Coupled-Mode Theory for Complex-Index, Corrugated Multilayer Stacks
Lüder, Hannes; Gerken, Martina; Adam, Jost

Publication date:
2016

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 09. Jan. 2017
We present a coupled-mode theory (CMT) approach for modelling the modal behaviour of multilayer thin-film devices with complex material parameters and periodic corrugations. Our method provides fast computation and extended physical insight as compared to standard numerical methods.

Nanostructuring of multilayer thin-film devices, like OLEDs, is a common technique to manipulate the light out-coupling from and/or the field distribution inside the device. Recently, compound binary grating structures have been proposed for tailoring the angular emission spectrum of light emitting thin-film devices [1] and for increasing the sensitivity of refractive index sensors [2]. Here, we show a coupled-mode theory approach for modelling such devices. We first calculate the unperturbed waveguide modes (Fig. 1), used as basis functions in the coupled-mode formalism. The waveguide corrugation is treated as a perturbation and leads to coupling between the modes. Expanding our previous work [3], we introduce perfectly matched layer (PML) boundary conditions, to maintain a discrete, complete set of modes [4], and allow for complex-index materials. These extensions, however, cause the resulting eigenvalue equation to be non-Hermitian, introducing two major consequences. First, the eigenvalues (i.e. the mode $n_{\text{eff}}$) have to be found in the complex plane (Fig. 2). Second, the classical mode orthogonality is no longer valid. We address both challenges by a combination of three complex-root solving algorithms, and by choosing a bi-orthogonal basis, obtained by solving the corresponding adjoint problem. With the once found modal solutions of the unperturbed waveguide, we can calculate the coupling coefficients, which describe the mode coupling caused by the introduced periodic corrugation.

![Figure 1: Multilayer slab waveguide with PMLs](image1)

![Figure 2: Phase portrait of a waveguide characteristic function](image2)

References