6-Channel Plasmonic Demultiplexer using Metal/Insulator/Metal Based Circular Resonators with Silver Nano Rods Arrays

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***Abstract*—In this paper, we design and propose a compact 6-channel plasmonic demultiplexer (DMUX), utilizing of metal/insulator/metal (MIM) circular resonators (CRs) with metal nano-rod arrays (NRAs). The resonance wavelengths of the output ports depend on the number of metallic NRAs in the CRs. For the numerical examination of the designed scheme, the finite-difference time-domain (FDTD) technique is chosen. The results show that a maximum transmitted power is 33%, and the average channel spacing value is 82nm. The proposed 6-channel DMUX with compact dimensions, can be used in future optical communications.**

***Index Terms*— Plasmonics, Demultiplexer, Nanorods.**

I. Introduction

SURFACE plasmon polaritons (SPPs) are electromagnetic waves that confine at the metal-insulator interfaces [1]. The metal-insulator-metal (MIM) structures powerfully restrict the incident light in the insulator area [2, 3]. In the last decade, plasmonic-based demultiplxers (DMUXs) have attracted much researcher attention and proposed for many applications [4,5].

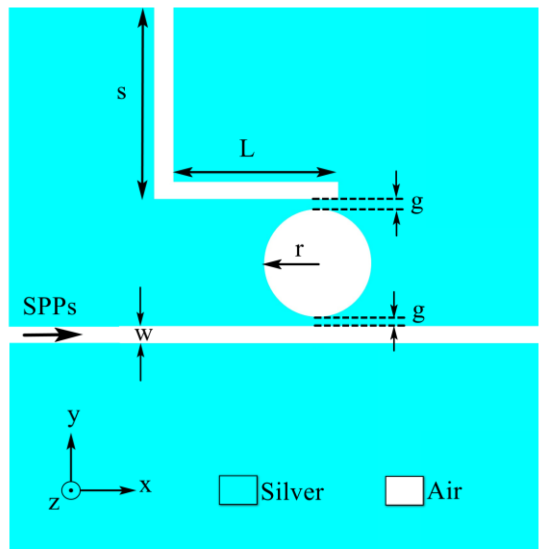
In this paper a compact 6-channel DMUX with circular resonators (CRs) with silver nanorods arrays (NRAs) is proposed ant its output characteristics is studied numerically.

II. Materials and Methods

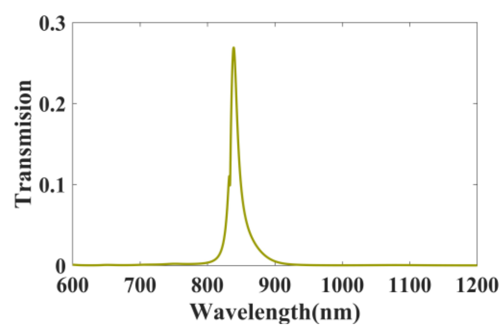
The schematic view of our proposed 1-channel plasmonic DMUX configuration, with one CR is shown in Fig. 1(a). All the model parameter quantities are given in Table 1.

The output spectrum of the 1-channel DMUX with finite difference time domain (FDTD) method FDTD is depicted in Fig. 1b. As shown, this structure produces a single mode at the resonance wavelength of 840nm with a maximum transmission of 28%.

The electric and magnetic field distributions of 1-channel DMUX for resonance wavelengths (λ=840nm) are depicted in Fig. 2. As seen in Fig. 2 the resonance wavelength has appeared in the CR and can pass through the output port.



(a)



(b)

Fig. 1. (a) Schematic perspective view of the proposed 1-channel DMUX. (b) Its output characteristic.

TABLE I
Summary of The Model Parameter Values

Parameter	Symbol	Quantity	Unit
Width of waveguide	*w*	50	*nm*
Length of horizontal Output channel	*L*	720	*nm*
Length of vertical Output channel	*s*	400	*nm*
Resonator radius	*r*	210	*nm*
Coupling distance	*g*	20	*nm*

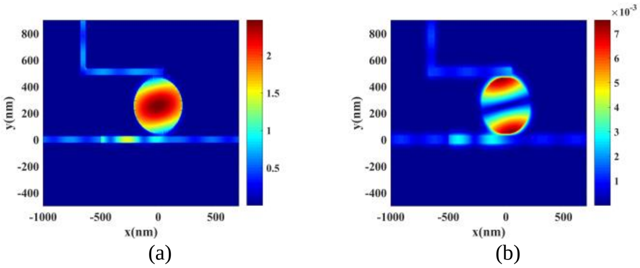


Fig. 2. (a) Electric and (b) Magnetic field intensity distributions of the 1-channel structure at resonance wavelength of λ=840nm.

