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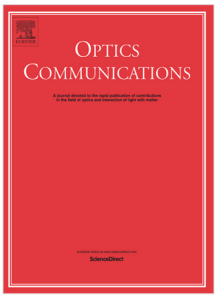

High sensitivity label-free refractometer based biosensor applicable to glycated hemoglobin detection in human blood using all-circular photonic crystal ring resonators

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PII: S0030-4018(18)30702-8
DOI: https://doi.org/10.1016/j.optcom.2018.08.019
Reference: OPTICS 23376

To appear in: *Optics Communications*

Received date : 8 June 2018
Revised date : 28 July 2018
Accepted date : 8 August 2018

Please cite this article as: A. Tavousi, M.R. Rakhshani, M.A. Mansouri-Birjandi, High sensitivity label-free refractometer based biosensor applicable to glycated hemoglobin detection in human blood using all-circular photonic crystal ring resonators, *Optics Communications* (2018), https://doi.org/10.1016/j.optcom.2018.08.019

High sensitivity label-free refractometer based biosensor applicable to glycated hemoglobin detection in human blood using all-circular photonic crystal ring resonators

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Abstract:

Lab-on-a-chip integrated optical biosensors have shown useful in non-invasive detection of biomaterials. Furthermore they are immune to electromagnetic interference rather than their electronic counterparts. In this paper, an all-optical photonic crystal (PhC)-based biosensor is presented. The biosensor is made up of two PhC-based W_1 waveguides which are critically coupled to a PhC-based ring-resonator (RR). The hub of the ring is designed in an all-circular quasi-crystal fashion to enhance output efficiency as well as easy injection of analyte. This PhCRR can distinguish 85±15% of amplitude change via resonant wavelength shift of 0.75±0.15 nm, or equally a 0.005 change in the refractive index unit (RIU). By introducing any change in the optical characteristics of desired biomaterials (i.e. refractive index of glycated hemoglobin), the resonance frequency of resonator changes and due to its high quality factor and sensitivity, a large amplitude difference appears in the output. The proposed glycated hemoglobin biosensor works in the wavelength interval of 1.545-1.565 μm, and its quality factor, figure of merit (FOM) and sensitivity are calculated to be 2500±500, 1400±200 RIU^{-1} and 690±50 nm/RIU, respectively. The simulations are performed in two-dimensional and finite difference time domain (FDTD) algorithm is used to numerically solve time-dependent Maxwell-equations within propagation domain.

Keywords: photonic crystal; ring resonator; all-circular hub; biosensor; glycated hemoglobin

1. Introduction

Lab-on-a-chip integrated biosensors have become important for diagnosis and detection in numerous fields such as biochemical systems, biological or disease detection and food safety [1, 2]. There are two general