A short-pulse fiber laser using an erbium-doped fiber as the saturable absorber

Fang-Wen Sheu [a,b] (許芳文), Sheng-Lung Deng [a] (鄧聖龍), Jung-Jui Kang [b] (康榮瑞),
Shu-Yen Liu [a] (劉書巖), and Shu-Chun Yang [a] (楊舒淳)

[a]Department of Applied Physics, National Chiayi University, Chiayi, Taiwan
(國立嘉義大學應用物理學系)

[b]Institute of Optoelectronics and Solid State Electronics, National Chiayi University, Chiayi, Taiwan
(國立嘉義大學光電暨固態電子研究所)

Abstract:

實驗目標是要自行設置組裝一套環型的短脈衝光纖雷射系統。我們使用980 nm的二極體雷射作為激發光源，並採用光纖通訊系統常用的摻鉺光纖（erbium-doped fiber）當作光增益介質，此時其連續波輸出雷射光波長約在1.5μm。然後我們在環型雷射共振腔中置入第二段摻鉺光纖作為飽和吸收體，以調制雷射輸出為短脈衝光源，使其產生連續的光脈衝。但在第二段摻鉺光纖之前必須加上光隔離器（isolator）或者波長分波多工器（wavelength division multiplexer, WDM），以將激發雷射光源隔絕掉或者引出雷射共振腔之外。我們藉由觀察短脈衝光訊號的特性來判斷第二段摻鉺光纖在此雷射共振腔中的工作特性。實驗中我們更換了幾種不同長度作為飽和吸收體的摻鉺光纖，並調整各種不同強度的激發功率（pump power），以觀察所調制出來的雷射光脈衝之脈衝寬度與脈衝重複率之變化。根據實驗結果發現第二段摻鉺光纖的飽和吸收特性提供了類似Q開關（Q switching）的功能。

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Experimental Setup(I):

We use a 980nm laser diode to pump the 10m EDF_1(Erbium doped fiber).Inorder to isolate the laser light at 980nm, we set an isolator as a filter. The polarization controller is used to maintain the polarization in this cavity.

The key point of this experimental setup is using the EDF2 (2m,3m,and 5m)as a saturable absorber to modulate the laser out put to be pulses. We use a fast photodiode as the photodetector and observe the output signal by an oscilloscope.

