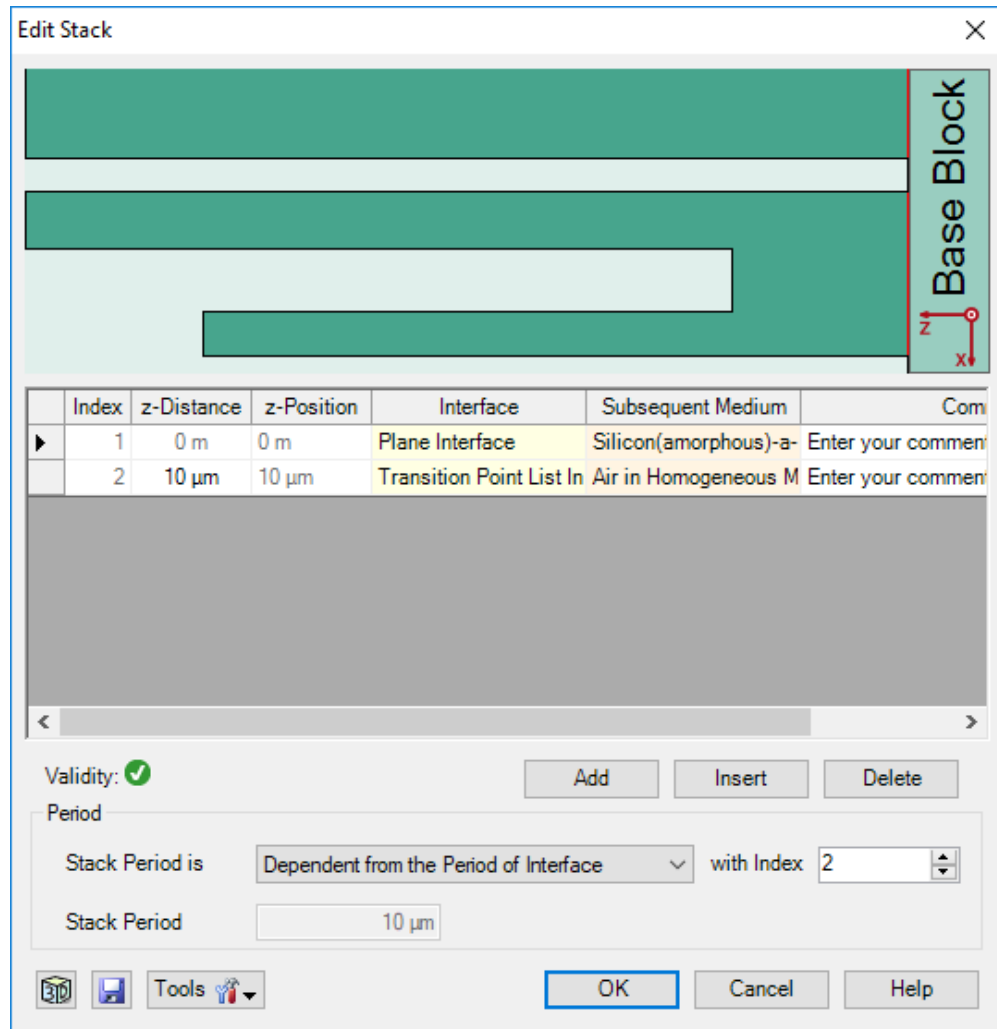# Configuration of Grating Structures by Using Interfaces

Abstract

Optical grating structures are widely used for several applications such as spectrometers, near-eye display systems, etc. VirtualLab Fusion provides rigorous analysis of arbitrary grating structures in an easy way by applying the Fourier modal method (FMM). In the Grating Toolbox, the grating structure can be configured by using various interfaces or/and media within a stack. The user interface to set up the geometry of a stack is user friendly and can be used to generate even more complex grating structures. In this use case the configuration of grating structures based on interfaces is explained.

This Use Case Shows ...

- How to configure grating structures in Grating Toolbox by using interfaces, e.g.:
    - rectangular grating interface
    - transition point list interface
    - sawtooth grating interface
    - sinusoidal grating interface

- How to change advanced options & inspect defined structure before calculation.

Grating Toolbox Initialization

- Initialization
  - Start ➔
    Grating ➔
    General Grating Light Path Diagram

- note: For usage of special type of grating, e.g. with rectangular shape, the specific light path diagram can be chosen directly.
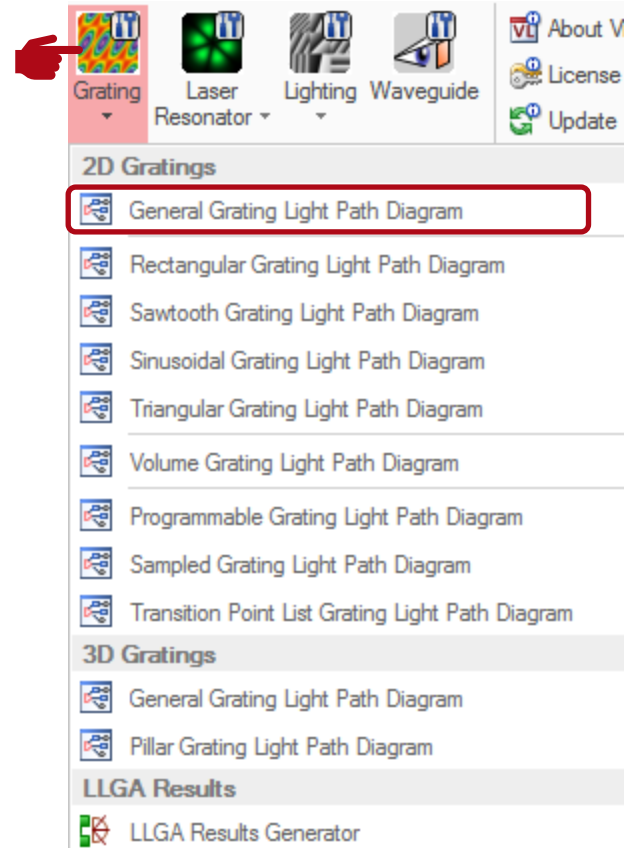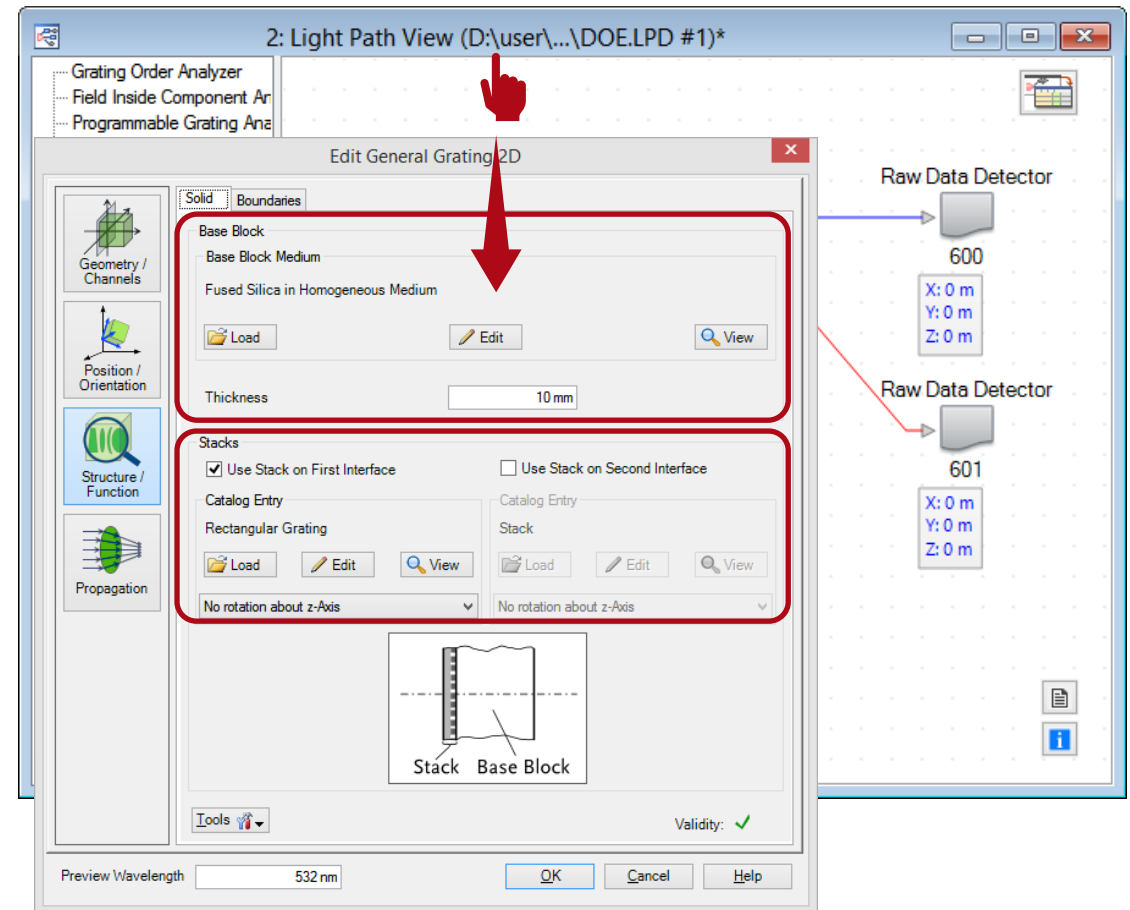
Grating Structure Settings

- First, the thickness and the material of the substrate (*Base Block*) have to be defined.

