

具耳語廊模態之準光子晶體共振腔柱狀結構用於電激發之研究

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摘要

在本篇論文當中，為了要突破現階段光子晶體共振腔懸空結構所遇到的困境：電激發結構以及連續性操作，我們提出了在共振腔下方加入柱狀結構的概念。在這裡我們使用三維有限時域差的方法去計算出耳語廊模態受到柱狀結構產生的影響，我們利用雷射 Q 值的改變來估計的耳語廊模態(Whispering-Gallery Mode, WG Mode)受到的影響，並找出在沒有明顯損耗影響下，耳語廊模態能承受最大的柱狀結構。我們更進一步使用有限元素分析法去計算磷化銦柱狀結構能夠提供的散熱效果，因為柱狀結構越大，其提供的散熱效果越好，但另外一方面卻也會造成更大的雷射 Q 值損耗，所以我們也試圖在其中找到一個最佳的值來改善我們的結構。

在製程的篇章中，我們將專注在電激發結構的開發，基於微碟型共振腔裡常用的柱狀結構電激發模式，我們提出了一個可具高效率電流載子注入的電激發結構，這其中包括了光罩設計、碟型結構設計、乾式蝕刻相關技術、電極設計等。我們成功的製作出可以當作電激發結構的平台，並針對製程中的問題以及後續的優化進行探討。此外，利用自行架設的近紅外光共焦顯微電激發光系統，也得以進行製程中結構對量子井破壞程度的監控。

Investigation on Quasi-Photonic Crystal Microcavity with Central Post Based on Whispering-Gallery Mode for Electrical Driving

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Abstract

Since there are still some challenges in achieving electrically-driven and continuous-wave operation membrane structure photonic crystal microcavity lasers, in this thesis, we propose the structure of central post under the microcavity. At first, we simulate the influences caused by the central post on quality (Q) factor of the whispering-gallery (WG) mode by three-dimension finite-difference time-domain method. By Q factor degradation, we can find the largest post size without affecting the WG mode. And we also simulate the heat sink effect provided by different post size by finite-element method. The heat sink will be better when the post size become larger. In contrast, the optical loss will increase with the post size. Thus, we will find a balanced post size to meet the trade-off between Q factor and heat sink.

In fabrication, we will focus on the developing of electrical driving structure. Based on the central post structure used in electrically-driven microdisk lasers, we propose a high efficiency electrically-driven structure for photonic crystal microcavity.

The related fabrication process will include photo mask design, disk structure formation, dry-etching technology, and electrode formation. We successfully fabricate a mesa for electrically-driven photonic crystal microcavity. We also analyze the problems in present fabrication process, which can be the reference for the following structure optimization. Besides, by using our near-infrared con-focal micro electro-luminescence system, we can confirm the quantum-wells degradation during above fabrication processes.



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