

國立交通大學  
光電工程研究所  
博士論文

研究在大面積氧化侷限型之面射型雷射  
之橫向模態

Transverse Mode in Broad-Area Oxide-Confined  
Vertical-Cavity Surface-Emitting Laser

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中華民國九十二年七月

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## 摘 要

我們量測了孔徑尺寸為  $20\ \mu\text{m}$  的氧化侷限型之面射型雷射的橫向模態。量測項目則有橫向模態的近場、遠場分佈圖。由於雷射磊晶片的品質十分優良，使我們可以在連續波(CW)的狀態下，當注入電流由臨界電流(threshold current)一直到遠高於熱轉折點(thermal roll-over point)時都能夠持續地進行量測。在遠場分佈圖中，可以觀察到大面積的氧化侷限型之面射型雷射展現了非常複雜、如花朵一般，以及分岔的橫向模態分佈圖。此外，為了瞭解不同的導波機制(guiding mechanisms)對於橫向模態的影響，我們將孔徑尺寸  $20\ \mu\text{m}$  氧化侷限型之面射型雷射的與質子佈植型之面射型雷射的橫向模態之間互相做了比較。由實驗的結果可以發現，非常不均勻的注入電流以及熱分佈使得大面積的氧化侷限型之面射型雷射傾向於選擇多重高階橫向模態。此外，由氧化層造成的邊界效應(boundary effect)也會影響的橫向模態的行為。由於這些機制造成了如花朵一般，以及分岔的遠場橫向模態分佈圖

的形成。

# Transverse Mode in Broad-Area Oxide-Confined Vertical-Cavity Surface-Emitting Laser

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## ABSTRACT

We present experimental studies on the transverse modal behaviour of oxide-confined Vertical-Cavity Surface-Emitting Laser (VCSEL). The near- and far-field transverse mode patterns are investigated under CW pumping condition. The VCSEL with 20  $\mu\text{m}$  diameter of the oxide apertures exhibits the complex flower-like and y-junction structured patterns in far-field images. A comparison between a 20  $\mu\text{m}$  diameter aperture oxide-confined VCSEL and a proton-implanted VCSEL enables us to clearly distinguish the influence of different guiding mechanisms on the transverse modal behaviour. From the experimental results, we conclude that the VCSEL cavities can usually support many transverse modes, especially in large-diameter index-guided structures due to nonuniform carrier-concentration profile and temperature distribution. Furthermore, the boundary effect induced by oxidized layers strongly influence the transverse modal behaviour of oxide-confined VCSELs. The combination of these mechanisms causes a strong tendency towards the emission of multi-high-order transverse mode which causes the formation of complex flower-like and y-junction structured transverse mode patterns.

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