

國立交通大學

光電工程系顯示科技研究所

碩 士 論 文

二維準週期性光子晶體雷射
之製程與特性分析

**Fabrication and Characteristics of
Two-Dimensional Quasi-Periodic Photonic
Crystal Lasers**

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在本篇論文當中，我們使用三維平面波展開法以及二維有限時域差的方法去計算出對稱性光子晶體雷射結構的能帶圖、和共振場圖。這些有效的計算方法幫助我們能最佳化我們的光子晶體設計，並且把這些設計確實的應用在我們的製程當中。

在製程的篇章中，主要分為兩大部分去介紹，分別是對稱性與非對稱性結構的製程。我們在對稱的薄膜結構上做了許多種不同設計的光子晶體元件去研究。而在非對稱性結構中，我們成功的把光子晶體寫在主動層與 DBR 接和的晶片上面。以上的製程步驟和遇到的困難以及解決方法都詳細的寫在內容中。

最後，利用自行架設的 micro-PL 系統把我們製程出來的所有元件做量測與討論。從量測的結果與模擬的結果去討論，可以得知我們量測到的發光模態與我們預測的是相同的。並且，達到我們所預期的雷射特性、從設計去減少共振模態、準週期性結構在製程中對誤差的容忍度和 DBR 接和晶片發光的光子晶體雷射，這些結果都已從量測中得到。

Fabrication and Characteristics of Two-Dimensional Quasi-Periodic Photonic Crystal Lasers

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Abstract

We calculated the band diagrams, photonic band gaps, resonance spectra, and resonance mode profiles of the symmetric and c two-dimensional photonic crystal lasers using 3D plane-wave-expansion method and 2D finite-difference time-domain method. These help us to optimize our photonic crystal design. And then, a modified quasi-periodic photonic crystal microcavity laser was designed.

In the fabrication, we introduced the procedures for two different structures. In the membrane structure, we demonstrated the basic photonic crystal lasers and the 12-fold quasi-periodic photonic crystal lasers. In the asymmetric structure, the wafer fusion technology was developed. And the PC microcavity structure was defined on the bonded sample successfully. All of the fabrication procedures for symmetric and asymmetric structure lasers were presented in detail.

The basic characteristics of two-dimensional quasi-periodic photonic crystal microcavity were measured by a micro-scale photoluminescence system. Furthermore, the characteristics were compared to the triangular lattice photonic crystal lasers. From the measurements, we achieve the goals of ultra-low threshold, high-Q, side mode reduction, the tolerance of QPC lasers, and PC devices lasing from DBR bonded wafer.

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