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Research Article

Intensity Loss of ZnO Coated on Fiber Optic

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Macrobends are optical fiber structures suitable for detecting motion changes. This structure has been developed using single-mode fibers and a combination of single-mode and multimode fibers called hetero-core. In this study, a new macrobending structure was designed and developed by adding a nano-ZnO element to the fiber optic core based on Revolution 4.0. The addition of nanomaterial elements involves an etching process that uses harmful chemicals or high-cost laser technology. Therefore, hetero-core was applied in this study to replace the etching process. The ZnO-coated fiber optics with 10 (ZnO1), 20 (ZnO2), and 30 (ZnO3) times of dip coating were developed using the dip-coating method and characterized using scanning electron microscopy (SEM) and energy dispersive X-ray (EDX) spectroscopy. Sensitivity measurement was conducted with glued optical fiber in the form of bending using a tape with a bending dimension of 2.5 cm × 1.5 cm and a wavelength of 1,550 nm. Morphological characterization using SEM proves that nanoparticles are attached to the optical fiber, and the EDX characterization confirms that the nanoparticles are ZnO elements. Optical fiber sensor sensitivity using core sizes 9, 50–9–50, 50–9–50 (ZnO1), 50–9–50 (ZnO2), and 50–9–50 (ZnO3) achieved sensitivity values of 0.91, 1.61, 2.98, 3.34, and 3.51, respectively. This study successfully produced ZnO-coated optical fiber sensors with a hetero-core structure without performing the etching process and successfully increased the sensitivity of the sensors.

1. Introduction

The studies on respiratory detection using smart watches known as Fitbit have evolved since 2013 [1]. In 2006, researchers in Japan started producing respiratory detection systems using optical fibers affixed to elastic textiles [2]. This study has attracted significant attention because of its importance for human health. Several studies have been conducted on smart textiles. Researchers have studied smart textiles using Bragg grating structures, microbending, and macrobending. The production of smart textiles using Bragg grating-structured optical fibers [3–7] has been developed; however, the operation process is complex and involves high-cost usage [8]. Simpler and more effective smart textiles are designed based on macro- and microbending structures. Krebber et al. [9] conducted studies using a single-mode and bending numbers of more than seven. Alemdar et al. [10] and Koyama et al. [11] developed macrobending and hetero-core-structured sensors to improve the performance of sensor sensitivity [10–12]. The operation of hetero-core optical fiber sensors (62.5–50–62.5 μm) typically involves evanescent field mechanisms to improve sensor sensitivity. This study proves that the sensitivity increases by using only a bending number of seven with the influence of the bending radius [13]. Dhia et al. [13] and Purnamaningsih et al. [14] developed sensors using a single fiber optic mode with a wavelength of 1,550 nm. They successfully produced a bending number of seven without a hetero-core structure. Based on a recent study, macrostructured optical fiber sensors have been successfully used by researchers to detect respiratory system movements. However, the large number of bends makes it difficult for users to wear freely, and most likely, the optical fiber is easily broken when multiple bending is adopted.

The sensitivity generated from an optical fiber sensor can be improved by changing the design of the optical fiber structure.