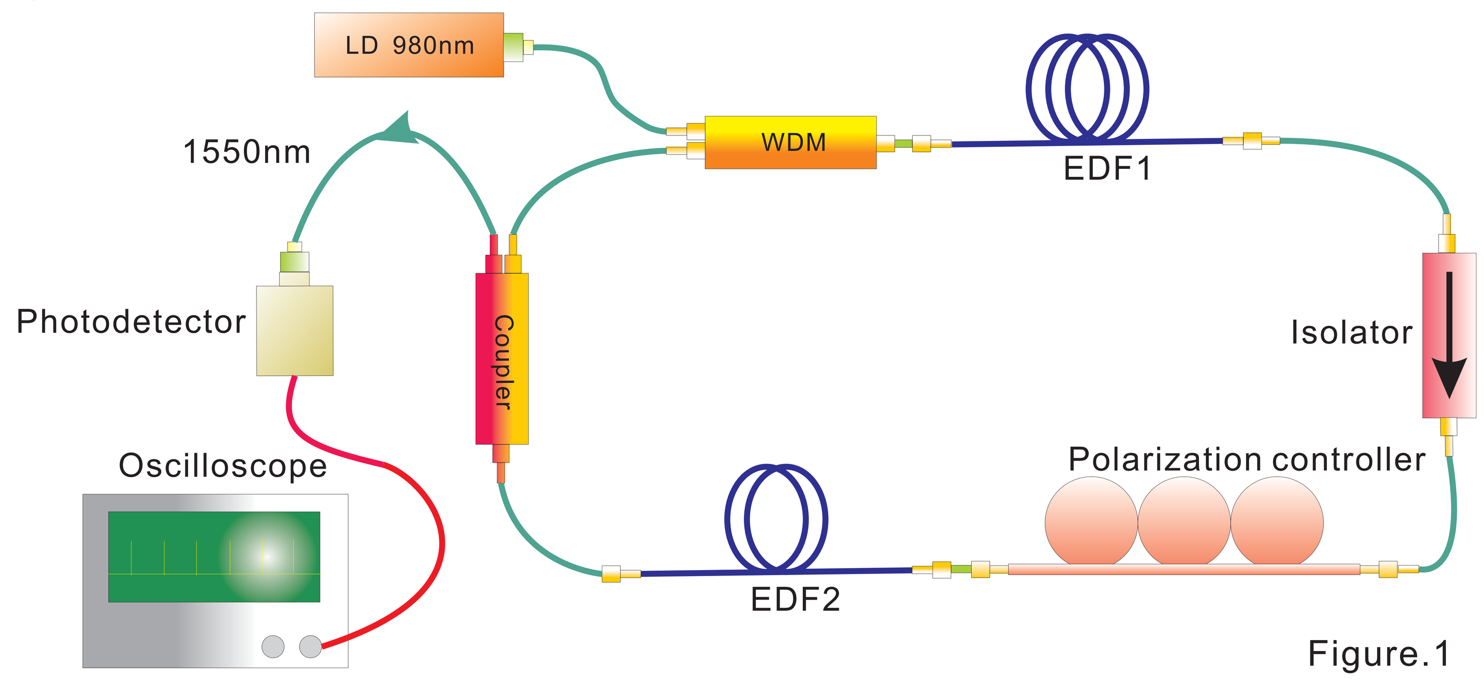


Figure.1

Experimental result:

In this experiment, we changed the pump power and the length of EDF2 to measure (A) the output pulse width and (B) the repetition rate in this fiber ring laser.

(A) the pump power is inversely proportional to the pulse width.

(B) the pump power is proportional to the repetition rate.

From(A),(B) we can control laser pulse width or repetition rate by tuning the pump power.

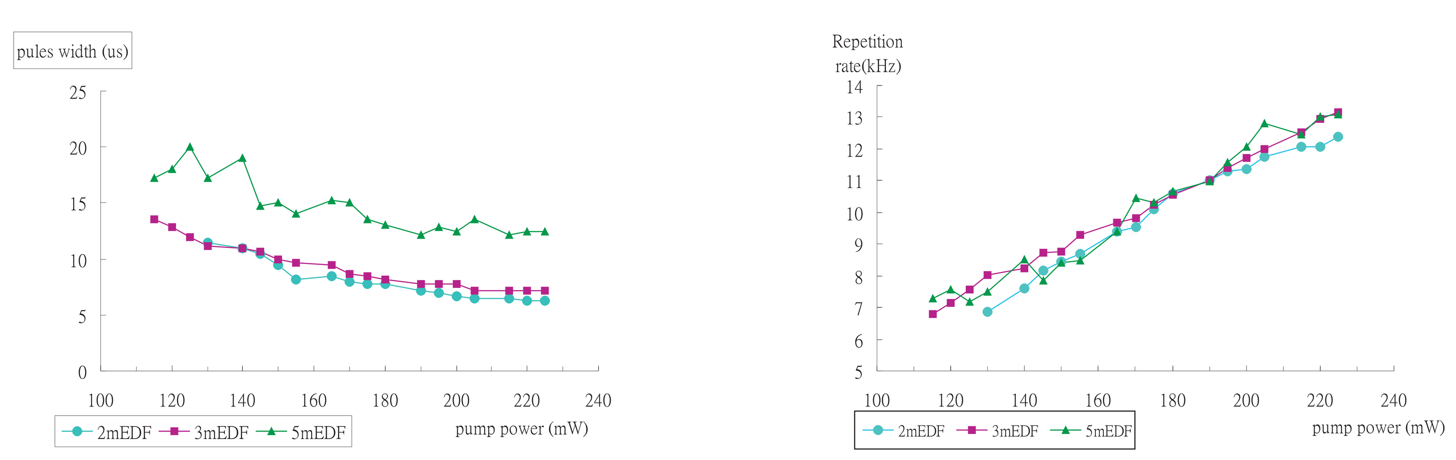
In figure.2 (C) to (E) we show the pulse shape and spectrum from different EDF2. The input pump power is 225mW.

From (C)to(E) we show that different length of EDF2 could cause different pulse width.

