

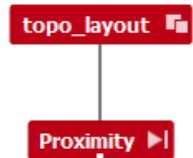
# LAB

What's new v5.9

# Topography Stack View

The topography definition has been improved, to allow an easier definition of topographic stacks

- The cross view is available after importing the layout.



- The user can choose between three stack types
  - Planar
  - Air stack
  - Topographic stack

The screenshot shows the 'Proximity Exposure' software interface. On the left, a table lists the stack layers:

Type	Thickness [µm]	Top-Z [µm]	Surface	Conformal Ratio	Layer	Angle [deg]
Resist	AZ1518	0.5	Planar	--	*	90
Layer	Si3N4	0.1	not available	Conformal	0.5	90
Layer	Cu	0.1	not available	Add	2	90
Substrate	SiO2	--	Planar	--	*	90

Below the table, there are sections for 'Resist Comment' (AZ1518), 'Positive DNQ' (softbake: 50 s, 100°C, 2 min relax; developer: AZ351 B 4:1), and a table for 'Load resist optical data from database'.

On the right, a 'Stack Preview At Cut Position: Y = 0 [µm]' shows a cross-section of the stack with layers in green, cyan, orange, and blue. Below this, 'Stack view parameter definition' shows 'X Start Position' at -2 and 'X End Position' at 2. The 'Y Cut Position' is 0.000000. The bottom part of the interface shows an 'Imported layout' with a red rectangular area and a blue vertical line labeled 'RZ'.

Topography stack view

Stack view parameter definition

Imported layout

- The stack definition allows to choose from five surface types
  - Planar: planar surface
  - Add: underlying topographical layer
  - Add inverse: inverse topography of Add layer
  - Conformal: a layer that „conforms“ to underlying topography
  - Conformal inverse: inverse of the conformal layer

Selection of surface type

Stack Type

Type	Material	Thickness [um]	Surface	Conformal Ratio	Layer	Angle [deg]	set color
Resist	AZ1518	0.5	Planar	--	*	90	
Layer	Si3N4	0.1	Planar	0.5	*	90	
Layer	Cu	0.15	Add	--	2	90	
Substrate	SiO2	--	Add Inverse	--	*	90	
			Conformal				
			Conformal Inv.				

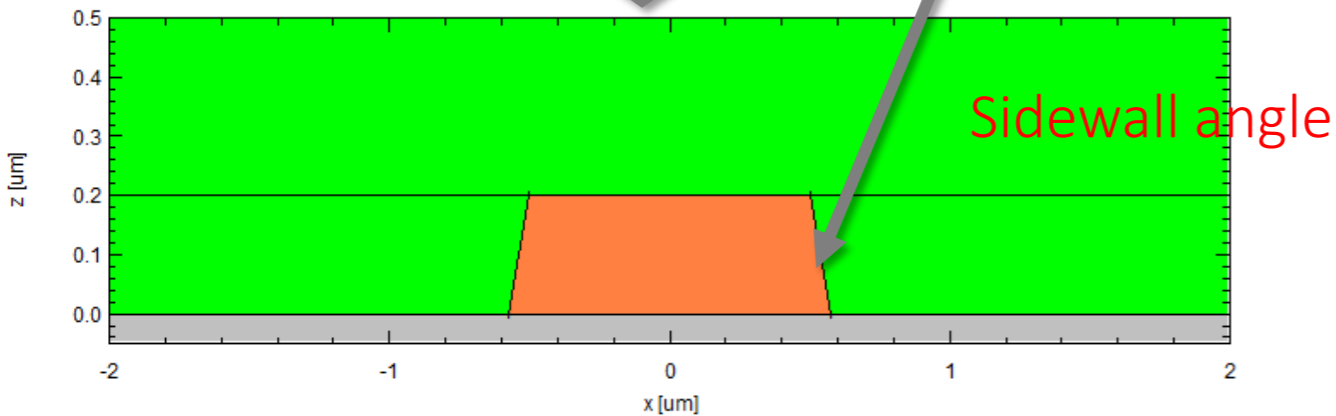
Color selection

- The stack definition allows to choose from five surface types
  - Add: underlying topographical layer
  - Add inverse: inverse topography of Add layer
  - Example: layer 2(0) is defined as Add or Add inverse.

## Surface type: Add

Stack Type

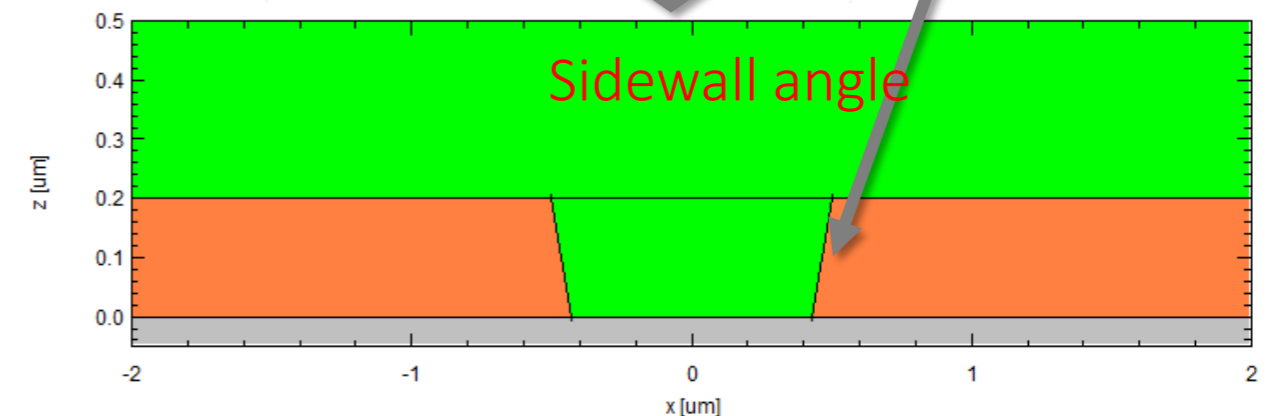
Type	Material	Thickness [um]	Surface	Layer	Angle [deg]	set color
Resist	AZ1518	0.5	Planar	*	90	
Layer	Cu	0.2	Add	2	70	
Substrate	SiO2	--	Planar	*	90	



