Materials Today: Proceedings 66 (2022) 3698–3701

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Plasmonics based refractive index sensor based on square ring resonator

Yazusha Sharma [a,b,*], Rukhsar Zafar [b]

[a] Department of Electronics and Communication Engineering, Jaipur Engineering College & Research Centre, Jaipur, India
[b] Swami Keshvanand Institute of Technology, Management and Gramothan, Jaipur, India

ARTICLE INFO

Article history:
Available online 18 August 2022

Keywords:
Plasmonics
Surface plasmon polaritron
Square ring resonator
Metal-insulator-metal waveguide

ABSTRACT

In proposed research, a square ring resonator designed with a straight metal–insulator-metal (MIM) waveguide is investigated for sensing purpose. The interaction between square resonator and waveguide is observed theoretically and calculated numerically using finite difference in time domain method (FDTD). The length of square ring resonator and waveguide width are selected in such a way to transfer maximum power. Different sensing parameters like sensitivity, figure of merit and resolution are calculated to characterize the qualitative analysis of sensor. The proposed refractive index based sensor can be used as different sensing applications like chemical sensing, bio-sensing application etc.

Selection and peer-review under responsibility of the scientific committee of the 3rd International Conference on "Advancement in Nanoelectronics and Communication Technologies".

1. Introduction

Optical sensing approach is very attracting because of its various advantages in the field of environmental monitoring, medical diagnosis and various control based applications [1–3]. Now days, Plasmonics based optical sensor is the latest choice of researchers. Plasmonics is an electromagnetic phenomenon that produces resonant excitation due to matching of frequency when the photon's frequency exactly matches with free electrons frequency and then plasmonic resonance has achieved [4,5]. At the interaction, the momentum of the photon also coincide with the momentum of electron then the surface Plasmon's polaritron (SPP) take place [2,6]. Due to overcoming the limit of diffraction and transfer of light at sub-wavelength range, Surface Plasmon polaritron (SPP) have found many applications for device working on nano-scale [5,7]. The MIM (metal–insulator-metal) waveguide geometry supports distinctive features of sub-wavelength transmission of the signal which enclose the signal far beyond the diffraction limit. Various waveguide plasmonics structures can be integrated on a single chip [8,9].

Many sensing applications are based on detection of change in refractive index of the substance under observation, further it is desirable that the sensor detects high sensitivity, and is capable of detecting very small and minute changes in the refractive index. Surface Plasmon resonance (SPR) based sensing methods are vastly adopted for numerous sensing applications as the phenomena used are capable of detecting minute changes in the refractive index of the material under observation, which is one of the essential conditions for its application as a sensor [10,15]. In 2017, Turduev and Geden et al. proposed a T-shaped photonic crystal waveguide coupled with T-shaped slot having the value of average sensitivity of 390 nm/RIU [10]. Wu, Tian et al.proposed a Plasmon transparent effect in a graphene waveguide embedded with a strip[11]. Yang and Xia et al. investigated a sensor based on indium tin oxide (ITO) and showed an increased value of sensitivity [12]. Zhou and Peng et al. represented a plasmonic sensor and their mode is defined in mid-infrared region showing the highest dip in their research [13].

So in this research we have design plasmonics based refractive index sensor by using the dual combination of metal–insulator–metal (MIM) waveguide and square shape ring resonator. The plasmonics metal –insulator–metal (MIM) waveguide coupled resonator is a suitable choice for Nano photonics based filtering (notch-filter).To manually design the plasmonic-based sensor first we categorized the type of sensor, then according to the application of the plasmonic material is adopted to obtain plasmonic resonance condition. Then we define the parameters of the proposed sensor. To optimize the sensor parameter, different calibrations have been done according to the literature review.

* Corresponding author.
E-mail address: yazushasharma@gmail.com (Y. Sharma).

https://doi.org/10.1016/j.matpr.2022.08.027
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the 3rd International Conference on "Advancement in Nanoelectronics and Communication Technologies".