以全正色散摻鐿光纖雷射產生似噪音脈衝之放大與色散控制

研究生：黃建彰　　指導教授：潘犀靈 教授

國立清華大學 光電工程研究所碩士學位論文

摘要

本論文主要探討由全保偏(polarization-maintaining)光纖構成之二階摻鐿光纖啁啾放大系統放大皮秒級全正色散(all-normal dispersion)非保偏被動鎖模(passive mode-locked)光纖雷射。種子光源輸出之功率為 50 毫瓦、脈衝寬度為 15 皮秒。兩級光纖放大器由核直徑分別為 10 微米及 30 微米，長度分別為 7 公尺及 5 公尺之保偏光纖所構成，最大輸出功率為 20 瓦。脈衝能量放大後，再以槽密度(groove density)為每毫米 1600 條之穿透式光柵對進行色散補償。實驗上之結果顯示，由於嚴重之非線性效應及第三階色散項之影響，我們無法將高能量之脈衝壓縮至亞皮秒尺度，但經將光纖放大器之光纖由普通光纖置換成保偏光纖後，由於偏振態在放大器出口保持高度線性偏極化且偏振穩定性高，能量不因光柵之偏振選擇性而損失，脈衝能量的使用效率顯著提升 50%以上。於最佳之第二階及第三階色散補償狀態之下，我們得到最高尖峰功率為 90 千瓦、半高全寬(full width half maximum)為 1.7 皮秒之脈衝，其中總脈衝能量 174 奈焦耳之中約有 65%的能量集中於主脈衝中，相較於非保偏摻鐿光纖啁啾放大系統，能量集中率提升了 35%。

Amplification and Dispersion control of Noise-like pulses generated by an ANDI Yb-fiber Laser

Student: Jian-Zhang Huang Advisor: Prof. Ci-Ling Pan

Institute of Photonics Technologies

National Tsing-Hua University

Abstract

In the thesis, we studied the chirped pulse amplification (CPA) system based on a dual-stage Yb-doped polarization-maintaining (PM) fibers seeded with a picosecond-scale all-normal dispersion (ANDi) fiber laser with pulse duration of 15 ps and average output power of 50 mW. The dual-stage amplifier was composed of 7-m-long 10-μm Yb-doped PM fiber and 5-m-long 30-μm Yb-doped PM fiber as a pre-amplifier and a main amplifier, respectively. In the experiment, due to strong nonlinearities induced by PM fibers and third order dispersion (TOD) of the fiber stretcher, we could not obtain sub-picosecond pulses in CPA system. But the power efficiency was raised up to about 50% for the characteristic of PM fibers in maintaining polarization of pulses so that the power would not loss due to the selection of polarization in grating compressor. Under the condition of the best compensation in SOD and TOD, the highest peak power of the compressed pulse was ~90 kW with pulse duration of 1.7 ps in FWHM and 1.94 ps in EA definition and the pulse energy was 174 nJ with 65% pulse energy concentration which was improved up to 35% comparing to normal-fiber-based CPA system.