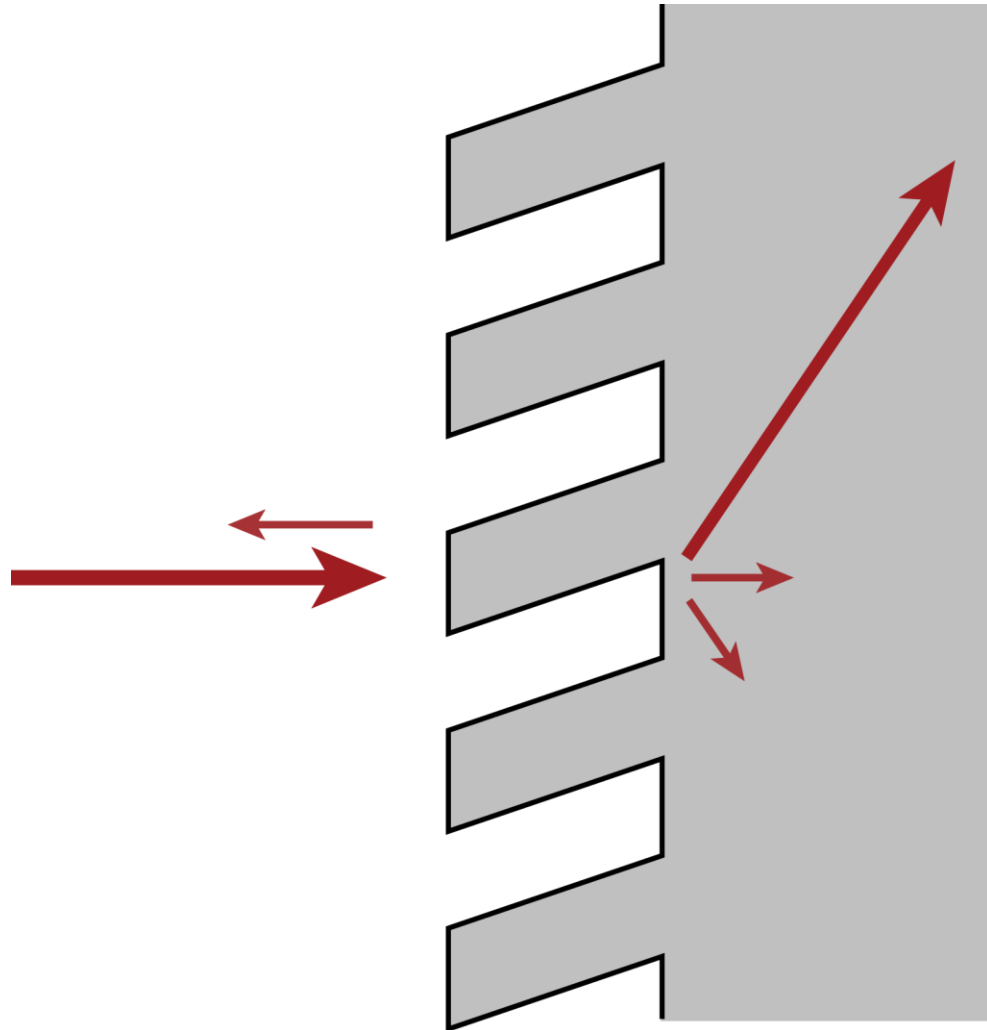# Parametric Optimization and Tolerance Analysis of Slanted Gratings