## Surface type: Add Inverse

Stack Type

Type	Material	Thickness [um]	Surface	Layer	Angle [deg]	set color
Resist	AZ1518	0.5	Planar	*	90	
Layer	Cu	0.2	Add Inverse	2	70	
Substrate	SiO2	--	Planar	*	90	



- In stack definition, each material is defined with one of the five surface types
  - Example: layer 1(0) is defined as conformal or conformal inverse.

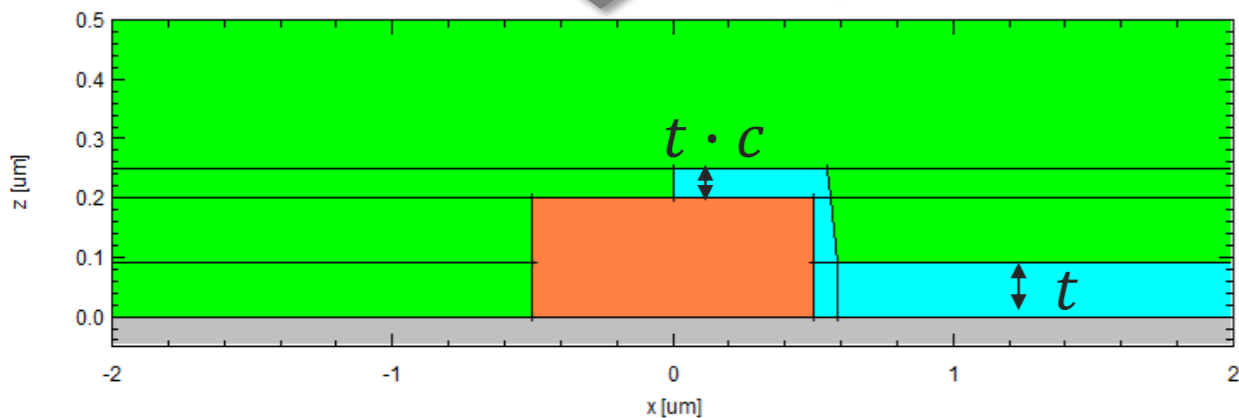
## Surface type: Conformal

$t$ : Conventional Thickness

$c$ : Conformal Ratio

Stack Type Topographic

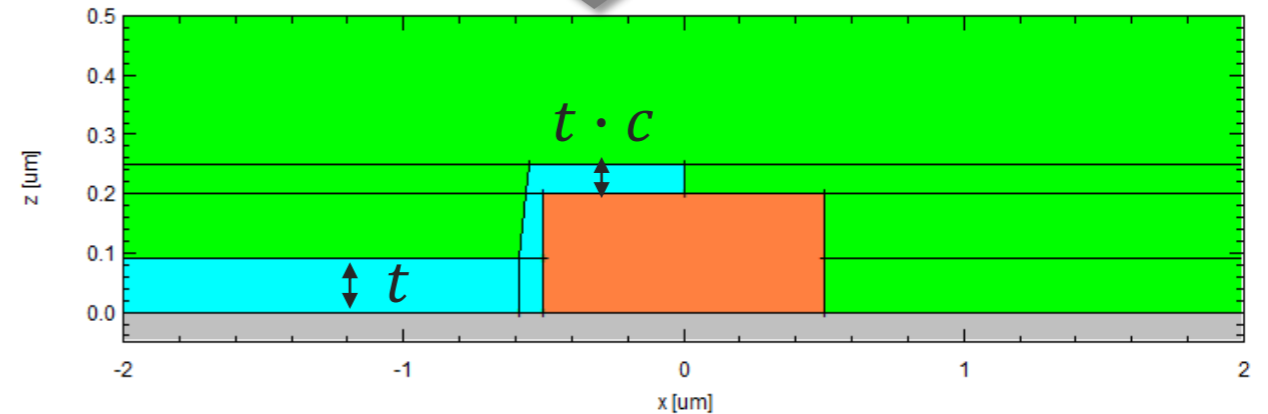
Type	Material	Thickness [um]	Surface	Conformal Ratio	Layer	Angle [deg]	set color
Resist	AZ1518	0.5	Planar	--	*	90	
Layer	Si3N4	0.1	Conformal	0.5	1	90	
Layer	Cu	0.2	Add	--	2	90	
Substrate	SiO2	--	Planar	--	*	90	



## Surface type: Conformal Inverse

Stack Type Topographic

Type	Material	Thickness [um]	Surface	Conformal Ratio	Layer	Angle [deg]	set color
Resist	AZ1518	0.5	Planar	--	*	90	
Layer	Si3N4	0.1	Conformal Inv.	0.5	1	90	
Layer	Cu	0.2	Add	--	2	90	
Substrate	SiO2	--	Planar	--	*	90	



