

# Photonic Crystal Fiber Mach-Zehnder Interferometer pH Sensing

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**Abstract.** In this paper, a photonic crystal fiber (PCF) pH sensor is demonstrated based on Transmission Mach-Zehnder interferometer (TMZI). Two sensors were fabricated. The general structure of sensor applied by fusion splices 2 cm and 4 cm of PCF between two multimode fibers (MMFs). The air holes in the adhesive regions completely collapsed to form a multi-media PCF interference. Because of the coupling between the core and the cladding modes the PCF-MZI were formed in the collapsed area. within the ranges of pH 4, 6, and 12, sensors were submerged in the solutions. The sensitivity of 2 cm sensor is equal 102 nm/pH IU and 125 nm/pH IU for 4 cm.

## INTRODUCTION

The potential of hydrogen (pH) level is a critical in different fields, namely, the environment, biomedical, and chemical sciences. Different approaches are proposed to monitoring the pH level, such as, filled glass electrode and semiconductor sensor [1-4]. Recently, both of the extrinsic and intrinsic fiber pH sensors have attracted noteworthy attention due to their promising features, such as compact size, immunity to electromagnetic interference and far distance sensing ability, and etc. [5, 6].

The photonic crystals fiber (PCF) is consider as a novel type of photonic and optical fiber has a unique structural features qualified it to use in different applications [7], such as optical communication, fiber laser, nonlinear devices, power transmission, and highly sensitive sensors [8, 9]. In recent years, the intrinsic optic sensors based on PCF are becoming prevalent through different domains such as medical, aerospace, automotive, civil, manufacturing and energy [10, 11]. There two main techniques are adopted to design the intrinsic PCF sensors, namely, the reflection and transmission technique. Regarding to the transmission technique, the PCF sensors based on MZI have been proposed in many published works due to their unique features including high resolution, simple architecture, and low cost.

In this article, the simple chemical PCF sensor based on MZI is experimental demonstrated utilizing transmission technique. The MZI is formed by splicing a short section of 2 cm and 4 cm of PCF between two MMFs. As a result of coupling between the core and the cladding modes within two breakdown regions of 250  $\mu\text{m}$  length the PCF-MZI was formed.

## SENSOR FABRICATION AND PRINCIPLE OF OPERATION

The suggested transmission PCF-MZI pH sensor contains of a small portion of PCF (LMA-10) and it will be fusion spliced between the two MMFs longitudinally, as presented in Fig. 1, it has a two collapsed regions (CR), located respectively at the two end points of the PCF.