# 850 nm 質子佈植面射型雷射的製作與電熱特性研究

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## 摘　　要

本論文主要是探討質子佈植式砷化鎵量子井面射型雷射的電熱特性。經由室溫下所量測的連續式光輸出－電流－電壓特性數據，我們觀察到面射型雷射的元件特性，例如串聯電阻、臨界電流、臨界電流密度、以及最大輸出能量，會隨著其活性區尺寸變化而有所影響。另一方面，空間燒洞(spatial hole burning)所造成的增益缺陷和熱透鏡(thermal lensing)造成的自聚焦(self-focusing)效應會使得佈植式面射型雷射元件模態發生變化。我們發現橫模的生成，與光輸出－電流曲線中扭曲的現象和變動的斜率有所關聯。爲了進一步地觀察橫模的變化，我們量測在光輸出－電流曲線中扭曲處附近的雷射發光頻譜。藉由所量測的頻譜，可以看到在扭曲處的模態由基模逐漸生成高階模。最後，我們討論溫度對於面射型雷射元件特性的影響。當注入的電流逐漸增加，元件內部的發熱效應使得其內部溫度變高，因而影響元件特性，造成光輸出－電流曲線在高注入電流時，光輸出能量會有反轉(roll-over)的現象。接著，利用法布里-珀羅(Fabry-Perot)共振波長隨著溫度的變化，將其想像成元件內部的溫度計，進而推算面射型雷射隨著不同的注入電流時的活性區域溫度。此外，我們改變散熱器的溫度，觀察不同溫度時由於增益模與法布里-珀羅共振模重疊程度的改變，對於面射型雷射元件特性的影響。

# Fabrication and Electro-Thermal Characteristics of 850 nm Proton Implanted Vertical-Cavity Surface-Emitting Lasers

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## Abstract

In this thesis, the electrical and thermal properties of proton implanted GaAs quantum-well vertical-cavity surface-emitting laser (VCSEL) devices were investigated. From the CW L-I-V characteristics at room temperature, it was observed that changes in the active region size affect the performance of VCSELs. The associated parameters, such as serious resistance, threshold current, threshold current density, maximum output power, scale differently with device size. On the other hand, the transverse mode formation of implanted VCSELs caused by spatial hole burning (SHB) and self-focusing effect due to thermal lensing is related to the kink phenomenon in L-I curve with variant slope efficiency. The emission spectra in the vicinity of the kink in L-I curve were shown, and we could see the variation of transverse mode in the vicinity of the kink in L-I curve to verify this phenomenon further. Finally, the influence of temperature on VCSEL device was discussed. We observed a thermal roll-over in the CW L-I characteristics, and we used the measured FP mode wavelengths as a thermometer to estimate the temperature of active region. In addition, it was also observed the performance of the VCSEL device changes with temperature, attributed to the variation of the overlap between the gain peak and the FP resonance mode.