# Topography Stack Example

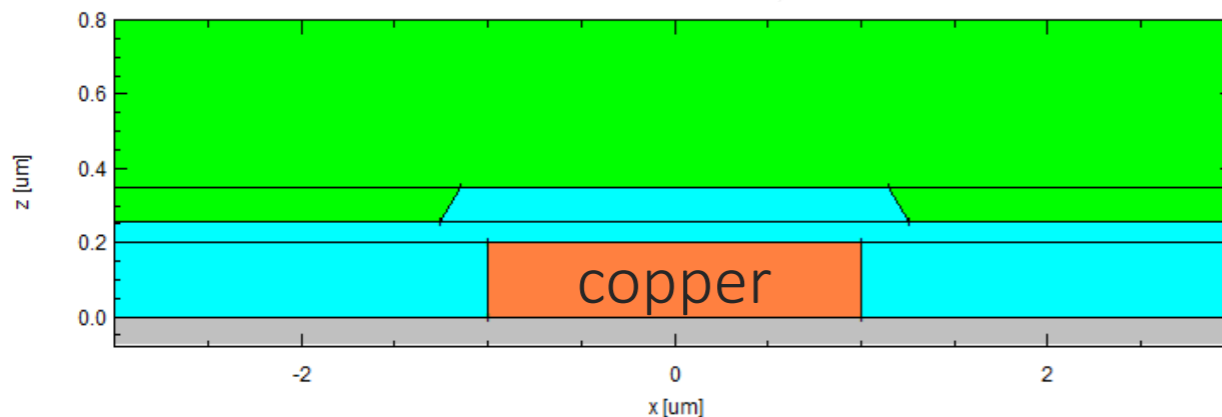
LAB models the whole stack to check the effect of non-planar substrate.

- The example below shows the effect of copper layer in modification of light intensity along the resist depth: shift of standing wave and hot spot at corners.

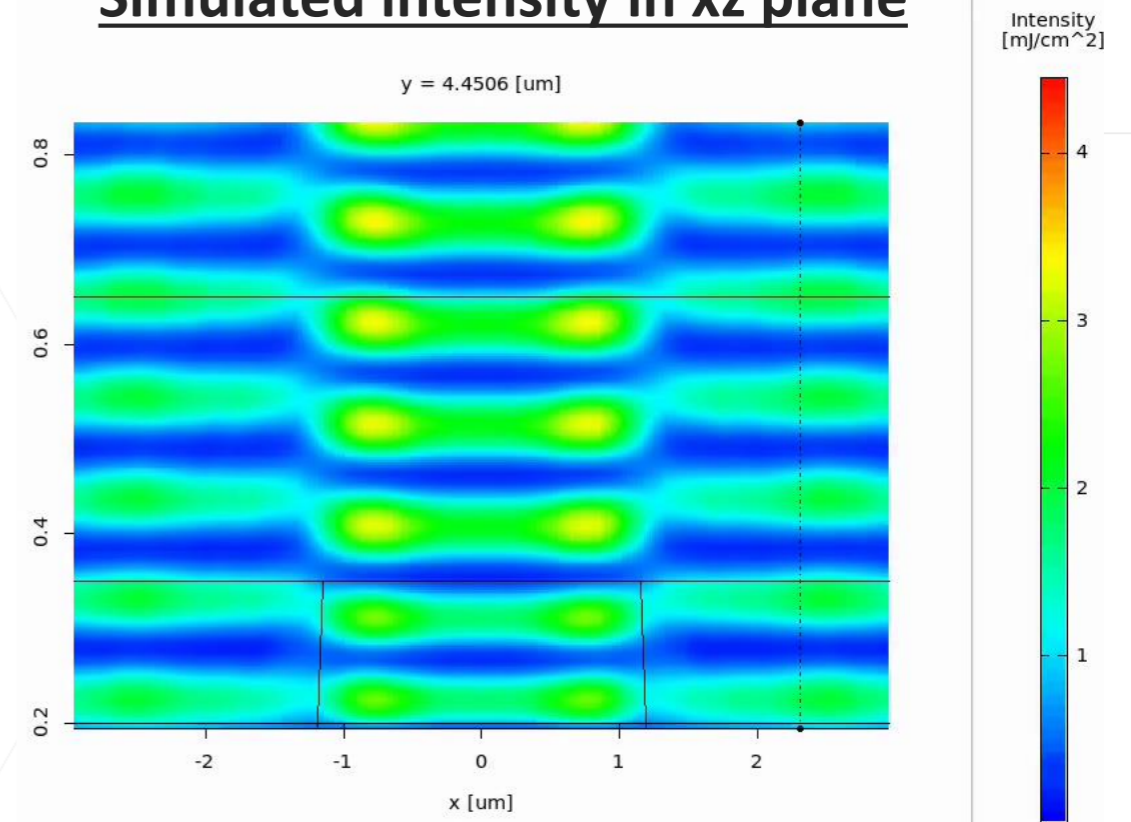
## Stack definition

Type	Material	Thickness [um]	Surface	Conformal Ratio	Layer	Angle [deg]	set color
Resist	AZ1518	0.65	Planar	--	*	90	
Layer	Si3N4	0.3	Conformal	0.5	*	90	
Layer	Cu	0.2	Add	--	2	90	
Substrate	Si-crystalline	--	Planar	--	*	90	

