

Gold Nanowires Based on Photonic Crystal Fiber by Laser Ablation in Liquid to Improve Colon Biosensor

Abstract

In this work, gold nanoparticles (NPs) have been synthesized using second harmonic generation ND-YAG laser ablation in ethanol employing 532 nm and 1064 nm wavelengths. Field emission scanning electron microscope (FESEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), atomic force microscopy (AFM), photoluminescence (PL) spectroscopy, and UV–Vis absorption were employed to examine the structural, chemical, and optical properties of Au NPs. XRD results showed that all synthesized Au nanoparticles are crystalline in nature. The optical band gap upon ablation using the higher wavelength (1064 nm) was about 4.02 eV. The value of the optical band gap increases to reach a value of 4.22 eV at the shorter wavelength (532 nm). The FESEM results reveal the formation of smaller nanorod size at second harmonic generation (SHG) wavelength was found to be about 30 nm at wavelength 532 nm and 44 nm at 1064 nm. After that, finite element analysis is used to simulate the photonic crystal fiber (PCF) as biosensors, depending on the surface plasmon resonance (SPR) phenomenon using the COMSOL multiphasic program. The hollow core photonic crystal fiber (HC-PCF) HC-800 was thus overfilled with water. The confinement loss (CL) of the fundamental mode for the proposed PCF with and without the gold nanoparticles was calculated; we observe without gold NPs the CL at the water and colon tissue about $1.08E + 03$ and $5.46E + 02$ dB/m, while at use the deposited PCF with gold NPs, the results ensured the decrease more than in the confinement loss at the water and colon tissue about $1.01E + 03$ and $3.16E + 02$ dB/m with a clear shift toward higher wavelengths, also when calculating the sensitivity, to increase HC-PCF biosensor performance by using wavelength interrogation and amplitude measurements; it found the bio-liquid (colon tissue) has the best electric field using the gold nanowire (NW) layer in the biosensor equal to 68.8 V/m by comparison when without using the gold NW layer which leads to high sensitivity.

Keywords

Biosensors; Gold nanowire; Laser ablation; PCF; Photonic crystal fiber