Surface Plasmon Resonance for Sensing

Zhihong Chen, [1, 2*] and Chun Jiang[1]

[1] State Key Laboratory of Advanced Optical Communication System and Networks, Shanghai Jiao Tong University, Shanghai 200240, China

[2] College of Information, Mechanical & Electrical Engineering, Shanghai Normal University, Shanghai 201418, China

Abstract: **We design a structure consisting of Ag strip pair arrays embedded in the background material to achieve localized surface plasmon resonance. Numerical simulation shows that one of the transmission dips of the structure is very sensitive to the background materials, which can be used to achieve high performance sensors.**

When interacting with electromagnetic radiation the collective electronic oscillation in metal nanoparticles can generate localized surface plasmon resonance (LSPR) [1]. Such LSPR strongly depends on the size, shape, and surrounding dielectric environment of nanostructures. The latter dependence makes them especially attractive for refractive index sensing [2-3].

In this paper, we design a plasmonic structrue to achieve LSPR, where the structure consists of Ag strip pair arrays among the background material. Numerical simulation shows that one of the transmission dips for the structure is very sensitive to the background materials.

Fig.1 (a) shows the top view of the proposed plasmonic structure consisting of Ag strip pair arrays among the background material. Fig.1 (b) is the sectional view of the structure of x-z plane. The geometrical parameters are defined as in the figure: the Ag strip pair arrays with the length L_x and width L_y of the metal (Ag) block, in which the period of the metal block along x direction and y direction are d_x and d_y, respectively; The slits width and thickness of the Ag strip pair are W and H, respectively.

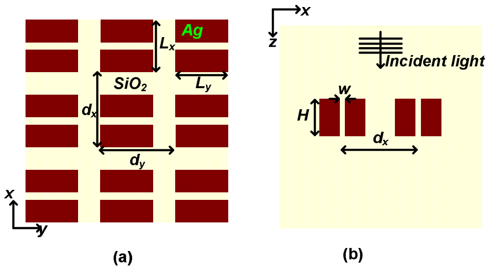

Figure1: (Color online). (a): top view of the Ag strip pair arrays structure. (b): the sectional view of the structure of x-z plane. Light propagates along z direction with the polarization along the x direction for TM mode.

We calculate the transmission spectra of Ag strip pair arrays structure among the background material of SiO_2 (refractive index n=1.5), using the finite-difference time-domain (FDTD) method [4] shown in Fig.2 (a). We also plot electric field intensity distributions of the structure (Fig.2 (b)). The computational domain consists of a single period of the structures with inhomogeneous mesh. We use the periodic boundary condition and perfect matched layer (PML) absorption boundary condition along the periodic direction and at the top and bottom boundaries, respectively. We describe the complex optical constants of metal Ag taking from experimental data [5]. Light propagates along z direction with the polarization along the x direction. For the structure, one Ag strip pair makes up a metal-dielectric-metal waveguide terminated by dielectric mirrors on both sides, and thus the array of Ag strip pairs form cavities that hold

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Fabry-Perot mode. Fig.2 (b) shows the localized surface plasmon mode between the Ag strip pair, and the energy distributes not only in the cavity, but also on the top and bottom surfaces of the Ag strips.

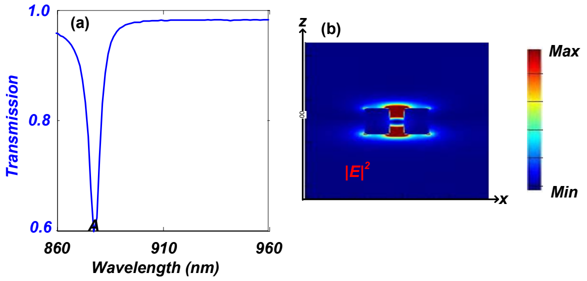

Figure2: (Color online). (a): Transmission spectra of the Ag strip pair arrays structure. (b): The electric field intensity distributions at the wavelength locations A marked in Fig.2 (a). (Lx= Ly=120nm, dx=dy =350nm, W= 30nm, H=120nm).

Meanwhile, one of the transmission dips is very sensitive to the background material; the structure may serve as a sensor. The parameters for the structure are same with Fig.2. Changes of the background material can be detected by measuring the shift of the sharp transmission dip. A clear shift of the transmission dip to longer wavelength is visible when the refractive index of the background materials increases from n=1.0 to n=2.0. The sensitivity (nm/RIU) of the structure is about 550nm/RIU.

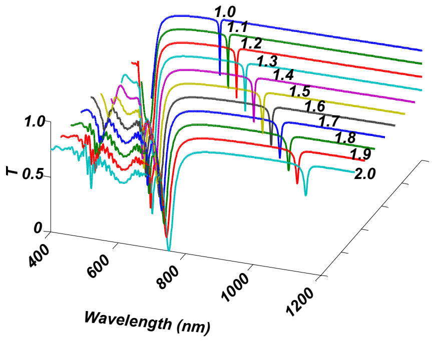

Fig.3 Electric Transmission spectra of the Ag strip pair arrays structure at different refractive index (Lx= L_y=120nm, d_x=d_y =350nm, W= 30nm, H=120nm).

In conclusion, we have explored a structure consisting of Ag strip pair arrays among the background material to achieve localized surface plasmon resonance. The simulated results indicated that one of the transmissions dips for the structure is very sensitive to the background material. The structure can be used to achieve high performance sensors. This will be a promising way for surface plasmon resonance applications toward sensing.

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