## Cross sectional view



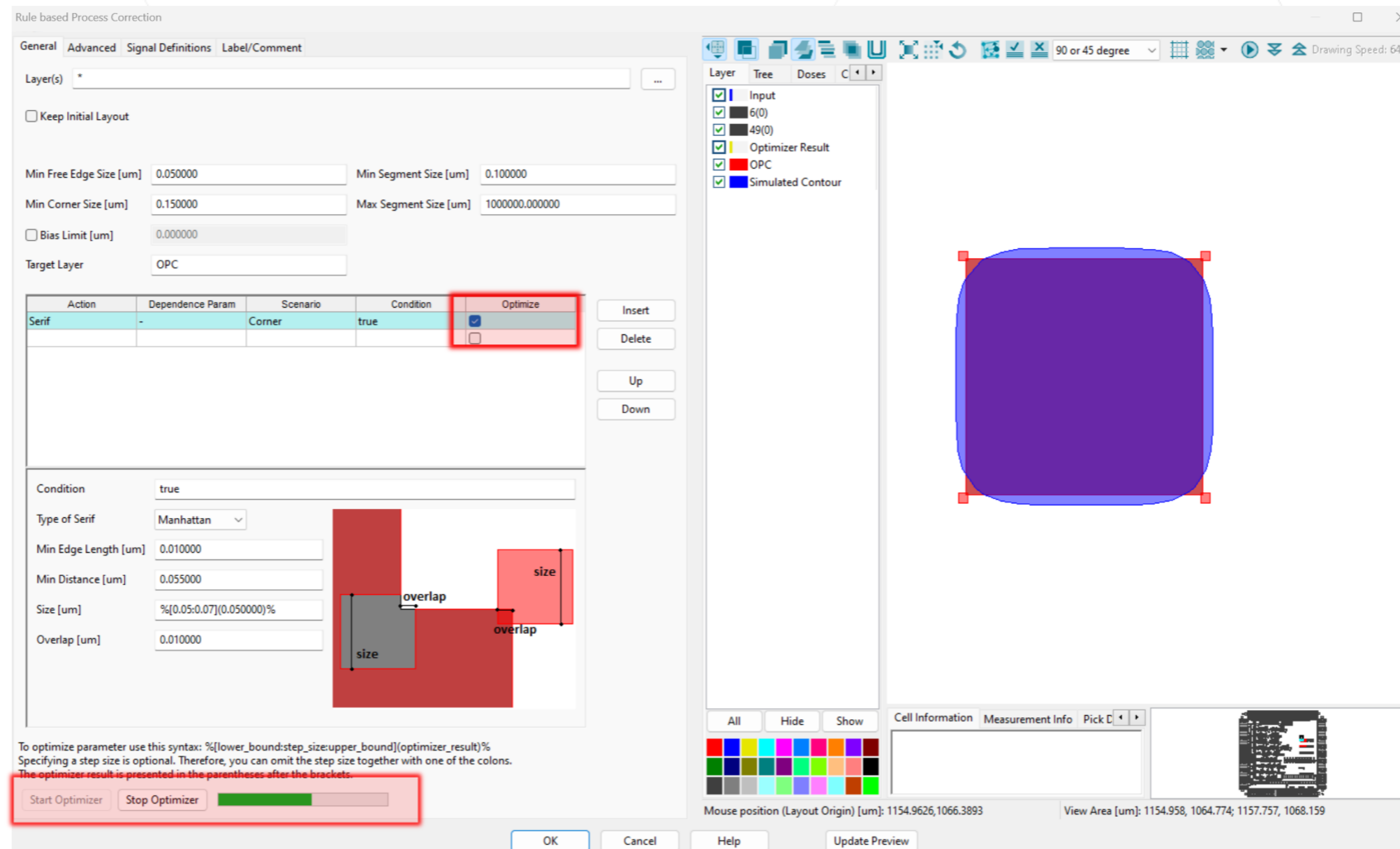
## Simulated intensity in xz plane



# Rule OPC



Rules in the RuleOPC can be optimized based on the exposure simulation settings, to allow an easier definition of rule parameters..



The screenshot displays the 'Rule based Process Correction' dialog box with the 'Advanced' tab selected. The 'Target Layer' is set to 'OPC'. A table lists a rule named 'Serif' with the condition 'true' and an 'Optimize' checkbox checked. Below the table, the 'Condition' is set to 'true' and the 'Type of Serif' is 'Manhattan'. Parameters for 'Min Edge Length', 'Min Distance', 'Size', and 'Overlap' are defined using optimization syntax. A diagram illustrates the serif rule with 'size' and 'overlap' labels. At the bottom, a 'Start Optimizer' button and a progress bar are highlighted. The background shows a CAD drawing of a square with rounded corners, overlaid with a simulated contour.

Action	Dependence Param	Scenario	Condition	Optimize
Serif	-	Corner	true	<input checked="" type="checkbox"/>

