Chapter Three

The Experimental Part

3.1 Introduction

Optical waveguiding in PCFs is ensured by an arrangement of air holes in the cladding running along the entire fiber length. PCFs classified into two main groups one is an index guiding PCFs, which posses a high refractive index core surrounded by a lower effective refractive index cladding, and the other group is referred to as a photonic bandgap fibers (PBGFs) or bandgap guiding fibers. Contrary to index guiding PCFs and conventional fibers, the core of PBGFS has a lower refractive index than the effective refractive index of the surrounded cladding. PBGFs guide light based on the photonic bandgap (PBG) effect. For study of the spectral width all the previous works have been carried out using conventional fiber. In present work we use hollow core photonic crystal fiber (HC-PCF).

The aim of this chapter is to describe the experimental setup and the function of each component that was used in this work and the procedure which was followed to achieve the spectral width of the input and output laser pulse in (HC-PCF).

3.2 The experimental setup

The experimental setup for study the spectral width of laser pulse before and after propagation in HC-PCF is shown in figure (3.1) while figure (3.2) shows the photographic arrangement for the setup

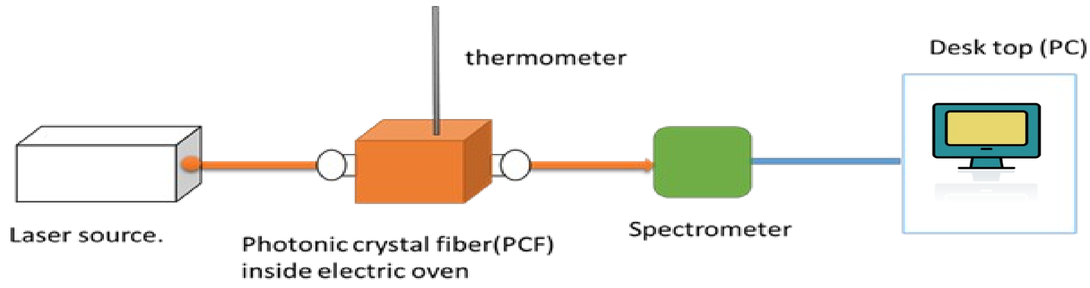

Figure (3.1): the experimental setup.

Figure (3.2): photograph of the experimental setup

3.3. Laser source

The laser source used to obtain the change in laser pulse width is Omega laser used in this work is a type of solid state laser with two probes. It was manufactured by Omega Company. An Omega Laser system involves one control unit, and one or more of a selection of probes plus laser safety goggles. Each probe is produced to emit laser light at a specific wavelength. The omega xp is managed by a microprocessor and displays the probe details on alphanumeric screen.

Figure (3.3): photograph of omega laser xp system.

The specifications of the probes used in this work are listed in table (2.1) and table (3.2).

Table (3.1): The red light probe specifications

Item	Data
Wavelength	675 nm
Frequencies used	1KHz, 5KHz, 10KHZ
Average power	30 mW
Coherence	Pulsed laser
Output operation	pulse
Classification	3B

Table (3.2): The infra red light probe specifications

Item	Data
Wavelength	820 nm
Frequencies used	1KHz, 5KHz, 10KHZ
Average power	200 mW
Coherence	Pulsed laser
Output operation	pulse
Classification	3B

3.4 Hollow Core Photonic Crystal Fiber (HC- PCF)

In the present work a hollow core PCF type is used. The HC –BGPCF was supplied from NKT Photonic made in Germany and has the following specifications table (3.3).

Table (3.3): The specifications of HC- PCF

Item	Data
Core diameter	$10 \pm 1\ \mu m$
Cladding pitch	$3.8 \pm 0.1\ \mu m$
Diameter of PCF region	$70 \pm 5\ \mu m$
Cladding diameter	$120 \pm 2\ \mu m$

Coating diameter	220 ±30μm
Coating material	Single layer acrylate
Center operating wavelength	1550 nm
Attenuation at operating wavelength	0.03 dB/m
Numerical aperture	0.2

The laser pulses enter inside the HC-PCF from one side to exit from the other end, the cross section of this fiber is illustrated in figure (3.4).

Figure (3.4): The cross section of HC- PCF

3.5 The electric oven

The electric oven was used to rise the HC- PCF temperature when the laser pulse is propagated inside it, to study the temperature effect on the pulse shape. The oven used in this work made in Germany by LEBOLD DIDACTIC

GMBH and has the listed specifications in table (3.4) and its photograph appeared in figure (3.5).

Table (3.4): The electric oven specifications

Item	Data
Device name	Vulkan
Co. No.	237526
Power	200 W
Operation voltage	220V
Maximum temperature	200^0C

Figure (3.5): The electric oven photograph

We used a thermometer its range from -10^{0}C to 110^{0}C with least count 1.0 to read the oven temperature.

3.6 The spectrometer

We use CCS 200 spectrometer to measure the laser pulse width from Thorlabs which have the specifications in table (3.5). Figure (3.6) shows the photograph of the CCS 200 spectrometer.

Figure (3.6): photograph of the CCS 200 spectrometer

There are four ports in the spectrometer as shown in figure (3.6).

(1) USB port.

(2) Fiber input.

(3) Statue LED.

(4) Trigger input.

Table (3.5): The CCS200 spectrometer specifications

Item	Data
Wavelength Range	200 – 1000 nm
Spectral Resolution	2.0 nm FWHM at 633 nm
Slit (WxH)	20 µm x 2nm
Grating	600 Lines/mm, 800nm Blaze
Detector Range	200 - 1100nm
CCD Pixel Size	8 µm x 200 µm (8 µm pitch)
CCD Sensitivity	160 V / (lx · s)
CCD Dynamic Range	300
CCD Pixel number	3648
Resolution	4 px/nm
Trigger Frequency Max	100 Hz
Trigger Pulls Length Min	0.5 µs
Interface	Hi-Speed USB2.0 (480 Mbit/s)
Dimensions	(LxWxH)(122 x 80 x 30) mm
Weight	< 0.4 kg

3.7 The Photodetector

We use semiconductor detector with amplifier called photoamplifier to measure the pulse duration of the laser pulse and connected to digital oscilloscope. Figure (3.7) show this device which manufactured from PHWE Company with the listed specification in table (3.6).

Table (3.6): The photoamplifier detector specifications

Item	Data
Device name	photoamplifier
Company	PHYWE
Serial No	471200436547
Voltage	9-12V

Figure (3.7): photograph of the photoamplifier detector

3.8 The experimental procedure

1. The experimental setup components were arranged as shown in figure (3.1)

2. The initial spectral width of the laser pulse was measured by using the spectrometer for each wavelength at the three repetition rates.

3. The laser beam was injected inside the (HC-PCF), and then we measured the pulse spectral width of the laser pulse at room temperature.

4. The temperature of the (HC-PCF) was increased by using the electrical oven gradually every 5^0C and the spectral width of the laser pulse was measured, starting from 40^0 C until 80^0 C.

5. To calculate the pulse duration of the pulse we used photodetector connected with digital oscilloscope before and after laser pulse passed through the fiber, starting from 40^0C to 80^0C

6. The pulse duration was calculated by using origin 6.1 soft ware