# Abstract

Coupling of light into guiding structures with high efficiency is an important issue for many applications, like backlight, optical interconnector, and near-to-eye displays. For such applications, slanted gratings are well known for being capable to couple monochromatic light with high efficiency. In this example, the optimization of a slanted grating with the rigorous Fourier modal method is presented. The optimized grating shows a diffraction efficiency of over 90% for a predefined direction order. In addition, the influence from the slope deviation of the grating is investigated.
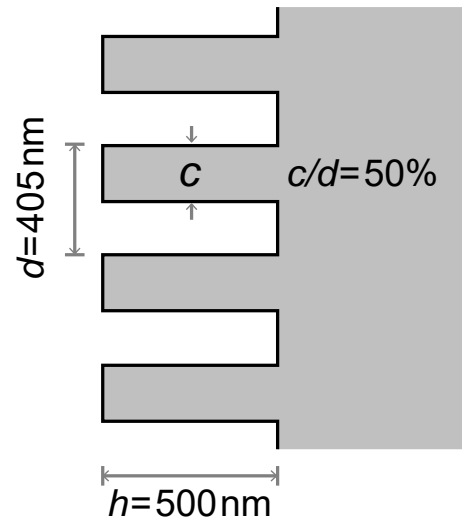
# Modeling Task
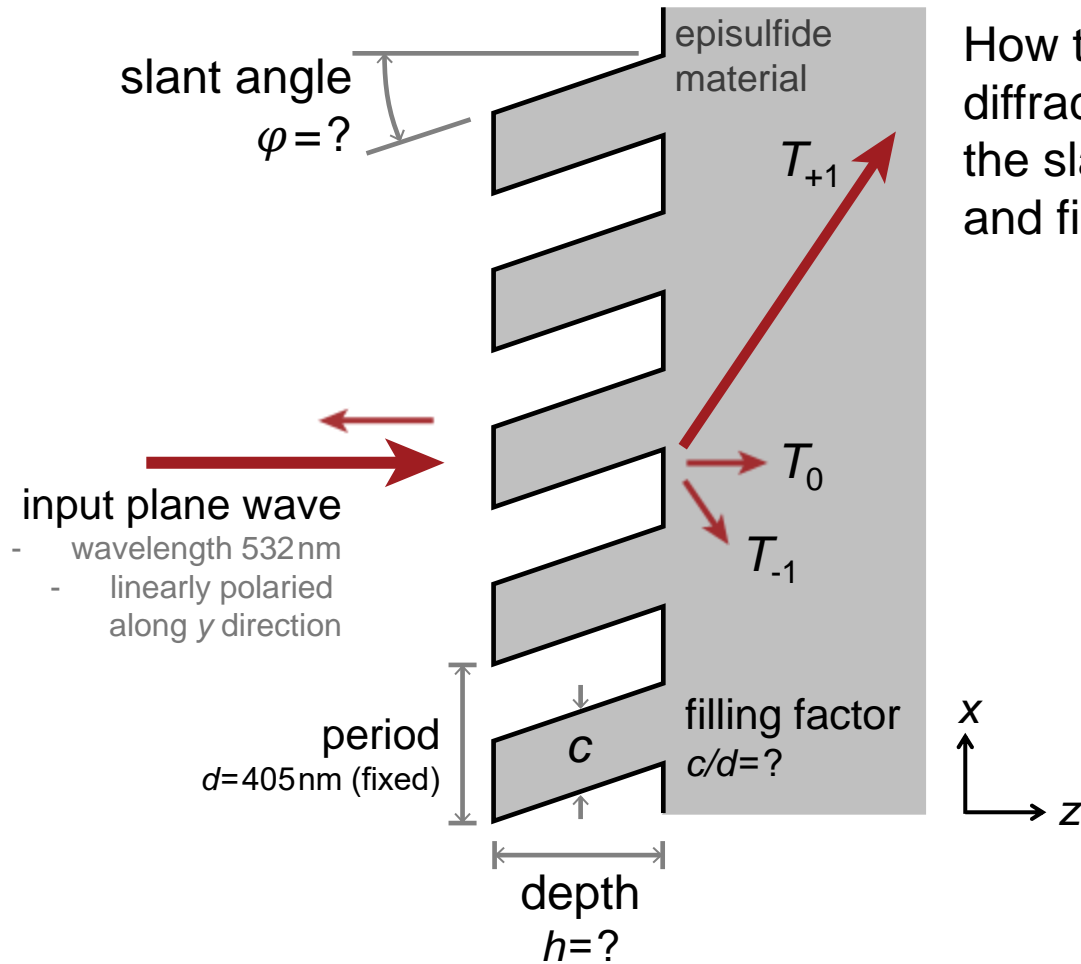


