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A coupled-mode theory analysis of intermixing in semiconductor distributed Bragg reflectors

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Abstract On the basis of the coupled-mode theory, we have been able to successfully model and analyse the effect of intermixing on important optical properties of semiconductor distributed Bragg reflectors (DBRs). An expression for the coupling coefficient κ as a function of diffusion length L_D for intermixed DBRs has been derived. The derived expression for the intermixed DBRs allows the reflectivity, stop-band width, and penetration depth, to be calculated analytically. A 25 period GaAs/AlAS DBR centred at 980 nm was used to validate and test the model. It has been shown that the obtained results agree with those reported earlier using the transfer matrix method. As so, the presented model may provide a simple yet versatile rapid technique for the analysis of intermixed DBRs composed of any material system in which the diffusion process is Fickian and its corresponding refractive index is known.

Keywords Intermixing · Distributed Bragg reflectors · Modeling

1 Introduction

Semiconductor distributed Bragg reflectors (DBRs) consisting of periodically grown quarter-wave semiconductor heterointerfaces are the essential components in many semiconductor optoelectronic devices including, but not limited to, vertical cavity surface emitting lasers (VCSELs) (Iga 2000) and resonance cavity light emitting diodes (RCLEDs)(Guida et al. 2001).

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