Condition: true

Type of Serif: Manhattan

Min Edge Length [um]: 0.010000

Min Distance [um]: 0.055000

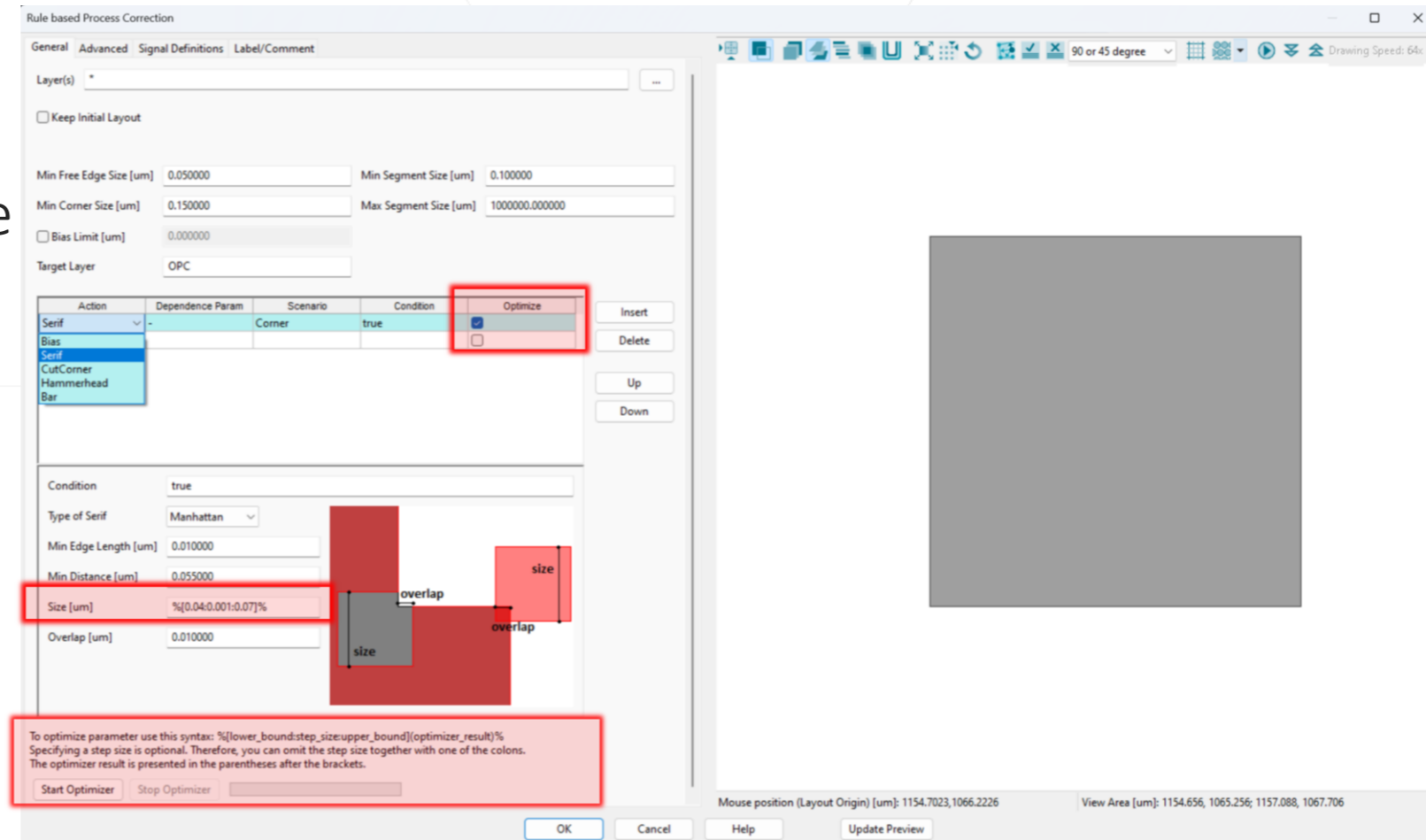
Size [um]: %[0.05:0.07](0.050000)%

Overlap [um]: 0.010000

To optimize parameter use this syntax: %[lower\_bound:step\_size:upper\_bound](optimizer\_result)%  
Specifying a step size is optional. Therefore, you can omit the step size together with one of the colons.  
The optimizer result is presented in the parentheses after the brackets.

Start Optimizer Stop Optimizer

- Enable the „Optimize“ check-box enables the Rule Optimizer
- Select the rule for optimization
- Then define the variables of the rule to be optimized. The format is  
 $\%[\text{min value}:\text{step}:\text{max value}]\%$
- Finally, press „Start Optimizer“



NOTE: „step“ is not a mandatory parameter, it defines the step width used during the optimization.

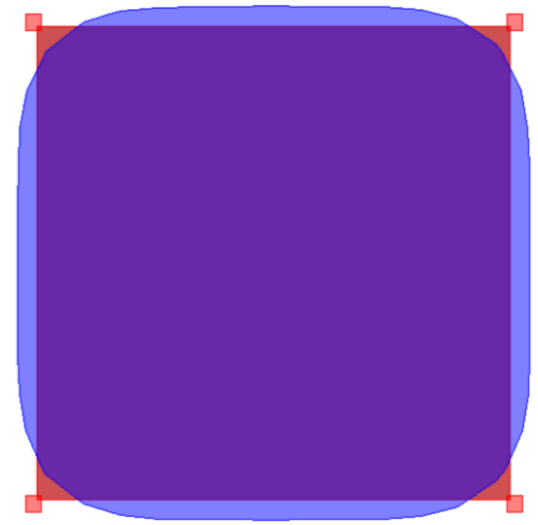
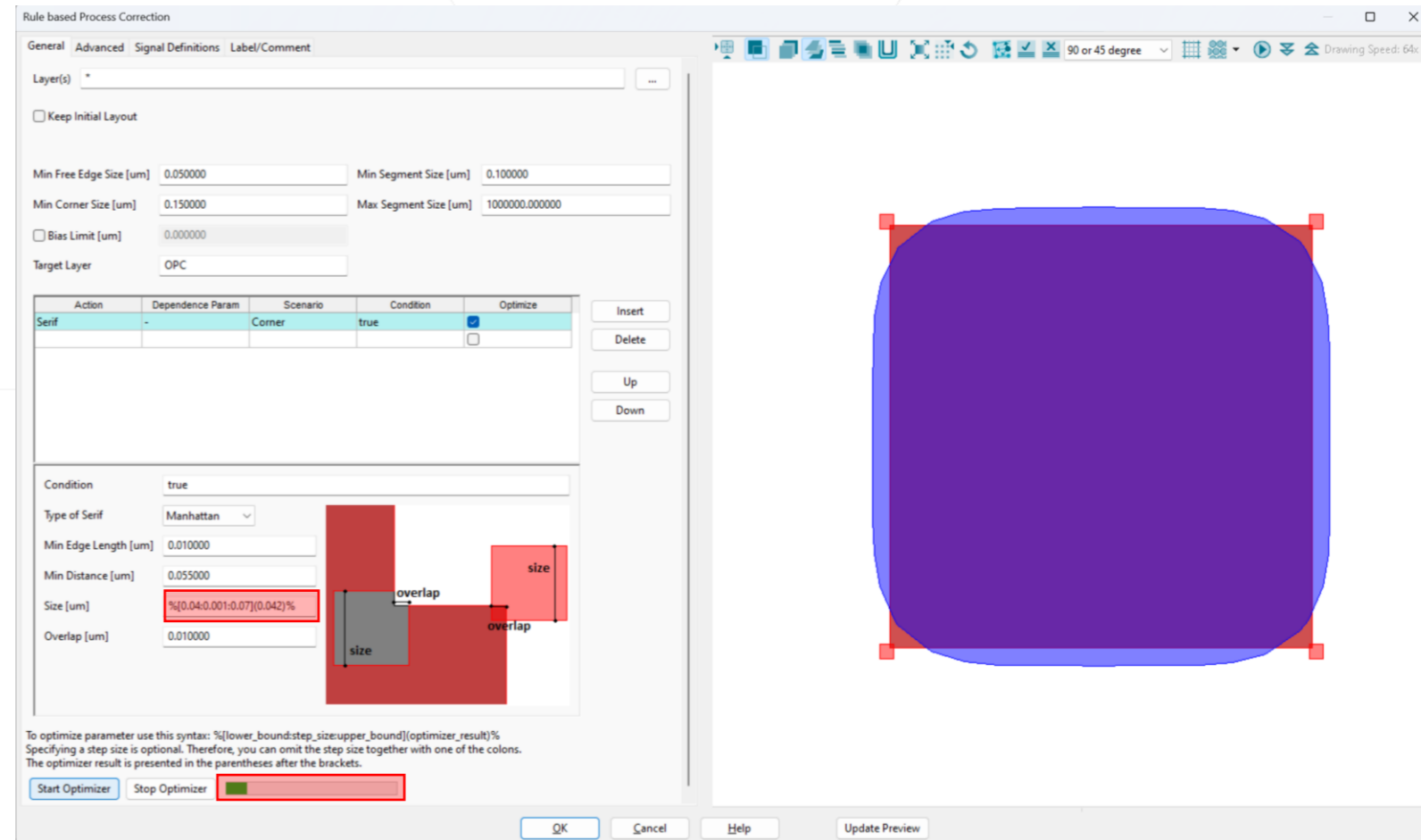
- The green bar shows the progress of optimization