- In VirtualLab grating structures are defined in a so called stack.

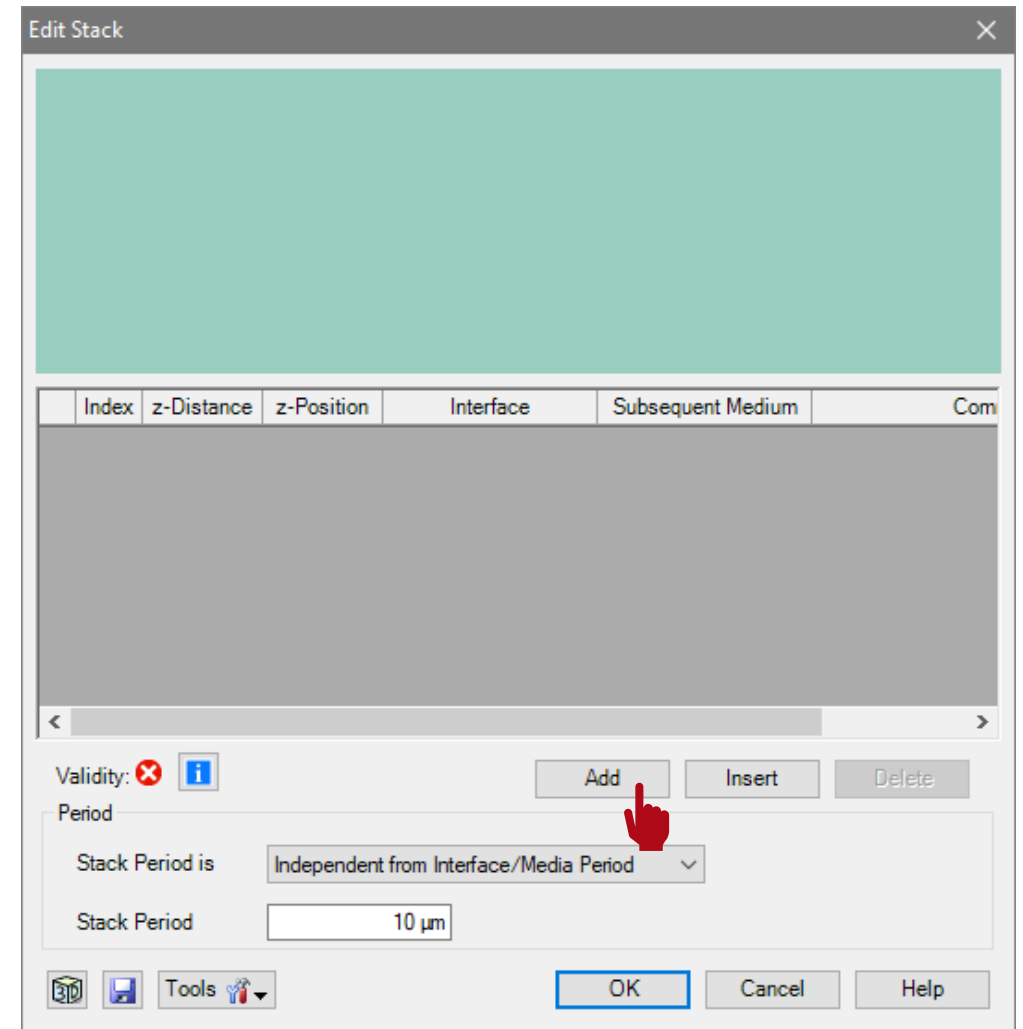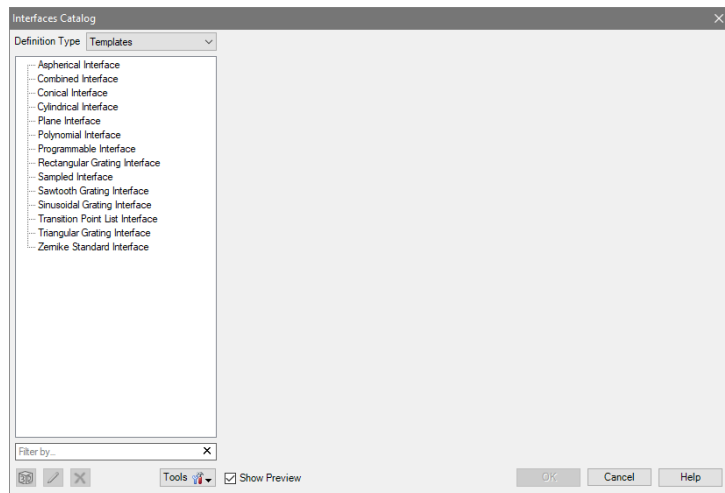- Stacks can be attached to either one or both sides of the substrate.
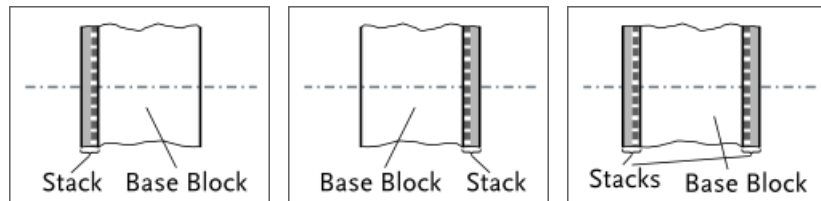
- For example, a stack on the first interface is chosen.

Stack Editor

- In the *Stack Editor* interfaces can be added or inserted from catalog.

