Computational Field Analysis of Bulk-Slotted Gold based Hybrid Plasmonic SOI Ring Resonator

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1. Introduction

The electromagnetic excitations propagating in a wave-like manner along the interface between two different media and evanescently confined in the direction perpendicular to the interface are known as surface plasmons [1], [2], [3]. In this manuscript, propagation of Electric and Magnetic fields are analysed for hybrid Plasmonic ring waveguide. A plasmonic ring waveguide based on Silicon-on-insulator technology is taken in to consideration consisting of a 220 nm vertical height fabrication technology. The ring structure comprises of a bulk Gold (Au) material at the central ring cavity with a slot adjacent to silicon material is analysed for its field and intensity propagation.

2. Structure

In plasmonic waveguide Gold (Au) metal plays a crucial role in the generation of surface plasmons. These surface plasmon waves are generated through the coherent oscillation of free electrons of Au at the metal-dielectric interface [4]. The schematic of bulk-slotted Gold based hybrid plasmonic waveguide ring resonator is shown in Fig. 1. The ring resonator is composed of a silicon circular strip encompassing a metal disk in the center of ring cavity, leaving a gap between silicon and gold material [5].

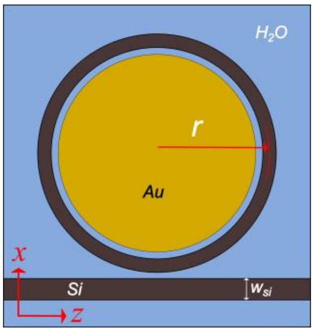

Fig. 1. Schematic of Au disk based hybrid plasmonic waveguide ring resonator with slot between silicon and Au disk.

The silicon ring radius from the center of silicon brick is ‘*r*’. The Au disk having radius of 4.84 µm and silicon strip in the ring portion having width of 200 nm. The metal layer has the same height as of silicon layer, and its separation from the silicon strip is 60 nm. The microring resonator is side-coupled with a regular 400 nm silicon ridge waveguide for resonance excitation.

3. Result and Discussion

The refractive indices of the fused silica, silicon, water and gold materials used in Fig. 1 at 1550 nm wavelength are 1.444, 3.477, 1.33 +1.2e − 4*i* and 0.55 + 11.5*i*, respectively. The TEM wave excitation is applied at the extreme-left-end of 400 nm silicon rectangular waveguide. The Finite Element Method (FEM) is applied in frequency domain to numerically calculate the coupling coefficient of this hybrid plasmonic ring waveguide structure. The coupling coefficient with respect to the wavelengths ranging from 1500 nm to 1600 nm is shown in Fig. 2.

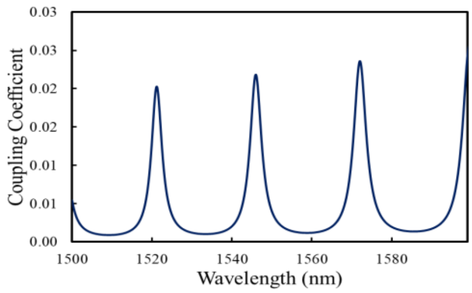

Fig. 2. Coupling coefficient of Au disk based hybrid plasmonic resonator.

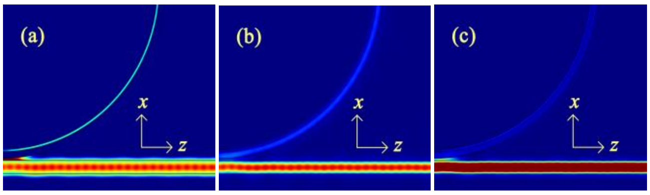

Fig. 3. (a) E-field; (b) H-field; and (c) Pointing vector distribution.

The resonance wavelength of 1521 nm, 1546 nm and 1571 nm are obtained for the defined geometry in Fig. 1. The distribution of electric and magnetic fields with corresponding pointing vector profile for resonance wavelength of 1546 nm is shown in Fig. 3. The nature of wave propagation inside the bulk-slotted Gold based hybrid plasmonic waveguide ring resonator can be easily analyzed from these results.

3. Conclusions

Gold disk based hybrid plasmonic ring resonator waveguide with a strip of silicon leaving a gap in between is analyzed successfully for its field propagation. The evaluated values of 3dB bandwidth, FSR, Finesse and Quality factor are 3.4nm, 25nm, 7.35 and 454.70 respectively.

References

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