How to optimize the $T_{+1}$ order diffraction efficiency, by adjusting the slant angle $\varphi$, grating depth $h$, and filling factor $c/d$?
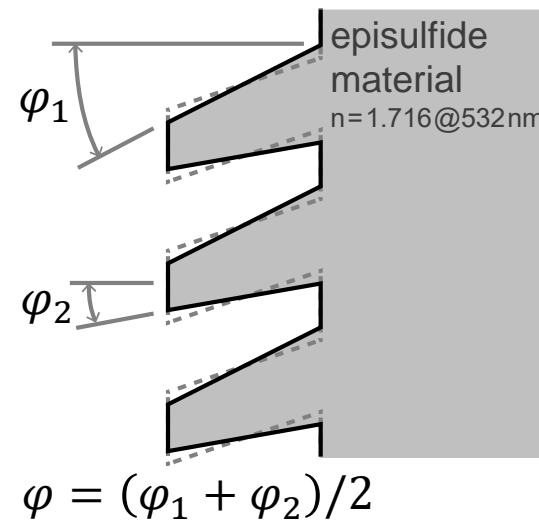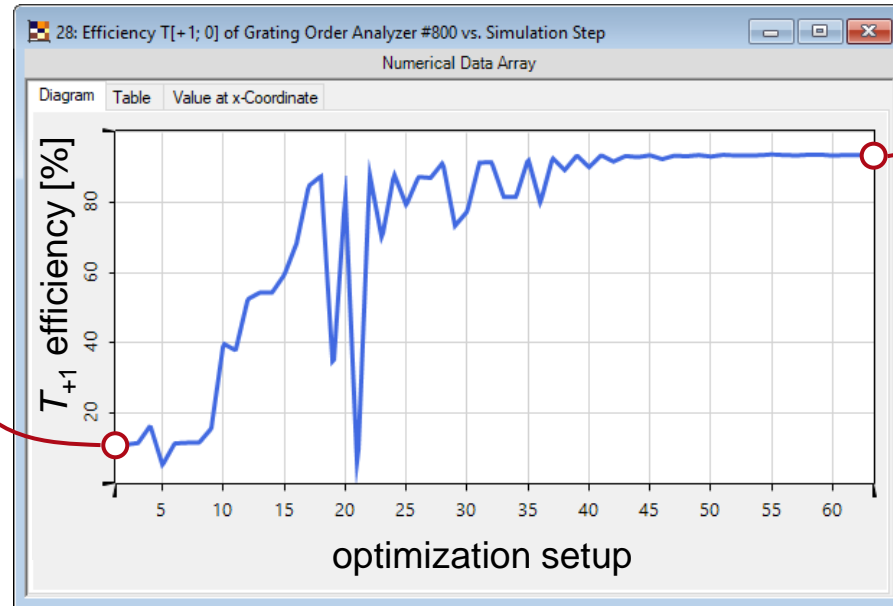
In addition, how to evaluate the grating performance with the slope deviation due to the fabrication technique taken into account?

$$\varphi = (\varphi_1 + \varphi_2)/2$$

# Results – Parametric Optimization

initial structure



$d=405\,\text{nm}$

$c$    $c/d=50\%$

$h=500\,\text{nm}$

| Order | Efficiency |
|-------|------------|
| -1    | 11.551%    |
| 0     | 72.795%    |
| +1    | 11.551%    |



28: Efficiency T[+1; 0] of Grating Order Analyzer #800 vs. Simulation Step

Numerical Data Array

Diagram | Table | Value at x-Coordinate

$T_{+1}$ efficiency [%]

optimization setup

parametric optimization with rigorous Fourier modal method for grating efficiency calculation