- The catalog of VirtualLab provides several types of interfaces. All of them can be used to define a grating.
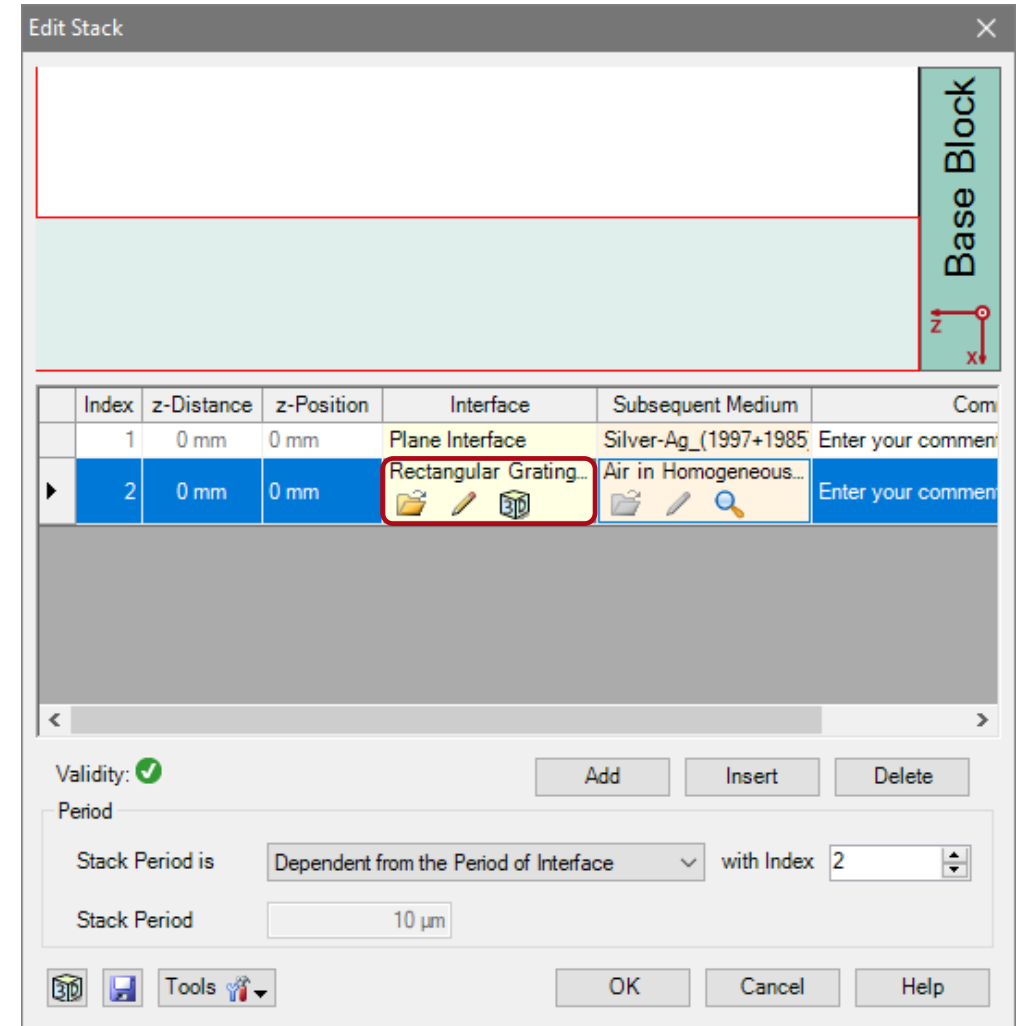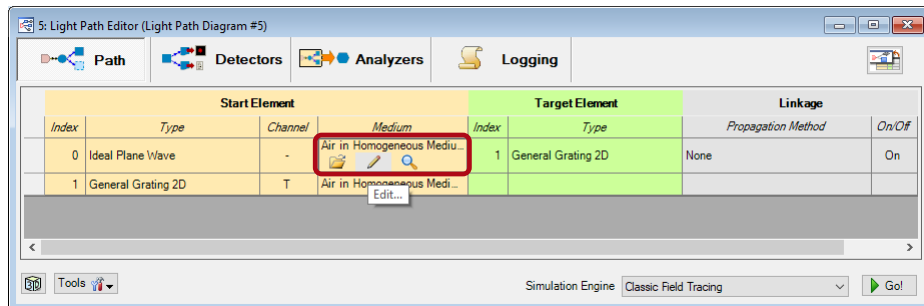
Rectangular Grating Interface

- One possible interface is the rectangular grating interface.

- This type of interface is appropriate for the configuration of simple binary structures.

- In this example, a grating made of silver is on a glass substrate.

- For this purpose, an additional plane interface was added in order to separate the grating structure from base block.

- In the view of the stack editor, different materials are indicated by other colors based on their index of refraction (dark means higher).
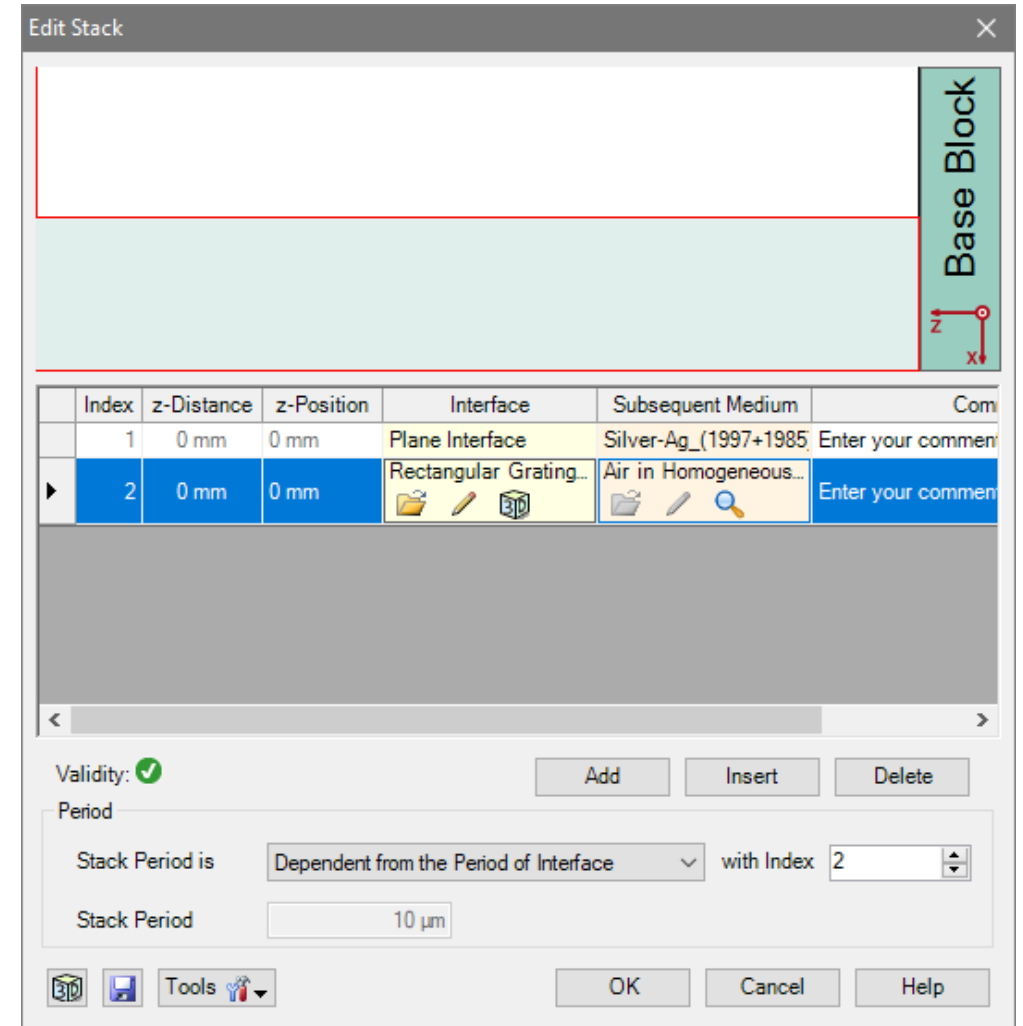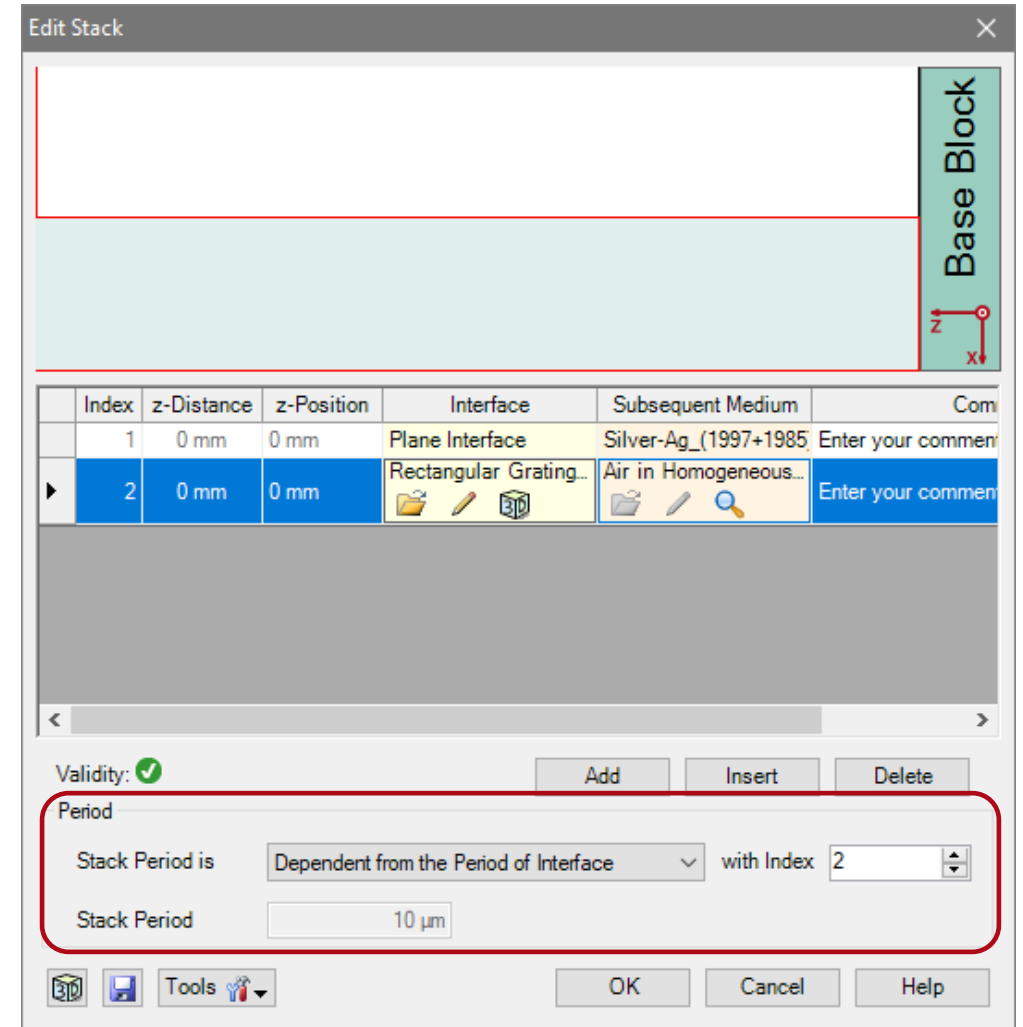
Rectangular Grating Interface

- Please note: the order of the interfaces is always counted from the surface of the substrate.

