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Research paper

Design and Simulation of Compact Band-Pass Filter Using Stub Loaded Plasmonic Mim Waveguide

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Abstract

In this article, plasmonic band-pass filters (BPF) have been studied and numerically analyzed. This filter has been designed based on the two-stubs. Pass-band can be realized by appropriately adjusting the lengths and width of the resonator. Based on the ideal characteristics of the proposed two stubs BPF is allowing the band at THz frequencies. Multiple transmission zeros are generated to improve the selectivity of the filter. All simulated results have been studied using CST Microwave studio suite. Usually, the transmission effectiveness is revealed by the exact resonance condition, whichwill confirmalong with the numerical simulation or theoretical analysis. This article delivers a promising application for plasmonic BPFsin addition to plasmonic integrated circuits (PICs).

Keywords: *MIMSIR,SPP,BPF,PLASMONICS,PIC*

1. Introduction

Surface plasmonpolaritons (SPPs) would be the basic elements for propagating the electromagnetic waves which have been generated and enclosed at the surface of the metal-dielectric interface [1], which are additionallyconsideredto overcome the diffraction limit in the light at nanoscale domain [2]. Recently, nanoplasmonic metal-insulator-metal (MIM) waveguide is one of various research topics [3], which can be confirmed to be a most effectivetechnique for guiding the light with nanoscalemode confinement and comparatively low loss [4], [5]. Being well recognized, severalsub-wavelength optical devices have been designed using nanoplasmonic MIM waveguide are generally studied and reported [6],[7], which can beobtained by simply coupling with different resonators. Various stub resonators are already studied and researched by theory and experiments, including V grooves [8], bends [9], disk-resonators [10]. Still, most of these stub resonators are the symmetricalshape. Keeping this fact in mind, we first propose a nanoplasmonic stub loaded MIMSIR. In this article, adual band-pass-band filter has been pro posed and a nanoplasmonic MIM-SIR with coupled stubs is investigated. The full-wave simulations are utilized to study the transmission functionality of the proposed device using CST Microwave studio suite. The transmission spectrum of BPFis realized with the lengths and width of the waveguide when the effectiveindex of the insulator is fixed. Additionally, the wavelengths and transmission spectrum of the dips and peak are discussed. The transmission and reflection coefficients of the nanoplasmonic MIM waveguide-based optical devices have been obtained atTHz frequencieswith a controllable transmission spectrum, which contains potential application in photonic integrated circuits (PICs) [11].

2. Analysis of the Dual band pass band filter with coupled stubs

Fig. 1shows the dual bandpass band filter with coupled stubs using plasmonic MIMSIR. The dual band resonator is formed by loading two similar open stubs at identical sides of plasmonic MIM-SIR with the dimensions W1=80 nm, W2=320 nm, lengths L1=1700 nm, L2=150 nm, L3=400 nm.

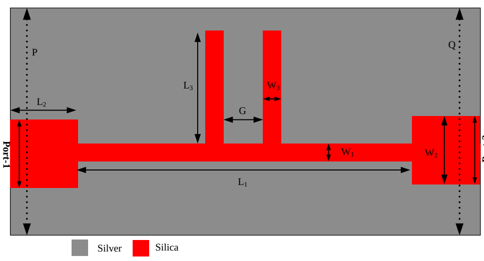

Fig.1 Geometry of the dual band Stub-Loaded MIMSIR based plasmonic Band Pass Filter for fixed widths W_1=80 nm, W_2=320 nm, lengths L_1=1700 nm, L_2=150 nm, L_3=400 nm .

The high impedance gap is generally represented by widthW1and the lower impedance gap is represented by width W2, W3respectively,althoughMIMSIR waveguidetotal electrical length is L1*θ1. P and Q are the power monitors, arranged for calculatingthe input and output power levels at same distances from the center point of the MTMSIR respectively.
From the simulationresults, the transverse magnetic (TM) mode with the nanoplasmonicwaveguide is usually excitedusing a dipole

source and 5nm x 5nm are the grid sizes along x and y directions. Here W1 > W3> W2, as a result Z1 < Z3> Z2 i.e. impedance is small , the width of the waveguide is largeandvice versa. Generally, for the admittance, resonance and spurious frequency of gap transmission line (λg/4) the suitable design equations for have been described in [12].

3.Results and Discussion

The filter response in addition to theresult of different modifications from width of MIM waveguide (W1) is shown in Fig.2 and Fig.3.