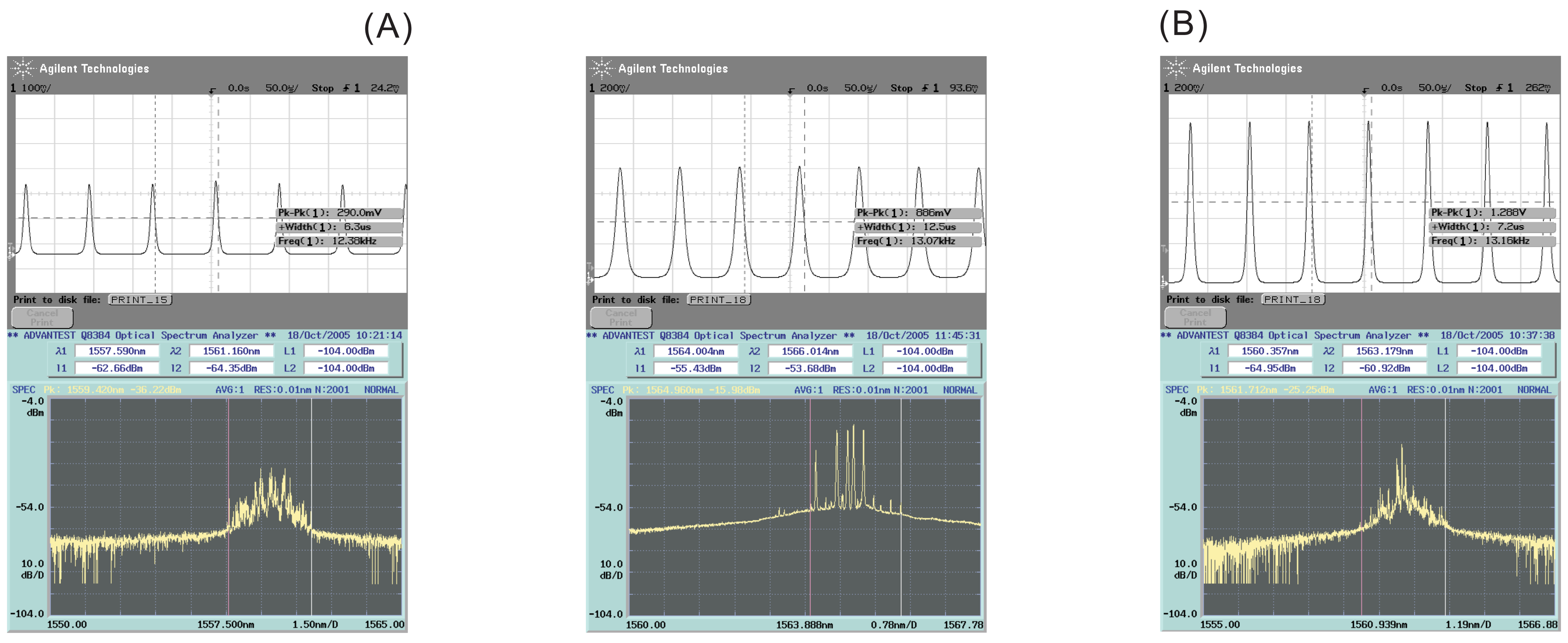
(C)(2m EDF2) The pulse width is 6.3μs, and the repetition rate is 12.38kHz.

(D)(3m EDF2)The pulse width is 7.2μs, and the repetition rate is 13.16kHz.

(E)(5m EDF2)The pulse width is 12.5μs, and the repetition rate is 13.07kHz.



(A) (B)



(C) (D) (E)

Figure. 2

Experimental Setup(II):

The difference from setup(I) is adding the second WDM before EDF_2 to ensure that the 980nm light could totally be isolated.

