Simplified modal method explores deeper into broad and high-efficiency gratings

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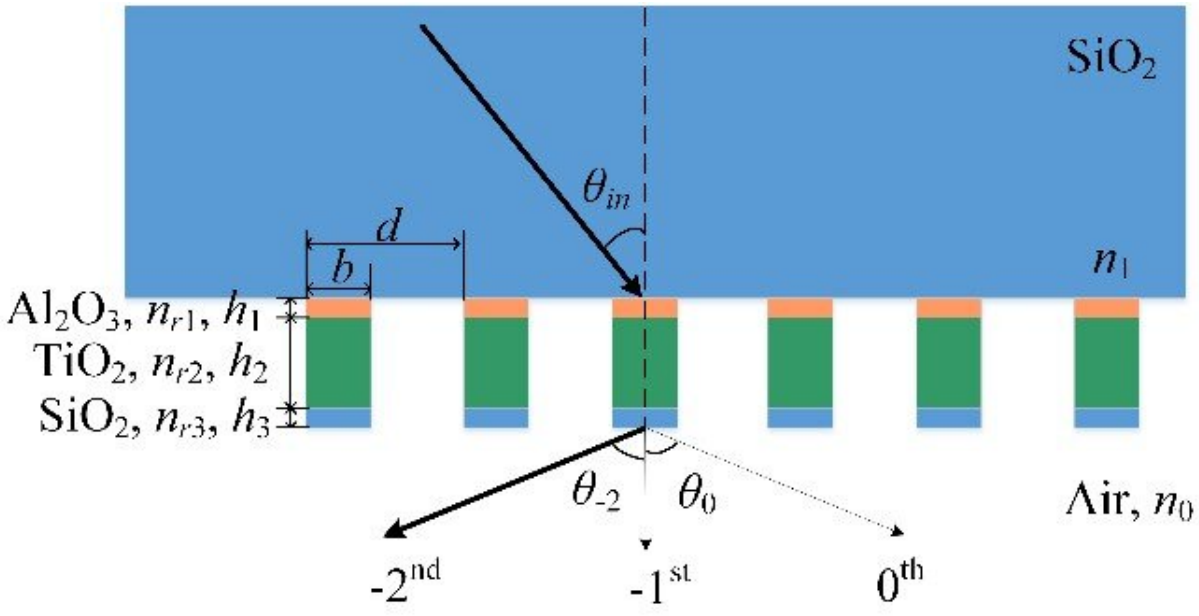

The schematic of high-efficiency three-layer transmission grating. Credit: SIOM

Owing to the excellent dispersion ability, diffraction gratings are playing an important role in widespread fields ranging from spectrometers to chirped pulse amplifiers. However, decades of extensive study on various broadband high-efficiency resonant gratings mainly focuses on those operating only at -1st order.

It is known that the resolving power is proportional to the operating

order compared with classical gratings with the same size. Using echelle gratings blazed at high order is a conventional method for realization of these high-order-operating gratings. However, typical efficiency is usually only 65%-75% for those grating due to uneven groove shape and variations in groove angle, which seriously degrades the performance of those echelle gratings.

Recently, a research group from Shanghai Institute of Optics and Fine Mechanics (SIOM), Chinese Academy of Sciences, has proposed a simplified modal method (SMM) applied to broadband high-efficiency grating. The result was published in *IEEE Photonics Technology Letters*.

In this research, a three-layer all-dielectric rectangular-groove configuration was analyzed and optimized for realization of broadband high-efficiency transmission gratings operating at the -2nd order under second Bragg angle incidence. SMM was used for analyzing the transmission gratings, which not only predicted well grating parameters to realize high efficiency at the -2nd order, but also revealed the diffraction process inside the grating region.

Furthermore, the rigorous coupled wave analysis (RCWA) and the simulated annealing (SA) algorithm were employed to optimize grating parameters to obtain more exact solutions. The simulation results indicated that a wavelength bandwidth of 1.454 μm—1.531μm and an angle bandwidth of 37.32° - 43.3° could be achieved for efficiency over 95% and the maximum efficiency could even reach 99.58% under second Bragg angle at the wavelength of 1.5 μm for TE polarization.

This is the first time using SMM to predict the broadband characteristic of multilayer-gratings under second Bragg incidence. Especially, the generation mechanism of broadband characteristics can be explained by SMM.

More information: Zhengkun Yin et al. Broadband High-Efficiency Gratings Operating at the 2nd Order Designed by Simplified Modal Method, *IEEE Photonics Technology Letters* (2020). DOI: 10.1109/LPT.2020.2972749