- The selected interface is highlighted red in the view.

- Further, the medium in front of the grating (means behind last interface) can not be defined here. It is automatically taken from the material in front of the grating component.

- This material can be changed in the *Light Path Editor*.

Rectangular Grating Interface

- The *Stack Period* allows to control the period of the whole configuration.

- This period is also taken for the periodic boundary conditions of the FMM algorithm.

- In case of simple grating structures, it is recommended to choose the option *Dependent from Period of Interface* and select the proper index of the periodic interface.

Rectangular Grating Interface Parameters

- The rectangular grating interface is defined by the following parameters
  - slit width (absolute or relative)
  - grating period
  - modulation depth

- A lateral shift and rotation can be set optionally.
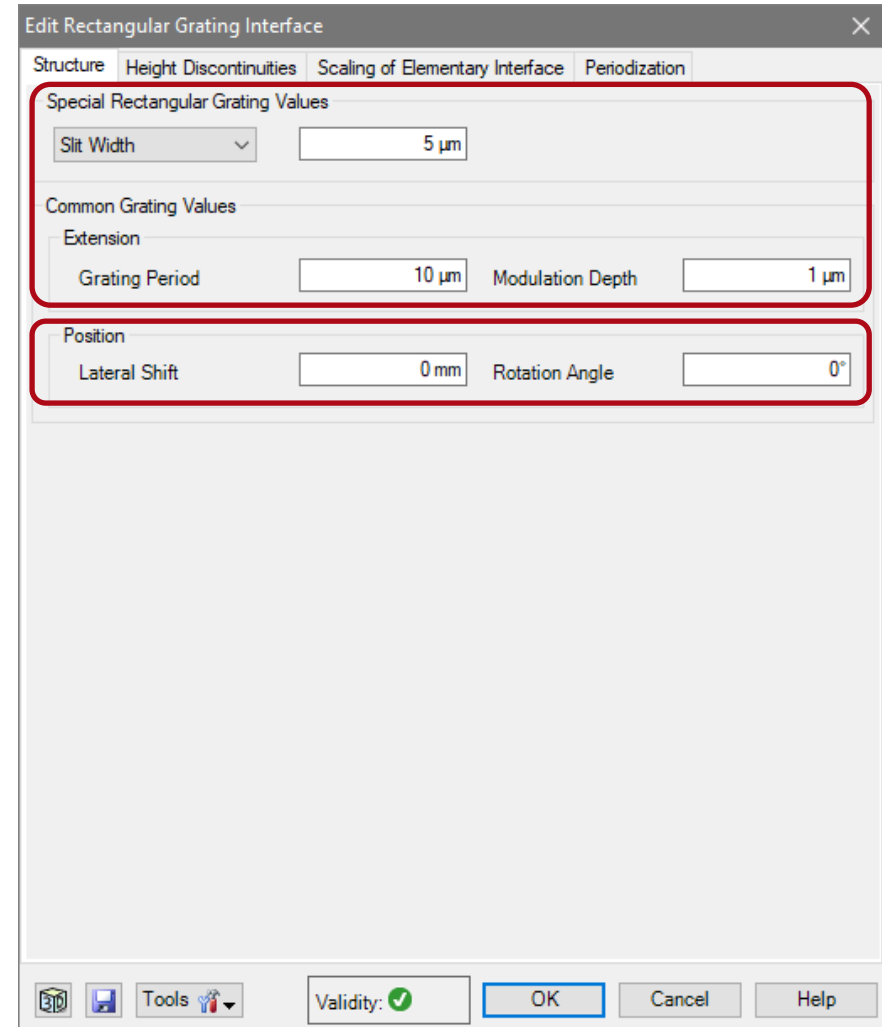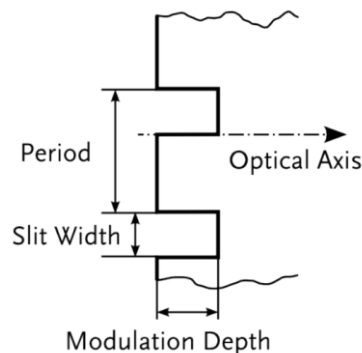
Advanced Options & Information

- In the propagation menu several advanced options are available.

- The propagation method tab allows to edit the accuracy settings of the FMM algorithm.

- Either the numbers of considered total orders or evanescent orders can be set.

- This might be useful, if metallic gratings are considered.

- In contrast, in case of dielectric gratings, the default setting will be sufficient.
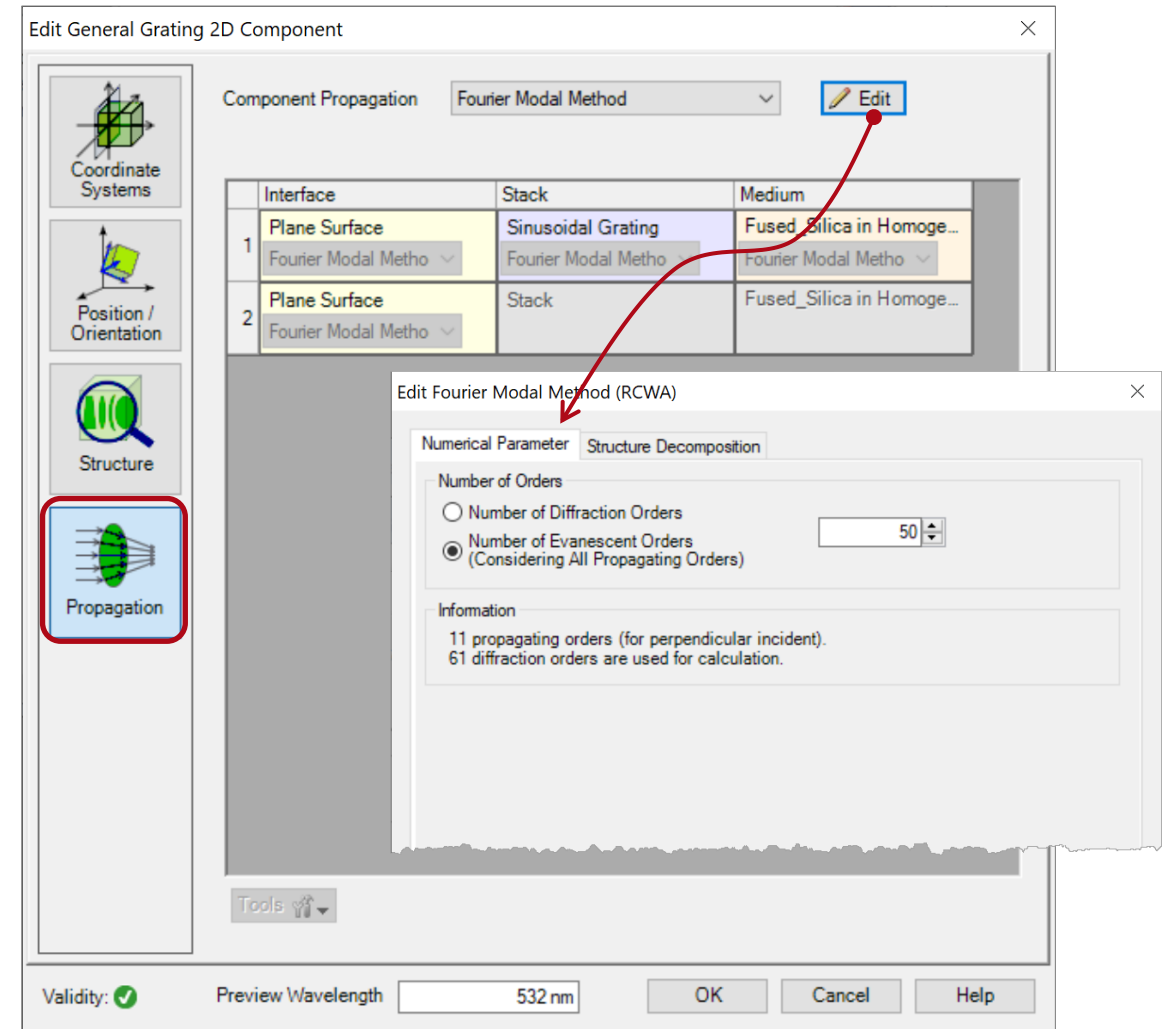
Advanced Options & Information

- The *Advanced Settings* tab provides information about the decomposition of the structure.

