Talbot Images of A Conical Phase Mask
In conventional Talbot lithography, only one image is employed in the photoactive layer. However, it is possible to produce two images of the phase mask in a depth-wise manner using a special phase mask. In this example, following the work of I.-H. Lee et al., a phase mask with a layer of cones is modeled in VirtualLab Fusion with the Fourier modal method (FMM, also known as RCWA). Different Talbot images are detected, such that the pillar pattern is reproduced in the primary image plane, while the hole pattern in the secondary.
How to model the phase mask structure, and calculate the Talbot patterns at different positions within the photoactive medium?

The phase mask is modeled with the 2D grating component in a grating-specific optical setup, using a Pillar Medium sandwiched between the embedding medium and the photoresist.

- Period $\Lambda_x = 500$ nm, $\Lambda_y = 500\sqrt{3}$ nm
- Cone diameter $D = 300$ nm
- Cone height $h = 300$ nm
The intensity at a certain $z$-position is calculated separately for the input beams with different polarization states (linear $x$- and $y$-polarization).
The total intensity is obtained by an incoherent average of the results from the linear x- and y-polarization states.
Talbot Pattern at Different Positions

Simulation result from reference:
I.-H. Lee, et al., Opt. Express 23, 25866-25873 (2015). [Fig. 2 (b) \( d_{M1} = 120 \text{ nm} \)]

Simulation result in VirtualLab Fusion:
\( z_1 = 120 \text{ nm} \)
\( z_2 = 239 \text{ nm} \)

Simulation result:
\( z = d_{M1} \)
\( z_1 = 120 \text{ nm} \)
\( z_2 = 239 \text{ nm} \)

\( z_1 = 120 \text{ nm} \)
\( z_2 = 239 \text{ nm} \)
Talbot Pattern at Different Positions

simulation result from reference:
I.-H. Lee, *et al.*, Opt. Express 23, 25866-25873 (2015). [Fig. 2 (c) \(d_{M2} = 920\) nm]

simulation result in VirtualLab Fusion

\(z_3 = 920\) nm

\(z_4 = 1114\) nm
Intensity along Z-Axis

Simulation result from reference:
I.-H. Lee, et al., Opt. Express 23, 25866-25873 (2015). [Fig. 2 (a)]

Simulation result in VirtualLab Fusion
VirtualLab Fusion Technologies

- Prisms, plates, cubes, ...
- Lenses & freeforms
- Apertures & boundaries
- Gratings
- Diffractive, Fresnel, meta lenses
- HOE, CGH, DOE
- Micro lens & freeform arrays
- SLM & adaptive components
- Diffractive beam splitters
- Scatterer
- Diffusers
- Waveguides & fibers
- Nonlinear components
- Free space
- Crystals & anisotropic components

Field Solver
## Document Information

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| further reading        | - [Ultra-Sparse Dielectric Nano-Wire Grid Polarizers](#)  
                         | - [Grating Order Analyzer](#)          
                         | - [Modeling of the Talbot Effect](#)   
                         | - [Configuration of Grating Structures by Using Interfaces](#) 
                         | - [Configuration of Grating Structures by using Special Media](#) |