Determination of Absorption Coefficient of Mg Doped Layers and its Influence on Internal Optical Losses in InGaN Laser Diodes

M. Hajdel [1,2], G. Muzioł [1], K. Nowakowski-Szkudlarek [1], M. Siekacz [1], A. Feduniewicz-Żmuda [1], P. Wolny [1] and C. Skierbiszewski [1,3]

[1] *Institute of High Pressure Physics Polish Academy of Sciences, ul. Sokołowska 29/37, 01-142 Warsaw, Poland*
[2] *Gdańsk University of Technology, ul. Gabriela Narutowicza 11/12, 80-233 Gdańsk, Poland*
[3] *TopGaN Ltd, ul. Sokołowska 29/37, 01-142 Warsaw, Poland*

Reduction of internal optical losses (α_i) is one of the key elements in the design of high power laser diodes (LDs). α_i influence both differential efficiency and threshold current density. Therefore, understanding of the mechanisms that generate optical losses in laser cavity is crucial for future optimization of high performance LDs. Total internal optical losses in lasers is a sum of products of absorption coefficient (α_{layer}) and confinement factor (Γ_{layer}) of each layer of the device. Previous works indicates that the major component of α_i in GaN-based laser diodes is caused magnesium doped layers [1,2,3] due to the high absorption coefficient [4]. Knowledge of the absorption coefficient of Mg doped layers is the key to designing efficient high power LDs.

The most highly Mg doped layer in the III-nitride LDs is the electron blocking layer (EBL). It is placed right after the active region to ensure high carrier injection efficiency (η_i).

In this work we will study the influence of Mg doping level on optical losses of the LDs. To examine this the InGaN blue LDs with different EBL designs were grown by plasma-assisted molecular beam epitaxy (PAMBE). The Mg doping concentration in the EBL was varied from $7 \cdot 10^{18}$ to $6 \cdot 10^{19} cm^{-3}$ and the thickness of the EBL was varied from 5 to 20nm for one doping concentration.

A strong influence of Mg doping concentration and EBL thickness on slope efficiency and threshold current of grown LDs was found. Moreover, it was observed that the external LD parameters are the result of interplay between η_i and α_i. Experimental data will be compared with theoretical predictions of our optical mode distribution model [5] and the SiLENSe simulation tool.

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