TUNEABLE DUAL-WAVELENGTH ERBIUM-DOPED FIBRE LASER USING LINEAR CAVITY

By

FAIRUZ ABDULLAH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Partial Fulfilment of Requirements for the Degree of Master of Science

July 2004

Dedicated to
My beloved parents and families
My ever-loyal friends
And my lovely beautiful inspiration…

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in partial fulfilment of the requirements for the degree of Master of Science

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Chairman : Associate Professor Mohamad Khazani Abdullah, Ph.D.

Faculty : Engineering

The growth of optical communication system in recent years has been phenomenal. It is either in its applications, bandwidth offered, speed of data transferred or even the techniques used to achieve these. In order to cope with the growth and meet demand, researchers worldwide had to come up with new laser system.

One of the areas of interest by is the development of the optical communication power source, i.e. the laser. Irrespective of whether it is a semiconductor laser or fibre laser, tremendous amount of research have been carried out to develop a better laser. There is a keen interest in developing a fibre laser.

In this study we have develop a fibre laser system as the optical communication source. The fibre laser uses the standing wave or linear cavity configuration. It produces two output wavelengths tuneable within a 30nm region. The tuneability of these output wavelengths is independent of each other. The tuning was done while maintaining the output power level to be almost if not equal. The power difference between the output is restricted to less than 0.5dB

The independent tuning and output power equality is achieved by controlling the system's cavity loss. To do this, variable optical attenuators are placed inside the cavity. The attenuators will control the cavity loss, making it equal thus allowing the system to produce two output wavelengths simultaneously. The system has been characterised and the performance is comparable to other typical fibre laser system.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

LASER GENTIAN TERDOP ERBIUM PANJANG GELOMBANG DUAAN BOLEH TALA MENGGUNAKAN RONGGA SEJAJAR

Oleh

FAIRUZ ABDULLAH

Julai 2004

Pengerusi : Profesor Madya Mohamad Khazani Abdullah, Ph.D.

Fakulti : Kejuruteraan

Sejak kebelakangan ini perkembangan sistem komunikasi optik semakin pesat. Samada dari segi aplikasi, lebar jalur yang ditawarkan, kepantasan pemindahan maklumat bahkan teknik-teknik yang digunakan dalam sistem ini. Penyelidik di serata dunia giat menjalankan penyelidikan dan menghasilkan idea-idea bernas untuk memenuhi keperluan dan perkembangan sistem ini.

Salah satu bidang yang menjadi tumpuan utama adalah perkembangan sumber kuasa kepada sistem komunikasi optik iaitu laser. Tidak kira samada laser itu laser semikonduktor atau laser gentian, pelbagai usaha telah dan sedang dijalankan bagi menghasilkan sistem laser yang lebih baik. Diantara kedua-dua jenis laser ini, laser gentian mendapat lebih perhatian.

Thesis ini mengemukakan satu konfigurasi baru untuk sistem laser gentian untuk digunakan sebagai sumber kuasa dalam sistem komunikasi optik khususnya. Laser gentian ini menggunakan konfigurasi gelombang berdiri ataupun rongga lelurus. Ia menghasilkan dua jarak gelombang yang boleh tala di dalam kawasan seluas 30nm.

Kebolehtalaan kedua-dua jarak gelombang ini adalah tidak bersandar antara satu sama lain. Penalaan ini juga dibuat sambil pada masa yang sama mengekalkan paras kuasa keluaran kedua-duanya supaya setara.

Kebolehtalaan yang tidak bersandar dan penyamaan paras kuasa keluaran ini dicapai dengan mengawal kehilangan dalam rongga. Proses ini dilakukan dengan meletakkan pelemah optik boleh tala ke dalam rongga. Pelemah ini akan mengawal kehilangan dalam rongga dan menjadikannya sama seterusnya membenarkan sistem menghasilkan dua keluaran jarak gelombang serentak. Sistem ini sudah diuji dan prestasinya adalah setanding dengan sistem lain yang ada.

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I certify that an Examination Committee met on 20th July 2004 to conduct the final examination of Fairuz Abdullah on his Master of Science thesis entitled "Tuneable Dual-Wavelength Erbium-Doped Fibre Laser using linear cavity" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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The thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for the quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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FAIRUZ ABDULLAH

Date:

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AOFS	-	Acousto-Optic Frequency Shifter
ASE	-	Amplified Spontaneous Emission
CFBG	-	Chirped Fibre Bragg Grating
DWDM	-	Dense Wavelength Division Multiplexing
EDF	-	Erbium-Doped Fibre
EDFL	-	Erbium-Doped Fibre Laser
ESA	-	Excited-State Absorption
FBG	-	Fibre Bragg Grating
FL	-	Fibre Loop
FLM	-	Fibre Loop Mirror
FP	-	Fabry-Perot
FPME	-	Fabry-Perot Micro-Etalon
GFF	-	Gain-Flattening Filter
GSA	-	Ground-State Excitation
MASER	-	Microwave Amplification Stimulated Emission Radiation
MFD	-	Mode Field Diameter
OL	-	Output Loop
OSA	-	Optical Spectrum Analyzer
PC	-	Polarization Controller
PDL	-	Polarization Dependence Loss
PMF	-	Polarization Maintenance Fibre
SMSR	-	Side Mode Suppression Ratio
TBF	-	Tuneable Bandpass Filter
VOA	-	Variable Optical Attenuator

WDM	-	Wavelength Division Multiplexer
WSC	-	Wavelength Selective Coupler