- The *Layer Decomposition* and *Transition Point Decomposition* settings can be used to adjust the discretization of the structure. The default settings are appropriate for nearly all grating structures.

- Further, information about the number of layers and transition points are provided.

- The *Decomposition Preview* button provides a depiction of the structure data which are used for the FMM calculation. The refractive index is illustrated by a color scale.
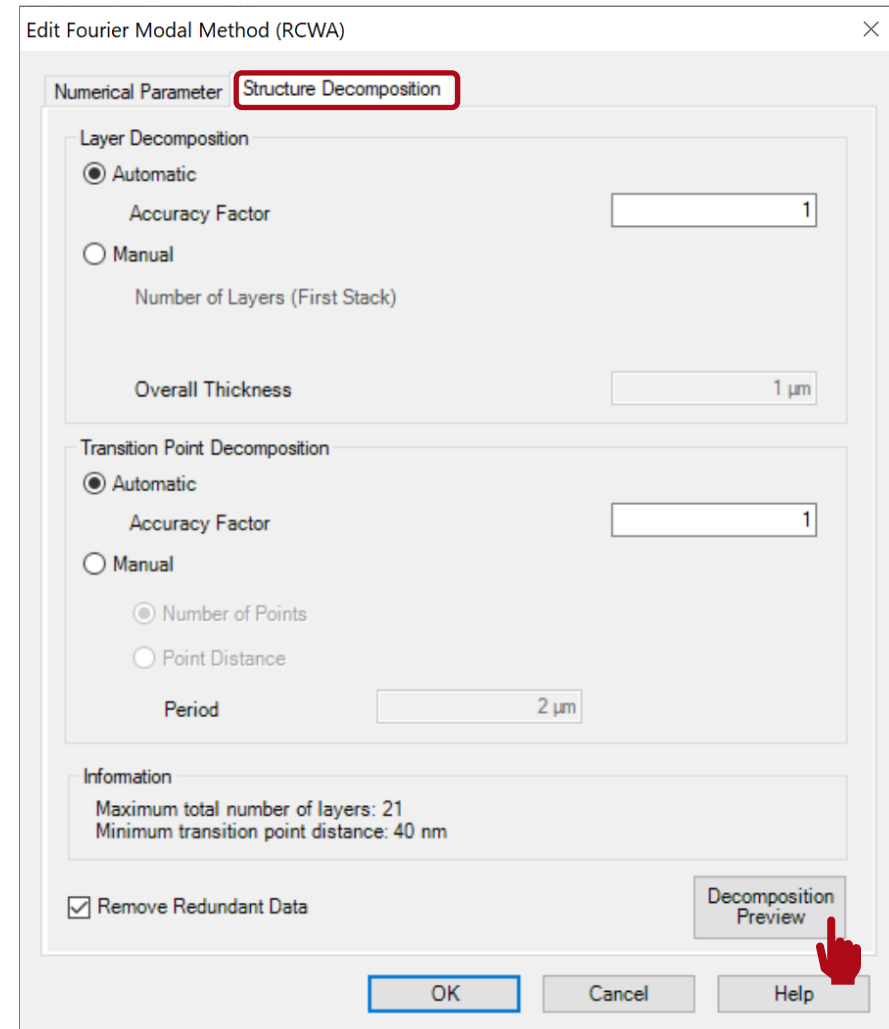
Transition Point List Interface

Transition Point List Interface

- Another type of interface which can be used for the configuration of gratings is the transition point list interface.

- This interface allows to configure a structure based on height values for different positions inside the period.

- Again, a plane interface is used to separate the grating material or medium from the one of the substrate.
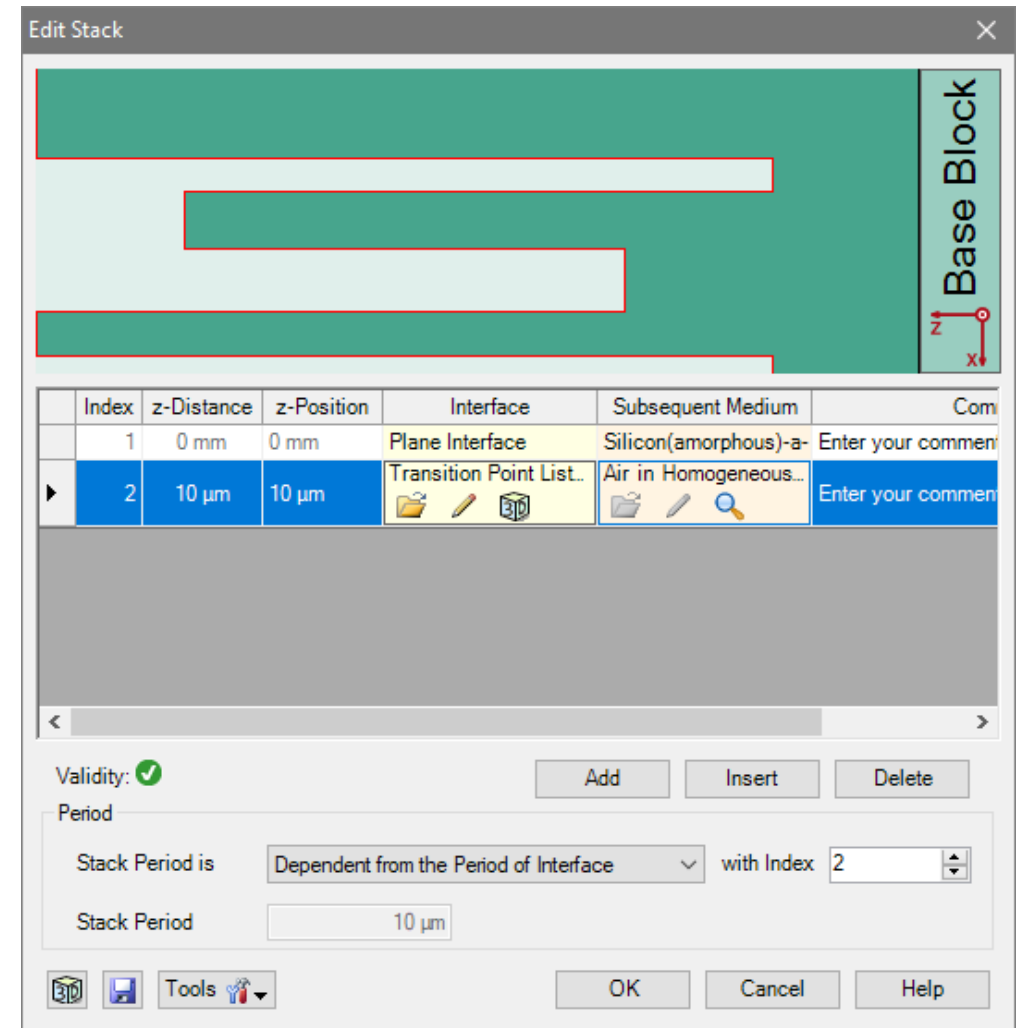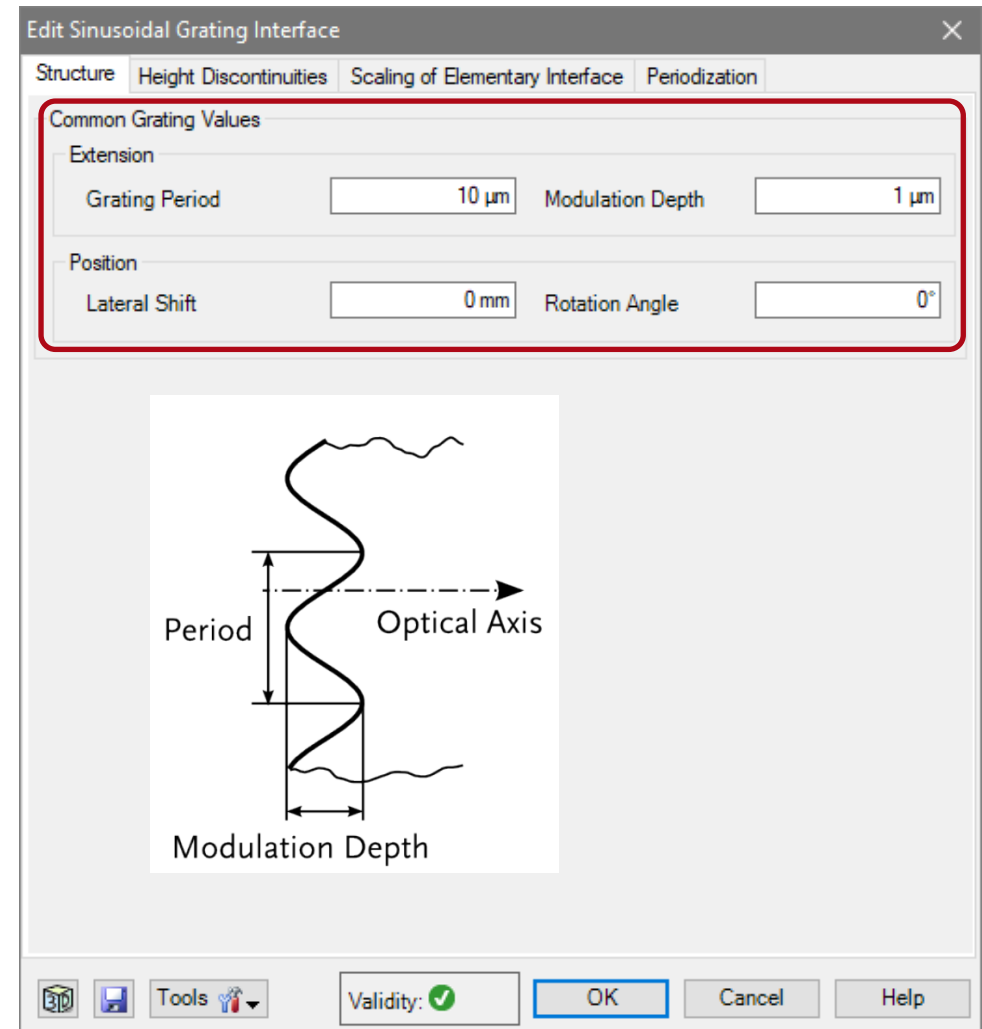
Transition Point List Parameters