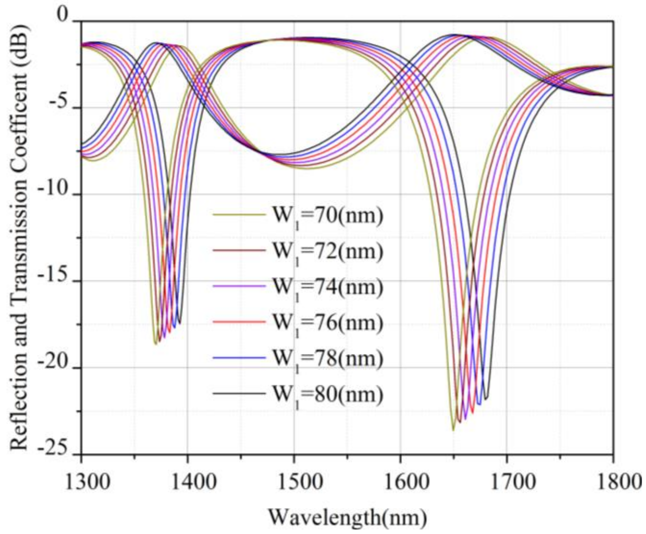

Fig.2 Variation of reflection and transmission coefficient with wavelength as a function of width(W_1) , W_2=320 nm, lengths L_1=1700 nm, L_2=150 nm, L_3=400 nm.

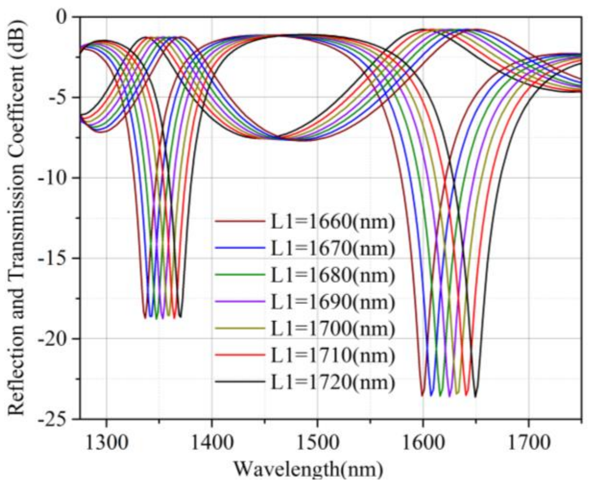

Fig.3 Variation of transmission and reflection coefficient with wavelength as a function of Length (L_1), W_1=80 nm, W_2=320 nm, lengths L_2=150 nm, L_3=400 nm.

A precise and unique passband is present around at 1358-nm and 1631-nm in the proposed geometry; Fig. 4 depicts the field distributions of the recommended geometry.

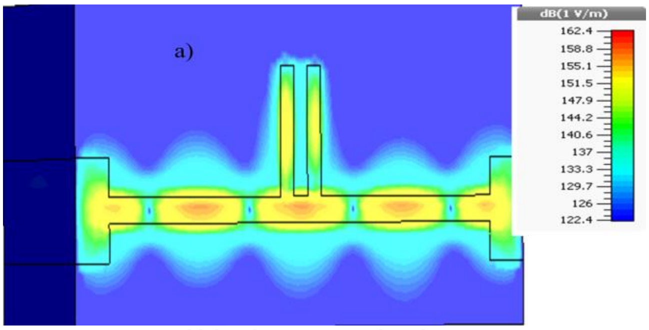

Fig.4 Field distribution at wavelength a)1631-nm

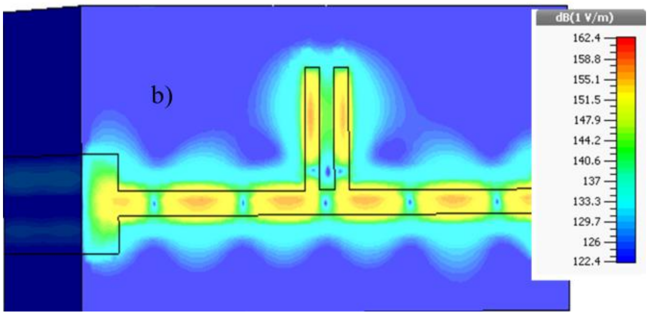

Fig.4 Field distribution at wavelength b)1358-nm

4.Conclusions

By utilizing a nanoplasmonic planar step impedance resonator in MIM gap waveguide, a newstub loaded plasmonic MIMSIR waveguide based dual band pass-band filter have been carried out and implemented. The simulation results of electromagnetic (EM) wave demonstratethe presence of two passbands at 1358nm and 1631nm. The proposed pass-band filter device offers low insertion loss and is compact; thus it might be helpful in high-density multi-band PICs.

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