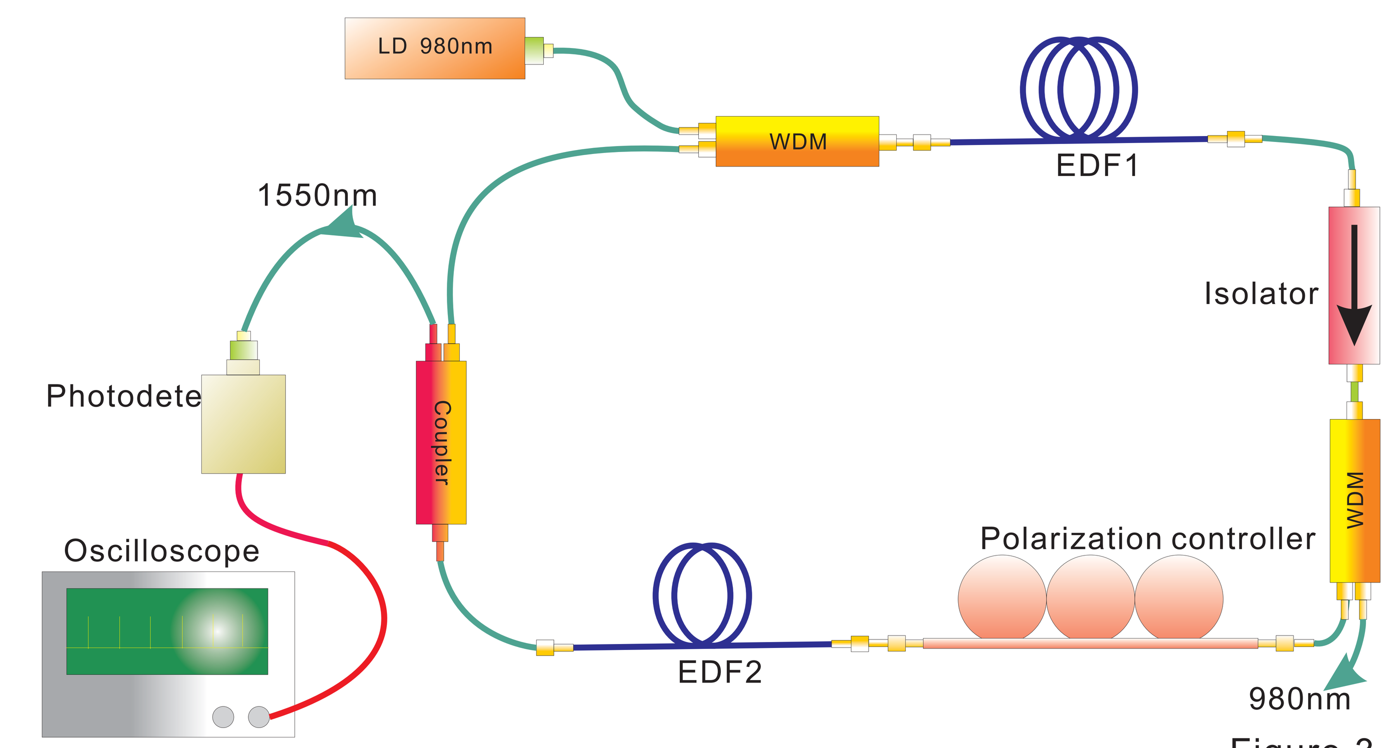


Figure.3

Experimental result:

The same as setup(I),figure.4 (a) and (b) show the relationship of the pulse width and repetition rate versus the pump power, respectively.