- The transition point list interface is defined by a list which contains the data of x-positions and heights.

- The *Upper Limit* has to be set to a value larger than half of the desired grating period, but is set automatically in case of periodic structures.
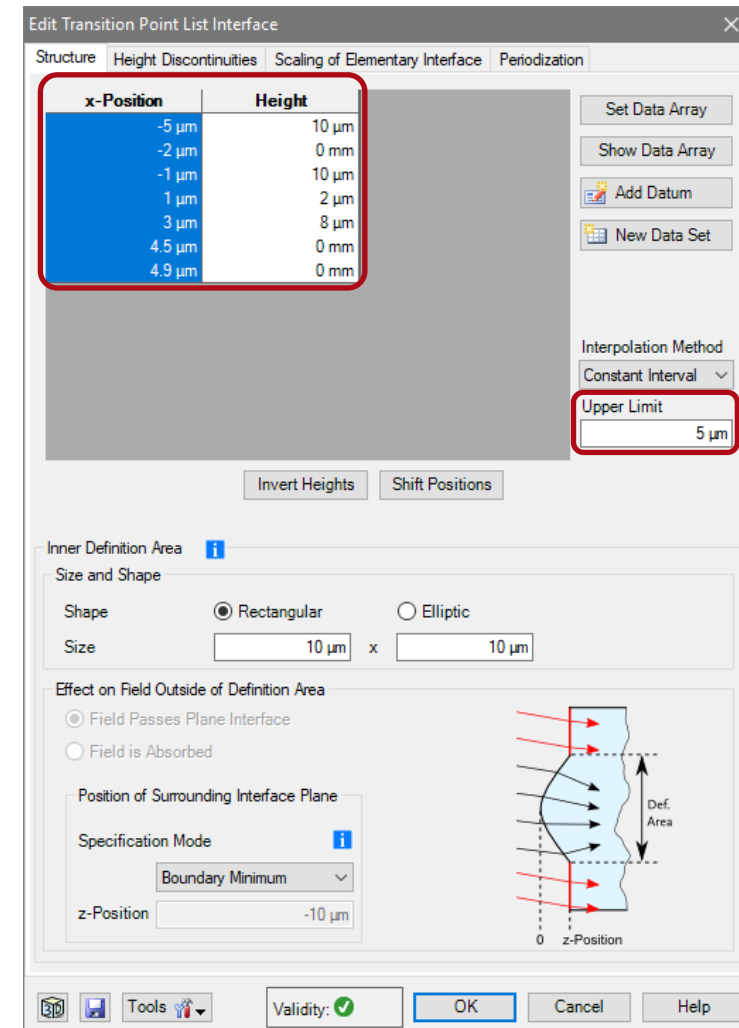
Transition Point List Parameters

- The period of this interface has to be set in the *Periodization* tab.

- Here, the periods in x- and y-direction can be defined.

- The settings of the inner and outer definition area can be neglected in this case, because the extension of the interface is already truncated by the periodic boundary conditions.
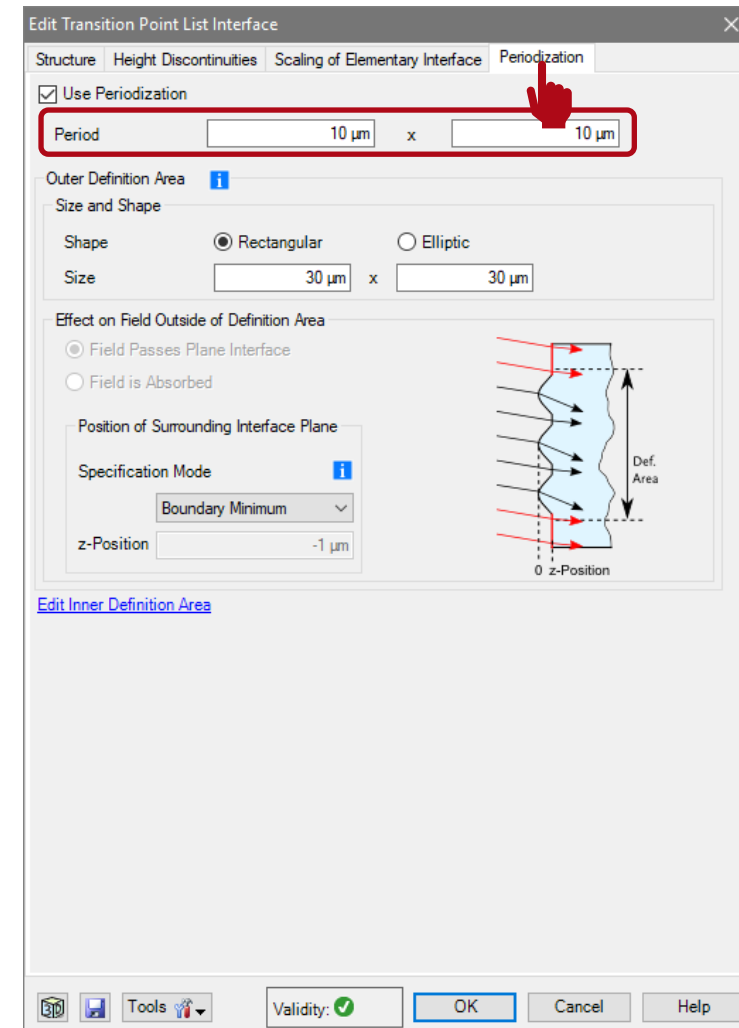
Advanced Options & Information

- Again, the data of the decomposed structure can be adjusted and investigated on the advanced settings tab page.