- Optimized value appears next to the variable-range definition

`%[min val:step:max val](optimization)%`

- The resulting contour is displayed on the right side

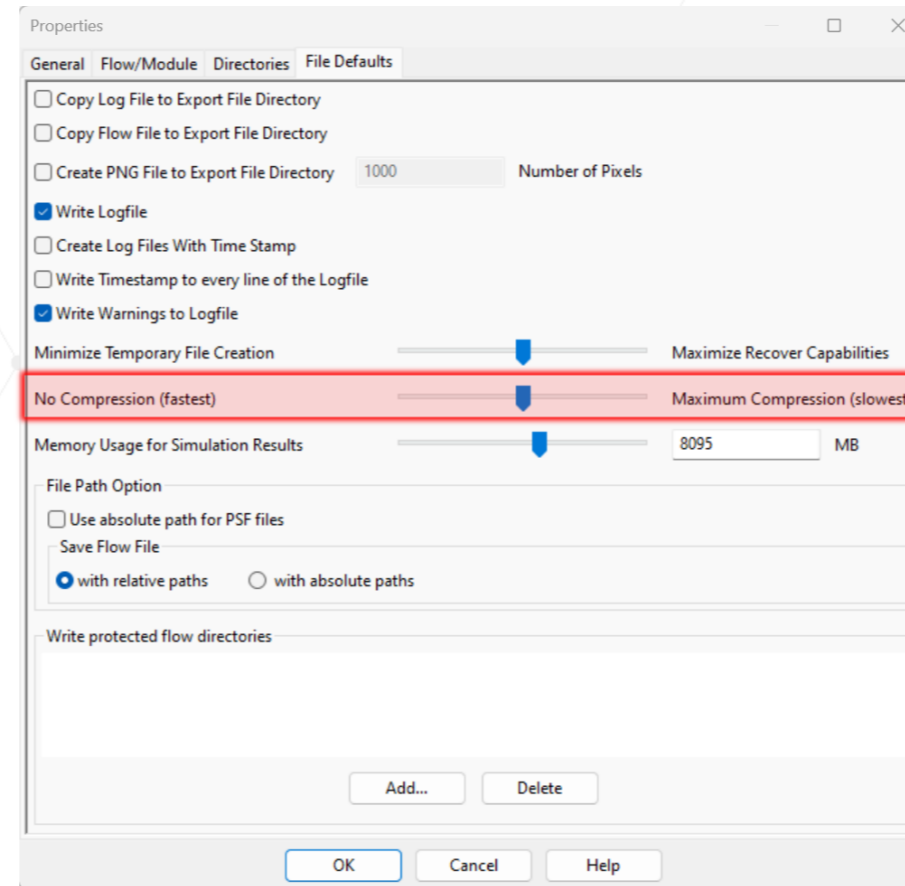
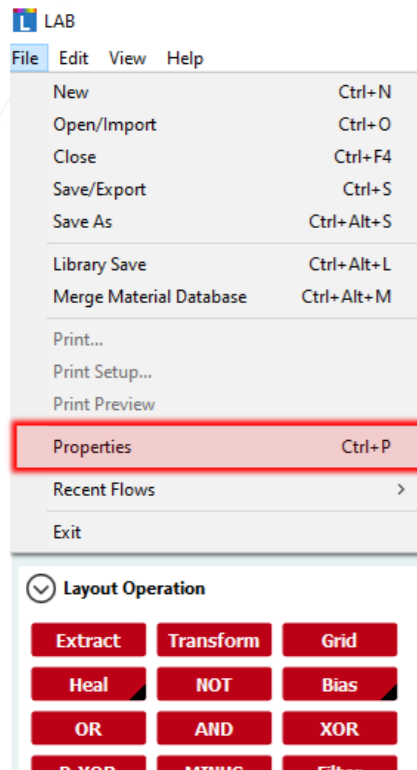
- The optimization can be stopped at any time, the last value of the optimizer will be used for the variable.