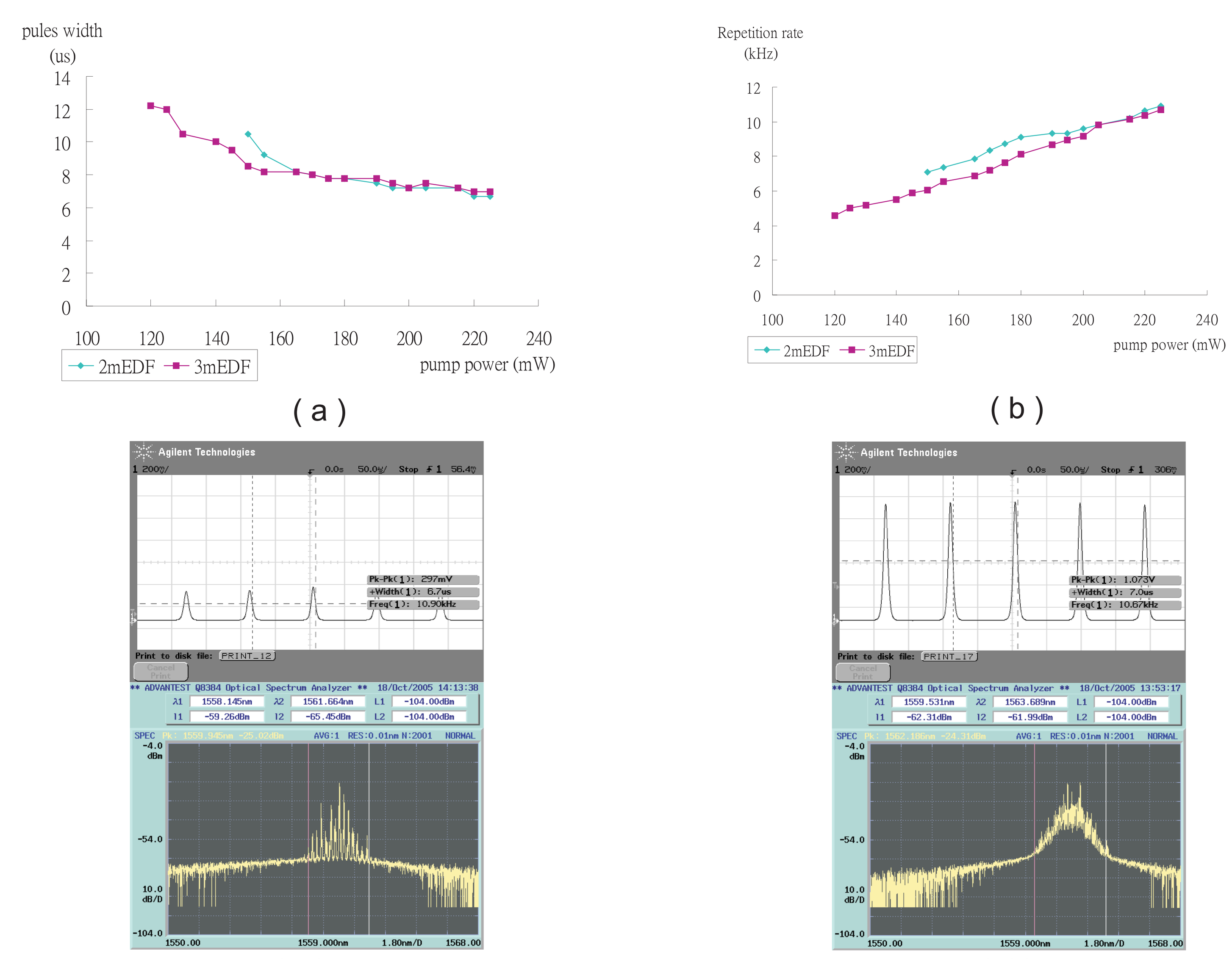
In experimental setup(II), we totally isolate 980nm pump source. But in this setup, we can't get the stable condition when using 5m EDF_2.

From figure.4(a),(b),we got the same trend as the experimental setup(I).

In figure.4 (c) and (d),we show the pulse shape and spectrum from different EDF_2. The input power is 225mW.

(c)(2m EDF_2) The pulse width is 6.7μs, and the repetition rate is 10.90 KHz.

(D)(3m EDF_2) The pulse width 7.0μs,and the repetition rate 10.67kHz.

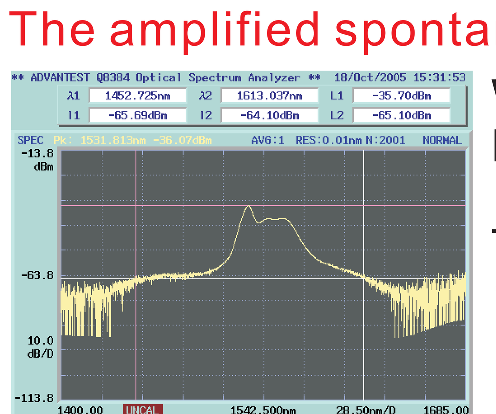


(a) (b)

(c) (d)

Figure. 4

The amplified spontaneous emission (ASE) spectrum:



We using 980nm pumping source to excite10m Erbium doped fiber(EDF_1).

The spectrum range is between 1452nm and 1600nm,and the maximum is at 1533nm.

Figure.5

References:

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