19a-C3-4

Isotropic perfect absorber in optical frequencies using vertical split-ring resonators

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1. Introduction

Plasmonic metamaterials are composed of artificial metamolecules exhibiting unusual optical properties such as negative refraction index, and toroidal dipolar response that can lead to applications that are otherwise unattainable in nature, such as sub-diffraction imaging, and optical and spectrum manipulation.

Split ring resonators (SRRs), commonly constructed building blocks of plasmonic metamaterials, have been proposed to produce electric as well as magnetic dipolar response. The dipolar response of such SRR structures can be excited by an incident wave with either electric field perpendicular to two prongs or the magnetic field passing through the gap of SRR. The benefits of making perfect absorber by SRRs are that this structure can confine both the electric field part and the magnetic field part of the energy of the incident light at the same time.

2. Results

Our structure consists of a gold mirror at the bottom, a dielectric layer in the middle and four vertical split-ring resonators (VSRR) on the top (Fig. 1). Then, by tuning the thickness of dielectric layer, we can get different strength of absorbance as the colormap shows in Fig. 2. According to the simulation result, a ultrahigh absorption intensity about 99.9 % can be approached by appropriate design.

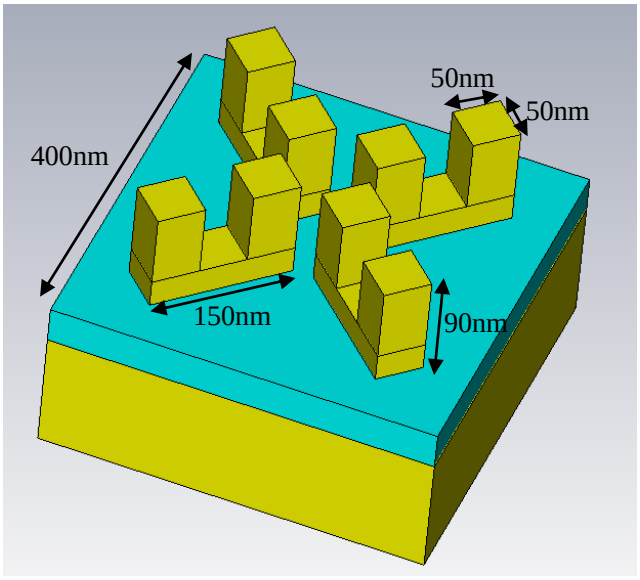

Figure 1. Schematic diagram for VSRR-based super absorber device. A unit cell composed of four VSRR structures with identical dimensions.

3. Conclusions

We demonstrate numerically a perfect absorber at optical region by VSRRs. An isotropic characteristic is observed by using symmetric arrangement of VSRR structures. Owning to the available to the confinement of electric as well as magnetic fields, the absorption can be approached to higher than 99% at normal incidence according simulation results. This work paves a way for a couple of potential applications, such as super absorber and plasmonic sensor with ultrahigh figure of merit (FOM).

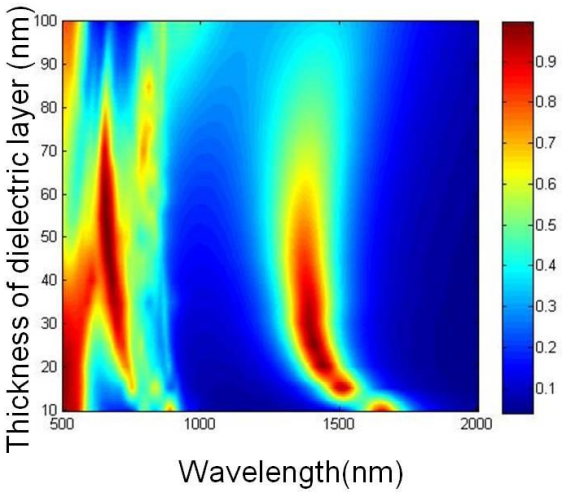

Figure 2. Absorption spectra for VSRR-based super absorber as a function of thickness of dielectric layer. A pronounced resonance peak associated magnetic dipolar response around 1.5 μm is recorded which can be employed for super absorber application in optical region.

References

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