Enhanced sensitivity of cancer cell using one dimensional nano composite material coated photonic crystal

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Abstract

We theoretically analyze the detection of a cancer cell in the one-dimensional photonic crystal by infiltrating different sample cells in the cavity layer. The defect modes appear in their transmission spectra only if the nanocomposite layers are included on either side

of the cavity layer. This analysis is carried out by a dielectric constant and the transmittance peak of the cancer cell is compared with the normal cell. The transmittance peak shifts are analyzed with various filling factors for optimization purposes. Through the shifting spectrum, the sensitivity of cancer cell from the normal cell is obtained from a minimum of 42 nm/RIU to a maximum of 43 nm/RIU.

1 Introduction

The detection of the particular diseases to the upkeep of patients is the challenging task in the medical field. Especially, the term cancer is like a rare and hidden factor for the human beings. Cancer is caused by a wide range of factors such as exposure to carcinogenic chemicals, radiation or microbiological objects including bacterial or viral infections. In recent glorious of technology, the emerging solutions presence in the field such as micro level, nano-level investigation of cells and tissues purposing the rapid growth of fast diagnosis and expectation of fast rate curing diseases in the nano-medical department (Preedy and Patel 2012). In that sense, the technology photonic should not be forgotten due to its nature strengthen level for Nanosensing. It's obvious to bring up the process using novel optical medium structures known as Photonic crystals (Udaiyakumar et al. 2018; Safaei et al. 2017; Afroozeh et al. 2016; Soltanian et al. 2015a, b). It has explicit character than the other optical medium.

PCs are dielectric materials which will give the immediate response in its output transmittance spectrum over the range predefine frequencies during the possible change in analyte material. The analyte refractive index (RI) brings the essential attention in many fields considering medical physics, biosensing, and biochemistry (Ahmad et al. 2017a, b; Amiri et al. 2018; Akbari et al. 2018; Soltanian et al. 2016). The chemical or ingredient modifications inside the cells may be detected by RI changes produced by the mutated genes (Liang et al. 2005). Recently, a considerable number of groups have employed PC sensors based on RI changes in various architectures (Lee and Fauchet 2007; Skivesen et al. 2007). PC based analyte sensors define the property of the wavelength shift with a change in RI's value associated with defecting layer also called as hollow cavity medium (Tomljenovic-Hanic et al. 2009). The principle of operation of PC based cavity sensors is the same as that of metal-clad waveguide sensors (Kullab et al. 2012; Kullab and Taya 2013, 2014; Taya and Kullab 2014; Taya and El-amssi 2015; Taya et al. 2017; El-Amassi and Taya 2017). The resonant wavelength of the PC cavity is highly sensitive to effective RI of the cavity defect. When the RI of the PC cavity varies slightly, a measurable resonant wavelength shift can be detected (Zhao et al. 2015). The PC based system is nominated as a potential object to procure the nano level changes while occurring in its structures for realizing narrow filters (Liu et al. 2004), optical transient switches (Rao et al. 2010), cavity-based electro quantum dynamics (Song et al. 2011) and sensible configurations (Yang et al. 2011).

Recently, the nanocomposite-based biosensor has revoked the lack of knowledge in nanomaterial, so it receives the greatest attention among researchers. The form of hybridization process in materials makes some sort of correlation between the materials

The cancer cells are infiltrated and detected by one dimensional coated nanocomposite material based photonic crystal from the output spectrum using the effect of PBG. The peak shifts towards a rightmost wavelength region with the higher degree variation of filling factor are probed. Then, filling factor is fixed with another dimension of the structure for sensing of cancer cells. Finally, it has been concluded that the variation of sensitivity purely depends upon the coated nanocomposite on the side of defect layer and its tuning gave the better sensitivity. By the effect of the presence of nanocomposite material (SiO_2/Ag), the sensitivity numerically calculated as the minimum of 42 nm/RIU and to the maximum of 43 nm/RIU. It is also possible for further tuning with scaling of material hybridization as well as the thickness of coating layers.

Notes

Publisher's Note

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