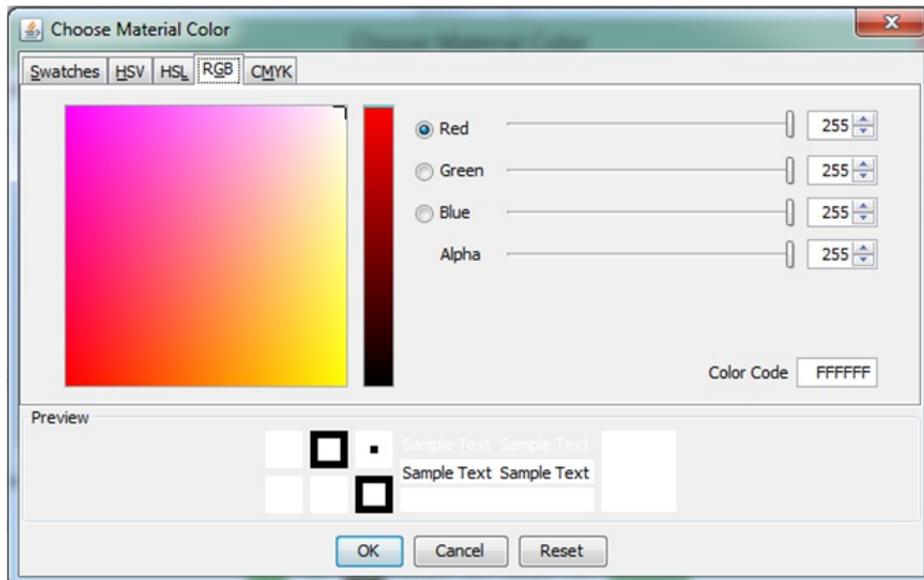
Choose Material Color using the 'Swatches' tab



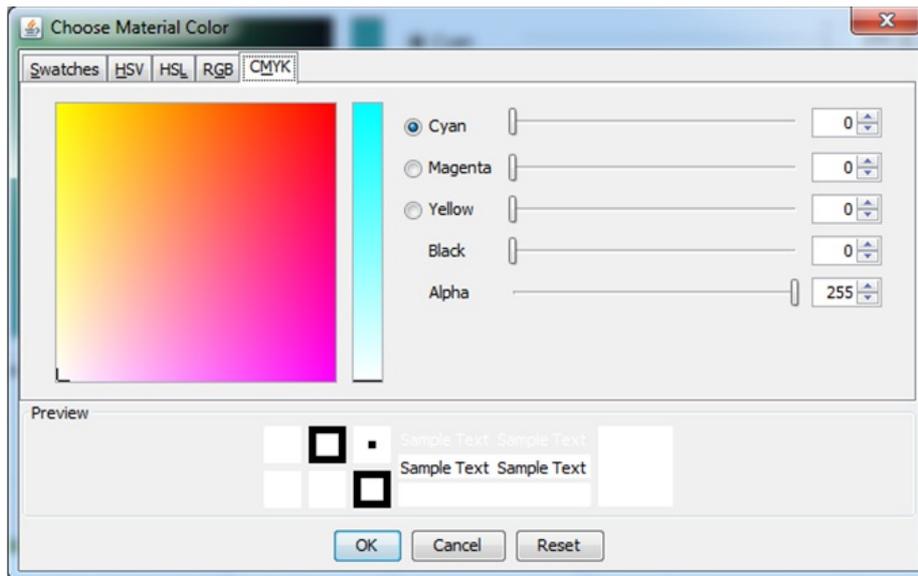
Choose Material Color using the 'HSV' tab



Choose Material Color using the 'HSL' tab



Choose Material Color using the 'RGB' tab



Choose Material Color using the 'CMYK' tab