Sinusoidal Grating Interface

Sinusoidal Grating Interface

- Another type of interface which can be used for the configuration of gratings is the sinusoidal grating interface.

- This interface allows to configure gratings with a smooth shape of a sinusoidal function.

- If a single interface is used to describe the grating structure, the materials are chosen automatically:
  - material of ridges: material of substrate
  - material of grooves: material in front of grating
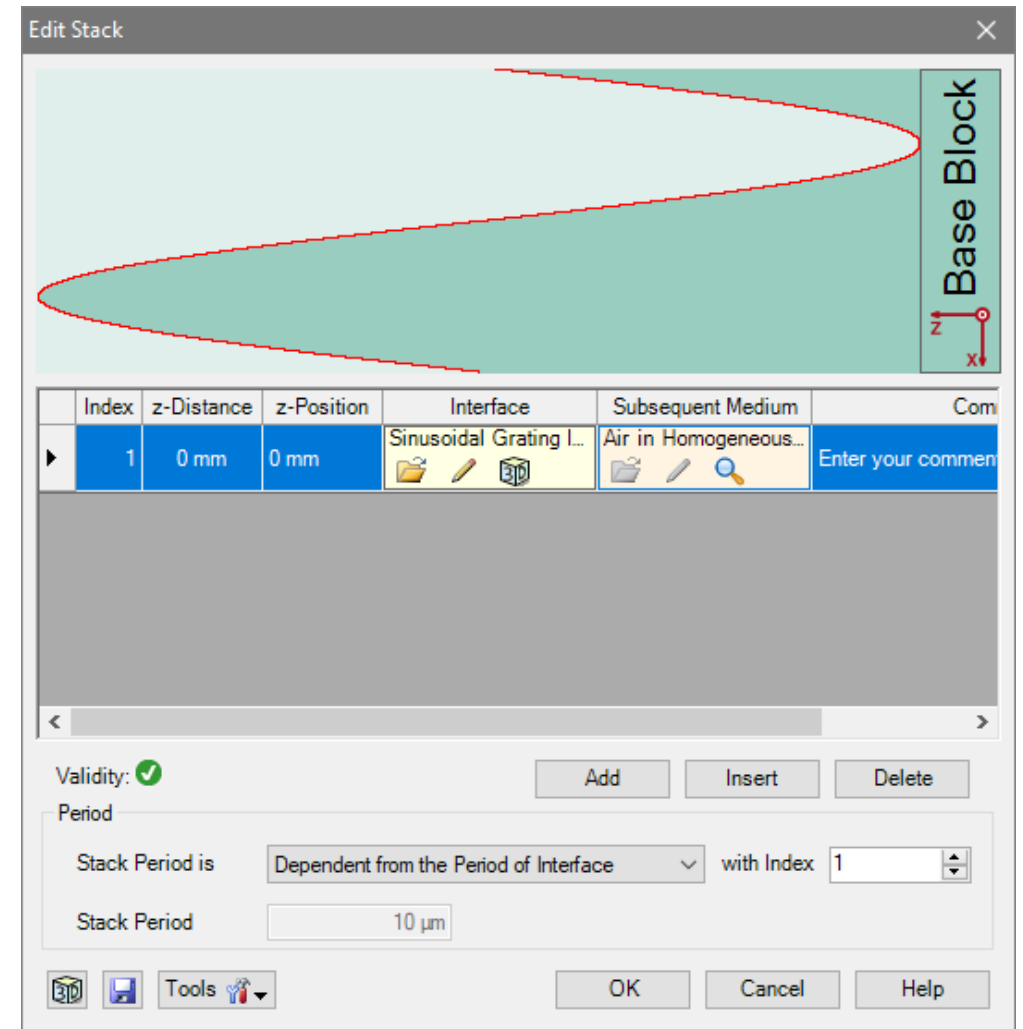
Sinusoidal Grating Interface Parameters

- The sinusoidal grating interface is also defined by the following parameters:
  - grating period
  - modulation depth
- A lateral shift and rotation can be set optionally.
- As this is a grating interface (likewise to the rectangular and sawtooth one) no periodization has to be chosen.

Sinusoidal Grating Interface Parameters

- The sinusoidal grating interface is also defined by the following parameters:
  - grating period
  - modulation depth

- A lateral shift and rotation can be set optionally.

- As this is a grating interface (likewise to the rectangular and sawtooth one) no periodization has to be chosen.

Advanced Options & Information

- Again, the data of the decomposed structure can be adjusted and investigated in the advanced settings tab.

Advanced Options & Information

- If the number of layers is increased (e.g. by a factor of 2), the discretization becomes less rough.
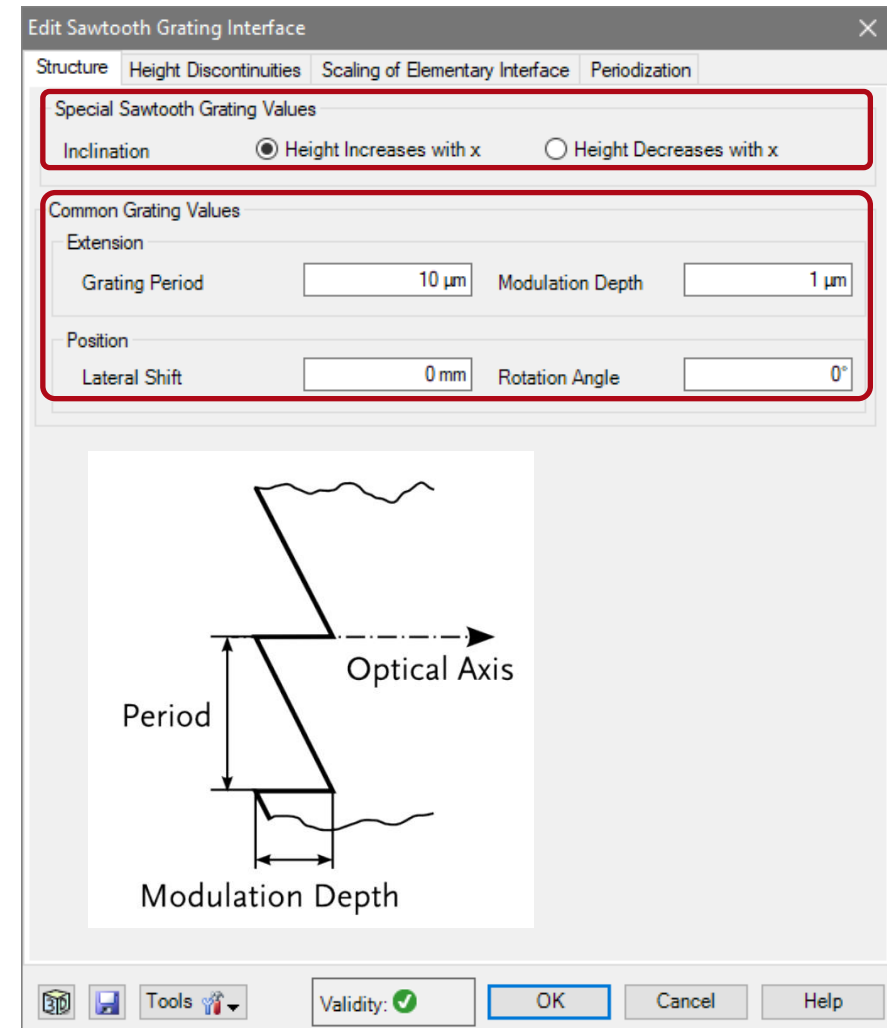
Sawtooth Grating Interface

Sawtooth Grating Interface

- Another type of interface which can be used for the configuration of gratings is the sawtooth grating interface.

- This interface allows to configure gratings with blazed structure.