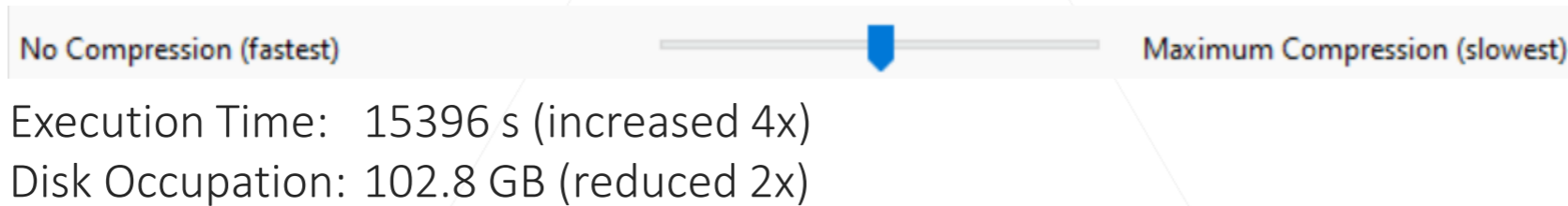
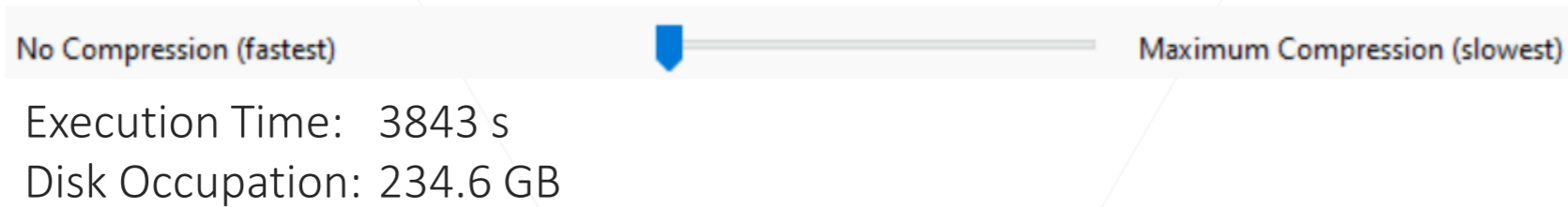
# Usability

# Temporary Files Compression

- The properties setting controls the compression of temporary files, to reduce the occupied memory



- Compromise between processing time and file size
  - For an example simulation with a large burden,



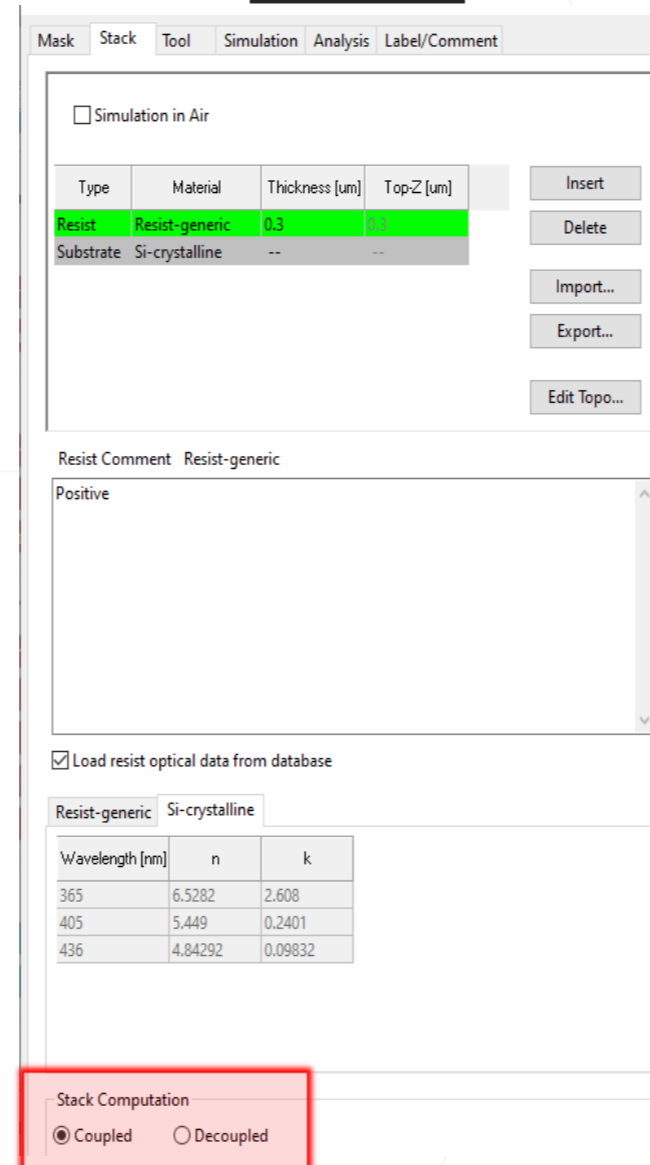
- The base dose for DWL tools is now calculated on machine parameters.

