

Dedication

This thesis is dedicated to:

My parents, who gave me the confidence and freedom to pursue any goal.

My wife Agab my best friend through everything.

My daughters' Saba and Sogoud.

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Abstract

Photonic crystal fiber (PCF) has attracted a significant attention in the last few years. Guiding of the light in a PCF is governed by one of two principal mechanisms are, modified total internal reflection (MTIR) phenomenon and photonic bandgap (PBG) effect. The present work focused on the study of the spectral width change of microsecond (μs) laser pulse propagated inside hollow core photonic crystal fiber (HC-PCF). The pulse spectral width is broadened according to Kerr effect in nonlinear systems.

Two wavelengths 675 and 820 nm with 30 and 200 mW average power respectively for diode lasers with three pulse durations (105, 35 and 25 μs) and three repetition rates 1, 5 and 10 KHz, have been injected to the HC-PCF. The spectral width of each laser pulse was measured at different sets of temperatures using a spectrometer. The results showed that the spectral width is changed with the temperature nonlinearly due to self phase modulation and group velocity dispersion. From the results it was concluded that the pulse spectral width is affected with the temperature, for this reason the HC- PCF may used as temperature sensor. By using the HC- PCF, the bandgap of this type of fiber and the temperature effect on its bandgap may studied in future work, also by filling the HC- PCF with blood and urine one can build biosensor.

المستخلص

في السنوات الاخيرة تم تطوير نوع جديد من الألياف البصرية, سميت بالألياف البصرية البلورية, ينتشر الضوء خلال هذا الليف البصري بأحدى طريقتين, طريقة الانعكاس الكلي الداخلي المعدلة, وطريقة فجوات الحزمة.

في هذا البحث سمح لنبضات ليزرية قصيرة في مدى الميكرو ثانية بالانتشار داخل الليف الضوئي البلوري مجوف القلب ومن ثم دراسة التغير في العرض الطيفي للنبضة الليزرية قبل وبعد انتشارها داخل الليف في درجات حرارة مختلفة.

و mW بمعدل قدرة 30 nm و 820 nm أُستخدم ليزر بطولين موجيين 675 علي التوالي بزمن نبضة 105, 35,25 بيكو ثانية ومعدل تكرارية 200 mW 1,5,10 كيلوهرتز على التوالي, تم قياس العرض الطيفي للنبضة قبل وبعد انتشارها داخل الليف الضوئي البلوري مجوف القلب عند درجات حرارة مختلفة تدرجيا كل خمس درجات مئوية بدءاً من 40 درجة مئوية وحتى 80 درجة مئوية.

أوضحت النتائج أن عرض النبضة الليزرية يحدث له تغيير عند مقارنته بعرضه الطيفي قبل انتشار النبضة الليزرية داخل الليف الضوئي البلوري, وهذا التغيير في الاتساع الطيفي لاخطي مع ارتفاع درجات الحرارة. يعزى هذا التغيير في الانظمة اللاخطية. من (Kerr Effect) العرض الطيفي للنبضة لظاهرة كير النتائج نجد أن العرض الطيفي للنبضة قد تأثر بدرجة الحرارة ولهذا السبب يمكن استخدام هذا النوع من الليف البصري كمتحسس لدرجة الحرارة.

يمكن دراسة فجوة الحزمة لهذا النوع من الليف البصري وتأثير درجة الحرارة عليه, وايضا يمكن تصميم متحسسات حيوية بملء هذا الليف البصري مجوف القلب بالبول او الدم.

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