Ultrabroadband TM reflection from high contrast grating: why ?

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A grating mode analysis of the unusually broadband TM reflection from a high contrast binary grating sheds light on the origin of this effect. This interpretation will be submitted to the workshop attendance.

Introduction

There has been a high interest lately in the unusually wide, close to 100% reflection spectrum of a normally incident, TM-polarized plane wave from a high index contrast binary grating or segmented waveguide [1]. All modeling results have been obtained by applying the RCWA numerical technique and although there was some attempt to give a phenomenological interpretation of the effect, the question of the wide bandwidth character of the reflection spectrum remains unanswered.

Results

We have first analyzed the phase of the reflection spectrum to discover that there is only one guided TM mode propagating along the segmented waveguide. Resonant reflection can therefore not explain the broadband character although it does participate in the effect.
We have taken up this problem on the basis of the two excited grating modes (TM_0 and TM_2) propagating up and down the vertical walls and slits of the structure and examined what may be responsible for a broadband destructive interference in the transmission medium. The two conditions for such effect to occur are a wavelength independent propagation constant difference between the two excited grating modes and a wavelength independent balanced excitation of these two modes. We will show that a TM mode close to cut-off exhibits a change of sign of the dispersion curve curvature, and that such feature is already present in a high contrast single slab waveguide. This leads to the possibility of achieving a parallelism between the TM_0 and TM_2 dispersion curves over a rather wide part of the spectrum. Examining the variation of the TM modal fields in this part of the spectrum teaches that the balanced excitation of the two modes by a plane wave can be kept over the same section of the spectrum.
This broadband effect will be discussed at depth and the interpretation submitted to the attendance.

References

[1] C.F.R. Mateus et al., *IEEE Photonics Tech. Lett.*, Vol. **16**, 518-520, (2004)