III. 6-CHANNEL DMUX DESIGN

In this section, by adding the metallic NRAs to the proposed 1-channel DMUX, a 6-channel plasmonic DEMUX has been designed. Figure 3 shows the schematic of the proposed 1×6 plasmonic DMUX. The structural parameters of the proposed DMUX are as follows: L=720nm, s=400nm, g=20nm, radius of nanorods is 10nm, period of nanorods is 20nm. By introducing the NRAs in the CRs, the resonance wavelength can shift to the higher wavelengths. Therefore, to obtain different resonance wavelengths at the output ports, silver NRAs are embedded in each CR.

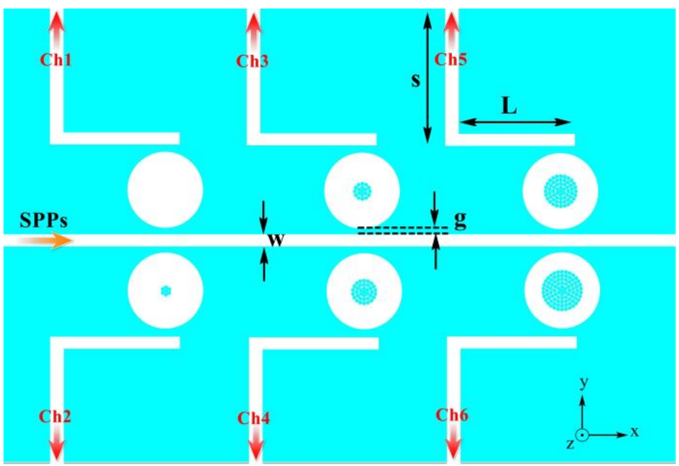


Fig. 3. The designed 6-channel DMUX with six CRs consisting of different rows of NRAs.

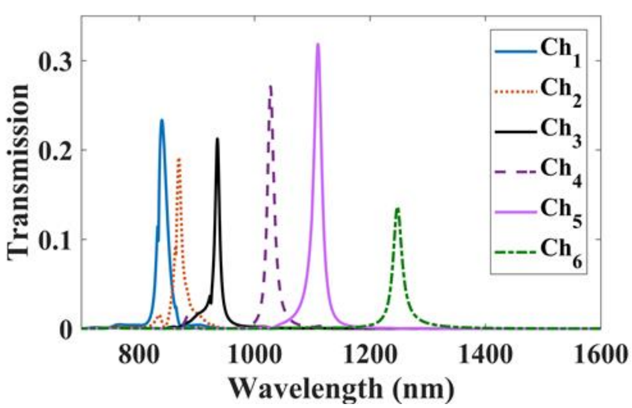


Fig. 4. Output spectrum of the proposed 6-channel DMUX.

Figure 5 shows the electric field distributions of the proposed DMUX at the resonance wavelengths of λ_1=840nm, λ_2=869nm, λ_3=936nm, λ_4=1028nm, λ_5=1110nm, and λ_6=1248nm.

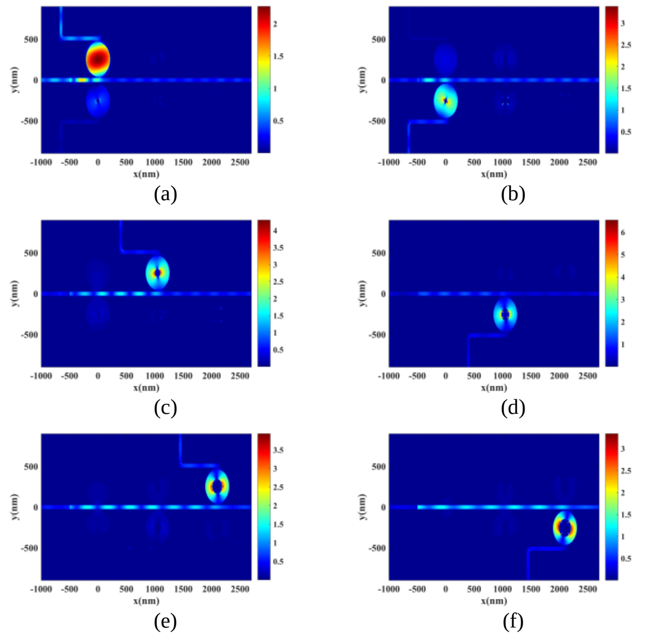


Fig. 5. Electric field intensity distributions of the proposed 6-channel DMUX for resonance wavelengths of (a) λ_1=840nm, (b) λ_2=869nm, (c) λ_3=936nm, (d) λ_4=1028nm, (e) λ_5=1110nm, and (f) λ_6=1248nm.

IV. CONCLUSION

In summary, we proposed the compact 6-channel plasmonic demultiplexer (DMUX), utilizing of MIM circular resonators (CRs) with NRAs. The FDTD simulation results indicate that by varying the number of NRA rows, different resonance wavelengths can be obtained at the output ports. The results show that a maximum transmission value is 33%, and the average channel spacing value is 82nm. The simple and compact designed DMUX structures are promised for optical integrated circuits.

V. ACKNOWLEDGMENTS

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