

# 摘要

論文名稱：以內腔半導體光放大器進行鎖模摻鉍光纖雷射的相位雜訊和超模雜訊抑制

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關鍵詞：增益半導體雷射、摻鉍光纖放大器、光脈衝注入、半導體光放大器、單邊帶相位雜訊、時序抖動量、超模雜訊

在本論文中，我們說明利用內腔半導體光放大器和光帶通濾波器加入諧波鎖模摻鉍光纖雷射研究極低超模雜訊和單邊帶相位雜訊的特性且與增益開關費比布洛雷射二極體和摻鉍光纖雷射的互注鎖定做比較。利用驅動在無增益情況下的內腔半導體光放大器作為高通濾波器時，我們首先探討諧波鎖模摻鉍光纖雷射的超模雜訊抑制比可同時與費比布洛雷射二極體摻鉍光纖雷射互注鎖定的超模雜訊抑制比做相比，並且不犧牲單邊帶相位雜訊和時序抖動量。

當半導體光放大器被超作接近透明增益情況下，摻鉍光纖雷射的超模雜訊抑制比增加到 86dB，但是犧牲了相位雜訊(-104.2dBc/Hz)，劣化時序抖動量(1.4 ps)且導致脈衝拓寬了(61 ps)。但藉由加入光帶通濾波器於環腔中時，則以半導體光放大器作為濾波器的摻鉍光纖雷射之超模雜訊抑制比、單邊帶相位雜訊、時序抖動量和脈衝寬度均可以進一步的被改善為 90 dB, -112 dBc/Hz, 0.7 ps and 42 ps。有半導體光放大器和光帶通濾波器的諧波鎖模摻鉍光纖雷射的超模雜訊抑制比特性已經與費比布洛雷射二極體摻鉍光纖雷射互注鎖定的超模雜訊抑制比做相比較。最後，我們結合鎖相迴路和壓電轉換控制器達成回授鎖模摻鉍光纖雷射技術。在這實驗，相位雜訊和時序抖動被進一步做分析。

# ABSTRACT

Title : Suppression of Phase Noise and Supermode Noise in Mode-Locked Erbium Doped Fiber Laser with an Intra-Cavity Semiconductor Optical Amplifier  
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Keywords : Gain-Switch Semiconductor Laser 、 Erbium-Doped Fiber Amplifier 、 Optical Injection Locking 、 Semiconductor Optical Amplifier 、 Single-Side-Band Phase Noise 、 Timing Jitter 、 Supermode Noise

In this thesis, we demonstrate that the ultralow supermode noise and single-sided-band (SSB) phase noise characteristics of a harmonically mode-locked (HML) Erbium-doped fiber laser (EDFL) with an intra-cavity semiconductor optical amplifier (SOA) and optical band-pass filter (OBPF) are investigated, and are compared to a mutually injection-mode-locking (IML) link of gain-switched Fabry-Perot laser Diode (FPLD) and EDFL with the state-of-the-art performances. With an intra-cavity SOA based high-pass filter driven at unitary gain condition, we primarily demonstrate that the supermode noise suppression ratio (SMNSR) of the HML-EDFL can be simultaneously suppressed to be comparable with that of the FPLD-IML-EDFL without sacrificing the SSB phase noise and jitter performances.

The SOA operated at nearly transparent condition enhances the SMNSR of the EDFL to 86 dB at the cost of degrading phase noise (-104.2 dBc/Hz), increasing jitter (1.4 ps), and broadened pulsewidth (61 ps). By adding an OBPF into the ring cavity, the SMNSR, SSB phase noise, jitter and pulsewidth of the SOA filtered HML-EDFL can further be improved to 90 dB, -112 dBc/Hz, 0.7 ps and 42 ps, respectively. The SMNSR performance of the HML-EDFL with SOA and OBPF has already been comparable with that of a FPLD-IML-EDFL link. At last, we use phase lock loop (PLL) and piezo-electric transducer (PZT) controller link to achieve regenerative mode-locked EDFL technique. The SSB phase noise and timing jitter are further analyzed in this experiment.