- If a single interface is used to describe the grating structure, the materials are chosen automatically:
  - material of ridges: material of substrate
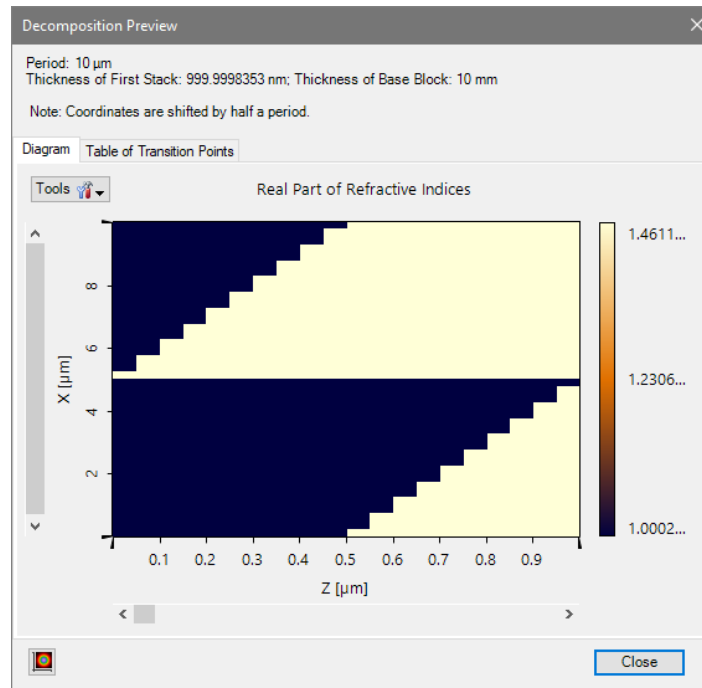 - material of grooves: material in front of grating
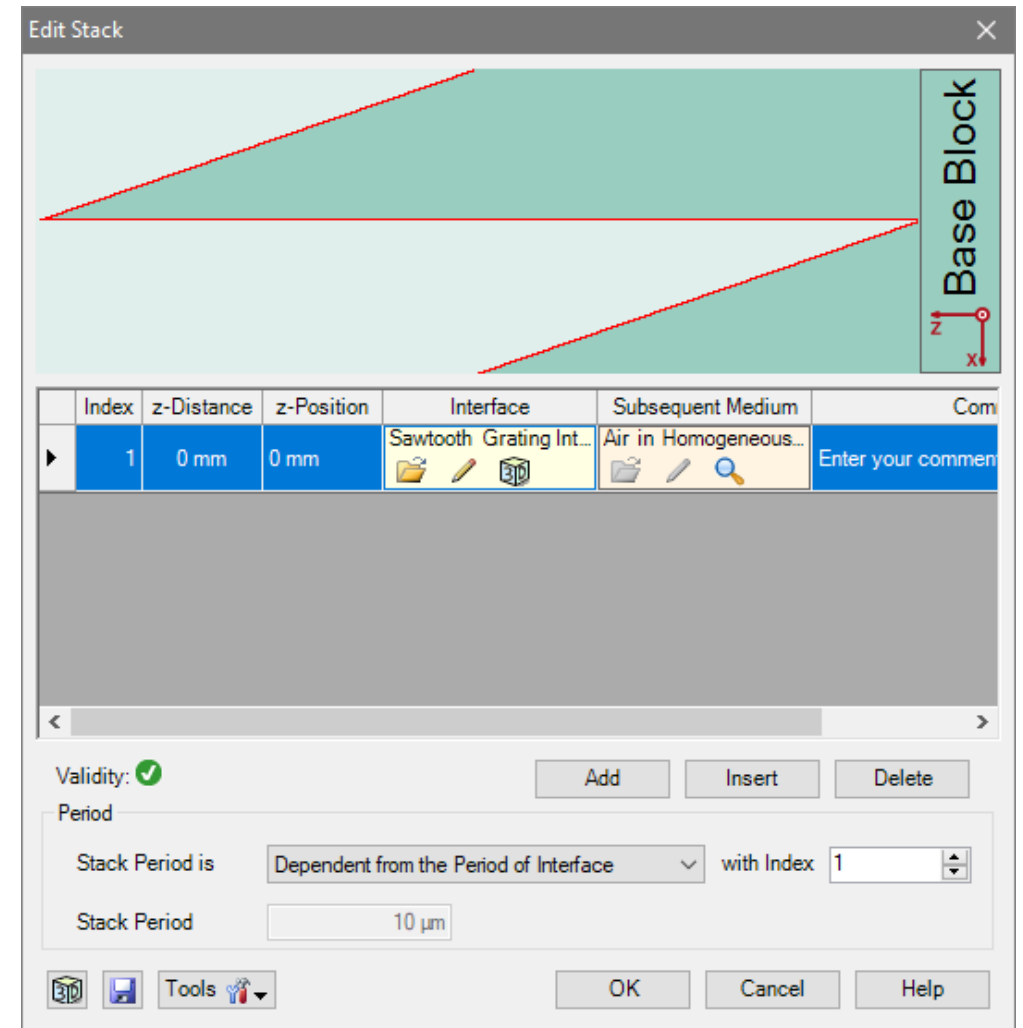
Sawtooth Grating Interface Parameters

- The sawtooth grating interface is also defined by the following parameters:
  - grating period
  - modulation depth
- Further, the direction of the blaze can be adjusted by setting the inclination.
- A lateral shift and rotation can be set optionally.
- As this is a grating interface (likewise to the rectangular and sinusoidal one) no periodization has to be chosen.

Advanced Options & Information

- Again, the data of the decomposed structure can be adjusted and investigated in the advanced settings.

Remark on the Position of the Detector

Remark on the Detector Position

- In VirtualLab the detector is located subsequent to the substrate in air by default.

- This is necessary if the grating is included in a complex optical setup.

- However, the perfect plane and parallel substrate may cause some interference effects, which not occur in reality.

- Thus, for calculation of just grating efficiencies it is appropriate to set the detector inside the substrate material (likewise to most of grating evaluation software).

- This avoids the undesired influence of those interference effects.
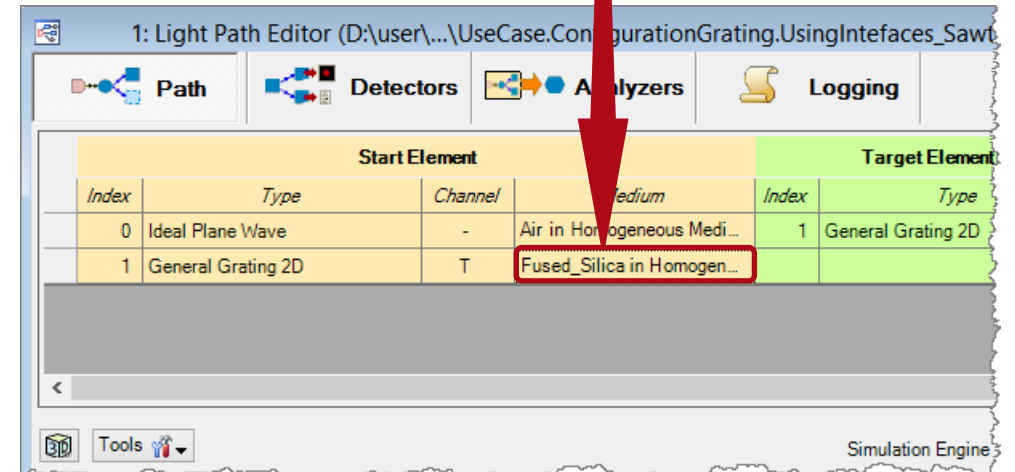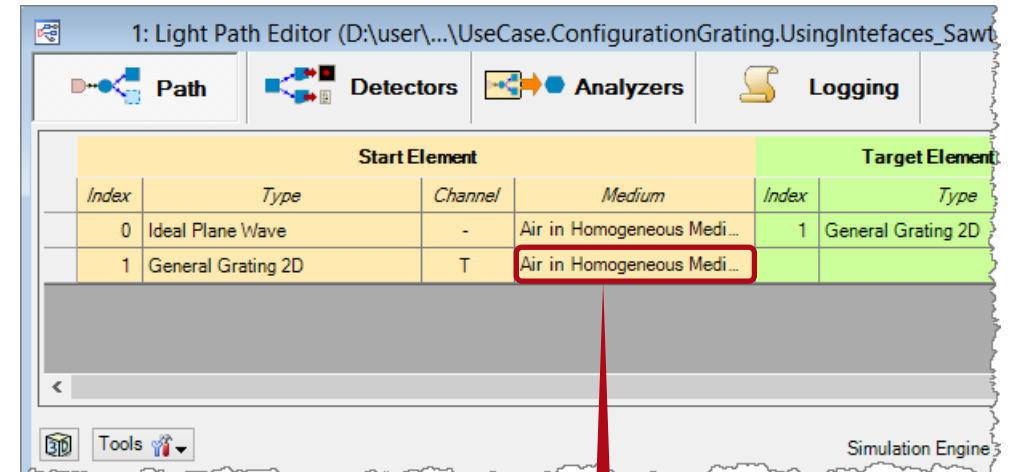
Document Information

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