Laser Exposure

Region	Stack	Tool	Simulation	Analysis	Label/Comment
		Machine Type	DWL 66+		
		DWL Head	2mm		
		Wavelength [nm]	375		
		Pixel Size [nm]	100		
		Number of Gray-Tone Levels	0		
		NA	0.9		
		Focus Offset [um]	0.000000		
		Flare Background	0.000000		
		<input type="radio"/> Wafer Parameter			
		Beam Size FWHM [nm]	555.555393		
		<input checked="" type="radio"/> Tool parameter			
		Gaussian Beam Radius [mm]	1.160740		
		Focal Length [mm]	2		
<b>Exposure Dose</b>					
		<input type="radio"/> Direct Input			
		Exposure Dose [mJ/cm^2]	14905.5		
		<input checked="" type="radio"/> Machine Parameters			
		Power [W]	0.3		
		Transmission Filter [%]	100		
		Optical Efficiency [%]	100		

- The decision for the stack computation method is based on the following criteria
  - Proximity:** *Coupled* for topography in non-periodic direction, else decoupled
  - Projection:** *Decoupled* for bleaching stack and  $NA \leq 0.5$ , else coupled
  - Laser:** *Decoupled*

## LAB 5.8



Mask Stack Tool Simulation Analysis Label/Comment

Simulation in Air

Type	Material	Thickness [um]	Top-Z [um]
Resist	Resist-generic	0.3	0.3
Substrate	Si-crystalline	--	--

Buttons: Insert, Delete, Import..., Export..., Edit Topo...

Resist Comment Resist-generic

Positive

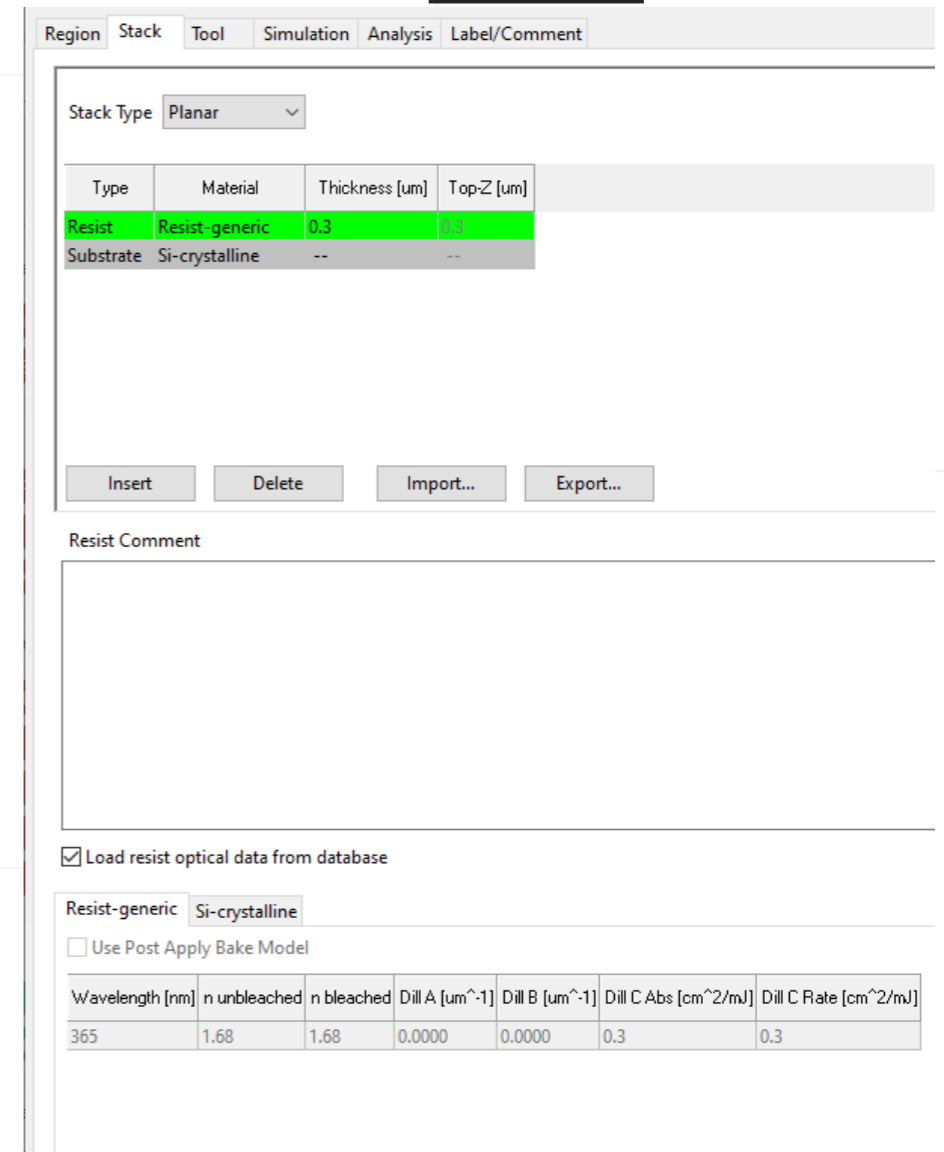
Load resist optical data from database

Resist-generic Si-crystalline

Wavelength [nm]	n	k
365	6.5282	2.608
405	5.449	0.2401
436	4.84292	0.09832

Stack Computation  
 Coupled  Decoupled

## LAB 5.9



Region Stack Tool Simulation Analysis Label/Comment

Stack Type Planar

Type	Material	Thickness [um]	Top-Z [um]
Resist	Resist-generic	0.3	0.3
Substrate	Si-crystalline	--	--

Buttons: Insert, Delete, Import..., Export...

Resist Comment

Load resist optical data from database

Resist-generic Si-crystalline

Use Post Apply Bake Model

Wavelength [nm]	n unbleached	n bleached	Dill A [um^-1]	Dill B [um^-1]	Dill C Abs [cm^2/mJ]	Dill C Rate [cm^2/mJ]
365	1.68	1.68	0.0000	0.0000	0.3	0.3



# Thank You!

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