

ABSTRACT

Photonic crystal fibers (PCF) have unique properties so that they are widely used for various applications.

In this work, two types of PCFs solid core LMA-10 and ESM-12 based on Mach-Zehnder modal interferometer for sensing PH values were prepared. The general structure of the sensor was applied by fusion splice PCF with a different length between two (SMF-25). At the fusion splice region, the air holes were fully collapsed, that the core and cladding mode can be coupled and recombined.

The sensor immersed in a solutions at different PH levels of ranges (2,4,6,7,8,12,13) which leads to different refractive indices in the range of (1.3428-1.3439), in the PCF (LMA-10) of 0.4 cm length the sensitivity was 85nm/RIU whereas, in 1.4 cm length the sensitivity was 914 nm/RIU and ,in 2.7 cm length, the sensitivity was 180 nm/RIU, in 2.8 cm length, the sensitivity was 59 nm/RIU, finally in the PCF (ESM-12) with length, of 2.5 cm length the sensitivity was 161 nm/RIU .

To enhance the sensitivity of the sensor, the PH sensor was designed by tapering the photonic crystal fiber (PCF) in-line interferometer. The PCF was fusion spliced between two (SMF-25) single-mode fibers and tapered in the middle of the PCF by hydrofluoric acid etching. In PCF (LMA-10) with length of 2.8cm, the sensitivity was 258 nm/RIU, in the PCF (ESM-12), with length of 2.5cm the sensitivity was 254nm/RIU.

In other model, the PH sensor operates in the reflection mode, which was designed by using two types of the PCF (LMA-10 and ESM-12) with different lengths, by fusion splice PCF with SMF from one side, and the other side of the PCF was cleaved and polished to be reflection surface like a mirror, for the

PCF (LMA-10) with length of 1.6, the sensitivity was 139 nm/RIU, and PCF (ESM-12) with length of 1.6, the sensitivity was 100nm/RIU

The previous uncoated reflection PCF interferometer was coated by the SPR technique with gold –nanoparticles and silver –nanoparticles ,the sensitivity of PCF(LMA-10) coated with Au – nanoparticles was 156 nm/RIU ,and for the Ag-nanoparticles coated the sensitivity was 395nm/RIU, for the PCF (ESM-12) with Au- nanoparticles the sensitivity was 370nm/RIU.

In another model , a photonic crystal fiber interferometer (PCFI) which operates in reflection mode, the sensor was based on coated by coating polyvinyl alcohol/polyacrylic acid (PVA/PAA) hydrogel onto a PCF surface ,the sensor was constructed by fusion splice a piece of PCF(LMA-10) with length of 1.4 cm with (SMF) ,whereas the other side of PCF was spliced with a very short piece of PCF the collapse region avoided the liquid to enter the sensor head , the sensitivity was 619 nm/RIU.

COMSOL Multiphysics Program was used to design different types of the PCFs (LMA-10 and ESM-12) to be used as a PH sensor and then to find the effective refractive index of the photonic crystal fibers when the air holes were empty and then to fill them with solutions of different PH values at 1550 nm, by using the same design of the PCFs which being immersed in solutions to find the effective refractive index .

The result of this work has been compared with each experiment done and with other works published recently and it found out that results are in a good agreement.