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Design and Implementation Respiratory Monitoring System Using Fiber Sensor

A Thesis

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By

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Abstract

The breathing process is very important for human health, so calculating the respiratory rate requires sensors with features such as fast response, high sensitivity, accuracy, etc. Fiber-optic sensing probes can perform these operations because of their unique advantages (high sensitivity, quick response time, compact size, electromagnetic interference isolation, and ease of manufacture), making those superior to traditional sensing probes.

This research was performed to develop and improve the characteristics of respiratory rate sensors, to sensitive the different breathing cases in high accuracy and short time.

In this work implemented four types of respiratory rate monitoring system, two of them based on Michelson interferometer (MI) by used (LMA-10 PCF and coreless) fibers, and the other two sensors based on Mach - Zenhder interferometer (MZI) by used (LMA-10 and coreless) fibers. The general structures of two first sensors was applied by fusion spliced PCF and coreless fiber in one side with multimode optical fiber then tapered in the collapsed region of PCF by changing the variables of fusion splicer machine, and etching the coreless fiber by dipped it in hydrofluoric acid with 40% concentration during 30 minutes to obtained a fiber with 66 μm. The second two sensors was applied by fusion spliced PCF and coreless fiber in two sides with single mode fiber and tapered in the collapsed region of PCF by changing the variables of fusion splicer machine, and etching the coreless fiber by dipped it in hydrofluoric acid with 40% concentration during 30 minutes to obtained a fiber with 66 μm .

(Sleeping, sitting, walking, running and working sport) different breathing cases applied on the sensors to sense the amount of humidity that these sensors can absorbed. Firstly prepared MP probe sensor and inserted into tube of oxygen mask then put it on the nose and mouth to sense the inhalation and exhalation processes. The sensitivity of this sensor was 231.8 pm/% RH, and also calculated resolution and response time there were (0.215 RH and 1.7 sec) respectively.

To enhance the sensitivity of the sensors and to produce SPR coated sensors (MC, SPS, SCS) with nanogold particles and tested them on different breathing cases. The sensitivity of theses sensors were in MC probe sensor was 473.2 pm/% RH and the resolution and response time were (0.105 RH and 2.3 sec) respectively, for SPS probe sensor the sensitivity was 347.8 pm/% RH and the resolution and response time were (0.143 RH and 2.1 sec) respectively, for SCS probe sensor the sensitivity was 294.8 pm/% RH and the resolution and response time were (0.170 RH and 2.5 sec) respectively.

To more enhance the sensitivity of these sensor coated them with graphene to obtain the sensors with more absorbed humidity, then tested on different breathing cases. The sensitivity of these sensor were in MC probe sensor the sensitivity was 513.8 pm/% RH and the resolution and response time were (0.097 RH and 1.5 sec) respectively, for SPS probe sensor the sensitivity was 457.8 pm/% RH and the resolution and response time were (0.109 RH and 1.4 sec) respectively, for SCS probe sensor the sensitivity was 432.6 pm/% RH and the resolution and response time were (0.115 RH and 1.2 sec) respectively.