Opt Quant Electron (2013) 45:581–588
DOI 10.1007/s11082-012-9640-6

Self-consistent analysis of thermal far-field blooming of broad-area laser diodes

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Received: 28 September 2012 / Accepted: 17 November 2012 / Published online: 30 November 2012

Abstract High-power broad-area laser diodes often suffer from a widening of the lateral (slow axis) far-field with increasing current, called thermal blooming, which is mainly caused by the non-uniform self-heating of the laser and has been studied for several decades. This paper presents the first self-consistent electro-thermal-optical simulation and analysis of such thermal blooming. Using a real InGaAs/GaAs broad-area laser as an example, a 900 A/cm^2 higher current density is shown to lead to only 0.5 K stronger lateral temperature drop inside the ridge waveguide but to a one degree wider slow axis far field. Small non-thermal blooming is also observed.

Keywords High-power broad-area laser diode · Thermal blooming · Slow axis far field · Self-heating · Thermal lens · Lateral laser modes

1 Introduction

High-power broad-area laser diodes often suffer from a widening of the lateral (slow axis) far-field with increasing current (see, e.g., Crump et al. 2012). This effect is also referred to as thermal blooming, since self-heating is considered the main cause. The non-uniform temperature profile inside the waveguide leads to a lateral refractive index profile that enhances the index guiding of lateral laser modes (thermal lens). Numerical simulation is a valuable tool in investigating this sophisticated interaction of electronic, thermal, and optical processes, however, a comprehensive numerical analysis has not been published yet. Previous simulation reports use simplified models (e.g., Hadley et al. 1988), neglect the self-heating (e.g., Lang et al. 1991; Hess et al. 1995), or only combine optical and thermal models (e.g., Pomplun et al. 2012).

This paper presents the first self-consistent electro-thermal-optical simulation of the thermal blooming effect, including the non-uniform heat power distribution inside the laser as

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