Impact of Mg doping on InGaN based laser diodes grown by PAMBE

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Worldwide commercialization of InGaN-based blue laser diodes (LDs) was possible thanks to, inter alia, the increase in the operating efficiency via reduction of internal optical losses (α_i). Previous works show that the major component of α_i in III-nitride LDs grown by metalorganic vapor phase epitaxy (MOVPE) is caused by Mg doped p-type layers [1,2] due to the high absorption coefficient [3]. However, the mechanisms governing the absorption losses for LDs grown by plasma-assisted molecular beam epitaxy (PAMBE) remain unknown. The enhancement in performance of LDs grown by PAMBE is of high importance as these LDs have more degrees of freedom in their design in comparison to MOCVD grown devices due to lack of hydrogen during growth. This fact enables an easy way to realize a high power stack of multiple lasers interconnected via tunnel junctions. [4]

In this paper we will discuss the impact of Mg doping on characteristics of blue (λ=450nm) LDs grown by PAMBE. We will study the influence of thickness, doping level and placement of electron blocking layer (EBL) in InGaN LDs. EBL is a heavily Mg-doped layer which acts as an energetic barrier formed in the conduction band to prevent electrons from escaping the quantum wells.

An interplay of two effects is observed. A thick highly doped EBL causes high optical absorption. On the other hand a thin and/or lightly doped EBL fails to prevent overshot of electron. A trade-off between the two effects is proposed to design a highly efficient LD.

Calculations based on a drift diffusion model and optical mode distribution are performed to build a comprehensive model of impact of the Mg dopant on the performance of InGaN LDs.

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