optimized structure

$\varphi=34°$

$d=405\,\text{nm}$

$c$    $c/d=57\%$

$h=324\,\text{nm}$
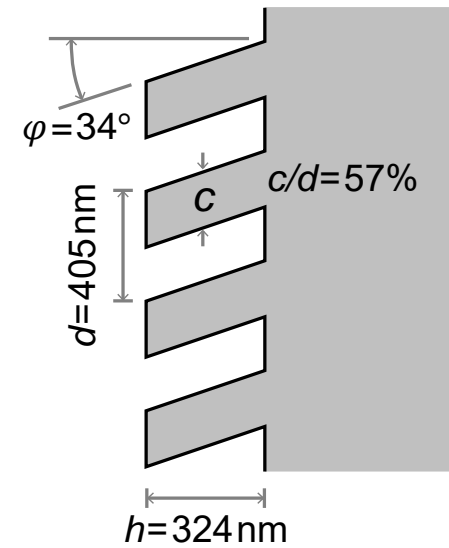
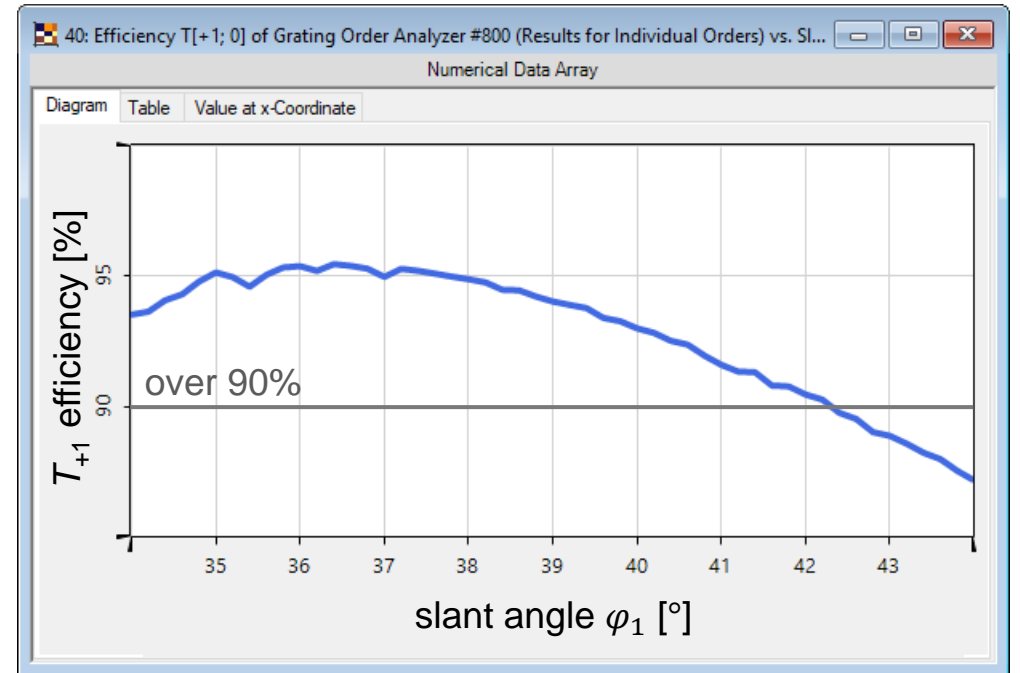| Order | Efficiency |
|-------|------------|
| -1    | 0.267%     |
| 0     | 6.027%     |
| **+1**    | **91.275%**    |

# Results – Tolerance Analysis

The fabricated slanted gratings often shows a deviation from the perfect parallel grating lines. Such slope deviations should be taken into account for the tolerance analysis.

$\varphi_1$

$\varphi_2$

$d=405\,\text{nm}$

$c$

$h=324\,\text{nm}$
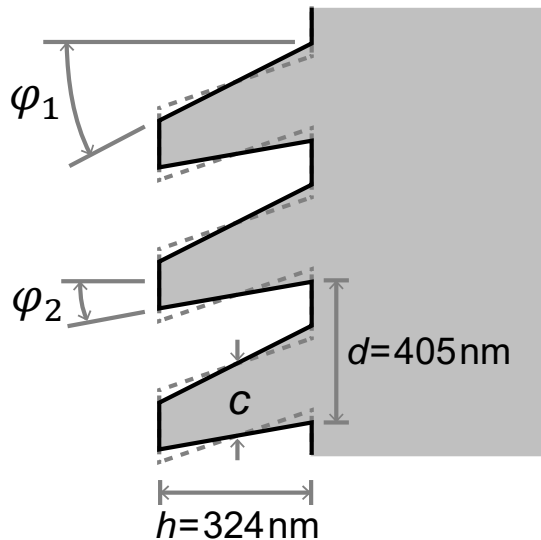
- fixed average slant angle $\varphi = (\varphi_1 + \varphi_2)/2 = 34°$
- fixed filling factor $c/d = 57\%$
- varying $\varphi_1$ from 34 to 44°



40: Efficiency T[+1; 0] of Grating Order Analyzer #800 (Results for Individual Orders) vs. Sl...

Numerical Data Array

Diagram  Table  Value at x-Coordinate

$T_{+1}$ efficiency [%]

over 90%

slant angle $\varphi_1$ [°]

Rigorous simulation with Fourier modal method, for tolerance analysis over 50 steps, takes 30 seconds.

# Document Information

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|---|---|
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| category | Application Use Case |